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Study on Asbestos Waste Management Practices and Treatment Technologies

RPA Europe

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List of abbreviations and acronyms

ACM	Asbestos-Containing Material
ACP	Asbestos-Containing Product
ACW	Asbestos-Containing Waste
AWD	Asbestos at Work Directive
BMK	Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology
BRGM	Bureau of Geological and Mining Research/ *Bureau de recherches géologiques et minières*
C&D	Construction and Demolition
CAD	Chemical Agents Directive
CDW	Construction and Demolition Waste
CEAP	Circular Economy Action Plan
CEE	Collaboration for Environmental Evidence
CMRD	Carcinogens, Mutagens and Reprotoxic Substances Directive
CNRS	French National Centre for Scientific Research
COFRAC	French Accreditation Committee
CRM	Critical Raw Materials
CSH	Calcium Silicate Hydrate
CSTB	French Scientific and Technical Centre for Building
D.HY.VA	Destruction by hydrothermal means of bound asbestos and recovery of neo-products
DNV	Det Norske Veritas
DPD	Detailed Preliminary Design
EC	European Commission
EoW	End of Waste
EPEEF	Environmental Protection and Energy Efficiency Fund
EU	European Union
EWC	European Waste Catalogue
GHG	Greenhouse Gas
IOM	Institute of Occupational Medicine
ISPRA	Italian Institute for Protection and Environmental Research/*Istituto Superiore per la Protezione e la Ricerca Ambientale*
JATS	Waste Reporting Information System
LAGA M 23	Communication from the Federal/State Working Group on Waste 23/*Mitteilung der Bund/Länder-Arbeitsgemeinschaft Abfall 23*
LCA	Life Cycle Assessment
LoW	List of Wastes
MS	Member State
MTT	Microwave Thermal Treatment
NGO	Non-Governmental Organisation
NIMBY	Not In My Back Yard
OSH	Occupational Health and Safety
OVAM	Public Waste Agency of Flanders
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCDD/F	Dioxin And Furan
PDA	Pre-Demolition Audit
PLM	Polarized Light Microscopy
PMB	Purified Metal Block
PMC	Purified Metal Company

PPE	Personal Protective Equipment
PRDA	Asbestos Research and Development Plan
PVC	Polyvinyl Chloride
RC	Reinforced Concrete
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SEM	Scanning Electron Microscope
SHS	Self-Propagating High Temperature Synthesis
SLIC	Senior Labour Inspectors Committee
SOMEZ	Société Méditerranéenne des Zéolithes
TCCT	Thermochemical Conversion Technology
TCLP	Toxic Characteristic Leaching Procedure
TEM	Transmission electron microscopy
TES	Thermal Energy Storage
TRL	Technology Readiness Level
UK	United Kingdom
US	United States
VOC	Volatile Organic Compound
WFD	Waste Framework Directive

Abstract

The protection of workers and citizens from the health risks resulting from exposure to asbestos is a long-standing priority in the EU. At the same time, ambitious preparing for re-use and recycling targets might be set for construction and demolition waste, including potentially for demolition waste containing asbestos. The aim of this study was to investigate asbestos waste management practices and technologies. For this purpose, this study reviewed 112 scientific articles and grey literature reports published since 2018 and experts were consulted through two online surveys, and 18 semi-structured interviews. Preliminary findings were discussed during a workshop held in June 2023. Comprehensive asbestos waste statistics do not exist for all Member States, and only around half of them have issued guidance documents for asbestos waste management. Asbestos waste is mainly generated by renovation and demolition activities, with landfilling being the main disposal option. However, landfill capacity may become an issue for several Member States in coming years. Several recovery technologies are in the final stages of development or ready for industrial implementation but face regulatory and economic barriers.

Résumé

La protection des travailleurs et des citoyens contre les risques sanitaires résultant de l'exposition à l'amiante est une priorité de longue date de l'UE. Dans le même temps, d'ambitieux objectifs de préparation pour le réemploi et le recyclage pourraient être définis pour les déchets de construction et de démolition, y compris, éventuellement, les déchets de démolition contenant de l'amiante. Le but de la présente étude est d'examiner les pratiques et les technologies relatives à la gestion des déchets contenant de l'amiante. À cet effet, l'étude a examiné 112 articles scientifiques et rapports de littérature grise publiés depuis 2018 et des experts ont été consultés par le biais de deux enquêtes en ligne et 18 entretiens semi-directifs. Un atelier s'est tenu en juin 2023 afin de traiter des résultats préliminaires. Il n'existe pas de statistiques complètes sur les déchets d'amiante pour tous les États membres, et seulement la moitié d'entre eux environ ont publié des documents d'orientation sur la gestion des déchets d'amiante. Les déchets contenant de l'amiante proviennent généralement des activités de rénovation et de démolition, la principale option d'élimination étant l'enfouissement. Cependant, dans les années à venir, les capacités d'enfouissement risquent de devenir problématiques pour certains États membres. Plusieurs technologies de valorisation sont en phase finale de développement ou prêtes à être mises en œuvre, mais elles se heurtent à des obstacles réglementaires et économiques.

Executive Summary

In October 2021, the European Parliament called for a 'European strategy for the removal of all asbestos' to protect workers and citizens from health risks related to asbestos exposure. Construction works — including renovation and demolition activities — and management of construction and demolition waste pose the highest risk of exposure to asbestos, due to the widespread historical use of asbestos-containing products in the construction sector. Asbestos is a hazardous material, and most common treatment for its waste in the EU is landfilling. The EU is seeking to reduce the landfilling of construction and demolition waste and promote its re-use, preparing for re-use and recycling, according to the Waste Hierarchy set out in the Waste Framework Directive. It is expected that the quantities of demolition waste containing asbestos will increase in the coming years due to renovations and demolitions carried out in the context of the energy transition. Hence, it is important to ensure that the Waste Hierarchy is properly applied also to this hazardous waste stream, considering options to reduce its landfilling and promote its recycling into a non-hazardous mineral fraction. The purpose of this study was to assess whether established asbestos waste management practices were in line with the Waste Hierarchy and if existing or emerging treatment technologies may enable a reduction of landfilling and the promotion of recycling of hazardous waste fractions (which are rendered non-hazardous after treatment). The study required:

- The collection of statistics on asbestos waste at EU and Member State levels, including on main sources, and amounts generated, collected, imported and exported, treated and landfilled;
- The provision of trends and projections regarding asbestos waste generation and treatment up to 2050;
- The investigation of asbestos waste management in the EU and the identification of best practices;
- The mapping of existing and emerging asbestos waste treatment technologies, including the description of barriers to commercialisation, future perspectives, and opportunities for mainstreaming these technologies.

Information was extracted through the review of 112 scientific articles and grey literature reports — including deliverables of EU-funded projects — published since 2018. Experts were consulted through two online surveys and 17 semi-structured interviews. Preliminary findings were discussed during a workshop held in June 2023. The workshop and expert consultation had the purpose of obtaining the views of different stakeholders, complementing and cross-checking the information found in the literature and collecting information on the more advanced asbestos waste treatment technologies. Thematic analysis was applied for the interpretation of the interview results. Based on the findings, thirteen conclusions and five recommendations have been formulated:

Conclusion 1. Comprehensive and reliable data on asbestos waste generation, disposal and treatment does not exist for all Member States. EU-level statistics on asbestos waste are not collected; asbestos waste is reported to Eurostat together with other mineral waste every two years. Hence, understanding what quantities of asbestos-containing waste have already been generated in the EU is not possible, although some estimations can be made. Member States apply different methods for collecting and reporting data on asbestos waste, which makes it difficult to compare data.

Recommendation 1. There is a need for an **EU-level guidance or methodology for asbestos waste data collection and management** to ensure that data in Members States is consistent, coherent and reliable. Requiring Member States to report asbestos waste data to Eurostat separately from other mineral wastes would improve their quality and reliability.

Conclusion 2. The EU extensively consumed asbestos until the EU-wide ban, and most asbestos was incorporated in construction products used in buildings. Currently, those buildings represent a significant portion of in-use building stock. As a result, **asbestos waste is mostly generated by demolition and renovation works** of these buildings. Almost 97% of asbestos-containing waste is reported as 'construction materials containing asbestos', followed by 'insulation materials containing asbestos', making up 99% of all asbestos-containing waste generated in Member States over the last decade or more.

Conclusion 3. Based on estimates by the study team, only a fraction of asbestos has been removed from buildings in the EU. Large quantities of asbestos remain in public and residential buildings, which will eventually become waste. The 'Renovation Wave for Europe' strategy aims to at least double the rate of building renovation by 2030, extending to 2050, with a focus on deep renovations. Therefore, quantities of asbestos waste generated in Member States is expected to grow, considering that the renovation work for increasing energy efficiency in buildings is generally made on walls, roofing, floors, obsolete technical systems and electric installations of the building, where asbestos is most commonly found.

Conclusion 4. There are significant differences between Member States with regard to what triggers the requirement to screen for asbestos in buildings. The triggers include, for example, demolition, construction or renovation where asbestos exposure is likely to occur, any construction or renovation, change of ownership of the building, a rental agreement or a blanket requirement that all buildings must be screened for asbestos by a certain date. As a result, in some Member States, stakeholders (including building owners) have better knowledge about the presence of asbestos in buildings. This is in turn the first step to devise an adequate management plan.

Conclusion 5. Most Member States do not appear to have any specific targets or strategies for the removal of asbestos from buildings other than in cases of demolition (and renovation). Some countries provide or provided in the past financial assistance for asbestos removal, but such schemes tend to be limited in scope (e.g., funding asbestos removal from schools) and time. There are therefore limited incentives in some countries to remove asbestos containing materials from buildings other than in cases of demolition and renovation.

Conclusion 6. Currently, the main disposal option for asbestos waste is landfilling. Asbestos waste is typically accepted in hazardous waste landfills and/or in some non-hazardous waste landfills (depending on availability in the relevant Member State). The specific landfilling practices for non-hazardous waste landfills may differ across Member States and can include requirements on packaging of landfilled asbestos waste, sectors or cells in which it can be deposited, covering of these cells, etc.

Conclusion 7. Around half of the EU Member States have in place guidance documents for the management of asbestos waste. The availability of such a document makes it more likely that stakeholders are aware of the legal obligations and follow correct and good practice procedures when removing and disposing of asbestos-containing waste.

Recommendation 2. There is the need for **EU-level guidance on asbestos waste management,** including the option for recycling where and when the technologies exist. The description of best practices could be added to the EU construction and demolition waste management protocol and guidelines. Greater EU-level co-ordination and the promotion of best practices would ensure that Member States with no or less developed approaches benefit from Member States with more advanced practices in the identification and management of asbestos waste.

Conclusion 8. Landfill capacity may become an issue for a number of Member States. Estimations by the study team show that the remaining capacity in hazardous and non-hazardous waste landfills in some Member States is not sufficient for asbestos waste that is yet to be generated if all asbestos is to be removed from buildings over time. The estimations do not anticipate the increase in landfill capacity, but they show which countries would potentially need substantial expansion of their landfill capacity to allow for disposal of the remaining asbestos waste while avoiding long-distance transportation across the EU that is costly and polluting.

Conclusion 9. The asbestos waste recovery capacity in the EU is currently close to zero. There is only one industrial asbestos waste recovery facility, which uses thermal plasma vitrification and is licenced to treat 8,000 tonnes of asbestos waste per year. The cost of recovery is approximately 10-20 times higher than the average cost of disposal in the EU, and the technology is very energy intensive. Indeed, the facility works only for six months during summer to cope with energy prices. Its operation is therefore dependent on energy prices and comes with a large environmental footprint.

Conclusion 10. Research on asbestos waste treatment has mainly been focusing on thermal treatment, followed by chemical treatment technologies. The review of scientific publications showed that thermal treatment was the most investigated treatment technology, with only few studies on chemical treatment. However, the number of patents for chemical treatment technologies was close to that of thermal treatment processes. This shows that these two technologies are receiving the most attention from the scientific community.

Conclusion 11. Several asbestos waste treatment technologies are emerging in the EU with the potential to be implemented at industrial scale in the near future. Literature review and stakeholder consultation identified a number of treatment technologies that are likely to be implemented at industrial scale in some Member States in the next few years. However, providers of these technologies point to many barriers hindering implementation efforts, including the financial risks due to the large investments needed to build facilities (CAPEX), high costs of treatment (OPEX) and the regulatory environment.

Conclusion 12. Asbestos waste recovery and disposal operations have different environmental, social and economic impacts which should be carefully balanced. Landfilling is considered an established practice with well-tried and tested control of risks to human health and the environment. Nevertheless, the asbestos legacy remains and is left to future generations to deal with the landfill sites, where full safety cannot be guaranteed in perpetuity. Existing and emerging asbestos waste recovery technologies have different adverse environmental impacts, mainly linked to very high energy consumption. These negative environmental impacts should be balanced against the benefits arising from the production of secondary materials (and therefore increased circularity), the opportunity of mitigating pollutant and greenhouse gas emissions through abatement measures and, importantly, the destruction of asbestos fibres down to their limit of detection.

Conclusion 13. A number of measures may be implemented at the EU and Member State levels to boost the development and implementation of asbestos waste recycling solutions. These include fiscal incentives, certification of end products, standardisation of operations, dissemination of best practices, among others. The adoption or amendment of national legislation to allow the recycling of asbestos waste and the establishment of EU-wide criteria for what is considered a sustainable and technically feasible treatment solution can also play an important role.

Recommendation 3. The development of the **EU-level framework for 'end of waste' criteria for secondary materials obtained through the recovery of asbestos waste** could increase confidence in the end products and allow such products to move freely across the single market. This could be supplemented with standards for recovery operations that would ensure the reliability and safety of the process through regular testing, monitoring, record keeping and reporting.

Recommendation 4. The European Commission could consider **including recycled products or products with recycled content in Annex III of Directive 2006/112/EC on the common system of**

value added tax to allow the application of a reduced VAT. This could potentially increase the demand of products made of secondary materials, including materials recovered through the treatment of asbestos waste.

Recommendation 5. The European Commission could consider developing **evaluation criteria for asbestos waste treatment technologies** to support Member States in assessing whether a technology meets the general environmental protection principles as laid out in the Waste Framework Directive and other environmental legislation.

Résumé analytique

En octobre 2021, le Parlement européen a appelé à une « stratégie européenne pour le désamiantage » afin de protéger les travailleurs et les citoyens contre les risques sanitaires liés à l'exposition à l'amiante. Les travaux de construction — y compris les activités de rénovation et de démolition — ainsi que la gestion des déchets issus de la construction et de la démolition, présentent le risque le plus élevé d'exposition à l'amiante, en raison de l'utilisation historique généralisée de produits contenant de l'amiante dans le secteur de la construction. Dans l'UE, le traitement le plus répandu des déchets d'amiante est l'enfouissement. L'UE cherche à réduire l'enfouissement des déchets de construction et de démolition et à promouvoir leur réutilisation, leur préparation en vue du réemploi et du recyclage, conformément à la Hiérarchie des déchets, présentée dans la directive cadre sur les déchets. Les quantités de déchets de démolition contenant de l'amiante devraient augmenter dans les années à venir en raison des rénovations et des démolitions effectuées dans le cadre de la transition énergétique. Il importe donc de veiller à ce que la Hiérarchie des déchets soit correctement appliquée à ce flux de déchets dangereux, en envisageant des options permettant de réduire leur enfouissement et de promouvoir leur recyclage en une fraction minérale non dangereuse. L'objectif de cette étude était d'évaluer si les pratiques de gestion des déchets d'amiante étaient conformes à la Hiérarchie des déchets et si des technologies de traitement existantes ou émergentes pouvaient permettre de réduire l'enfouissement et de promouvoir le recyclage des fractions de déchets dangereux (devenus non dangereux après traitement). L'étude a nécessité :

- La collecte de statistiques sur les déchets contenant de l'amiante au niveau de l'UE et des États membres, y compris sur les sources principales et les quantités générées, collectées, importées et exportées, traitées et enfouies ;
- La fourniture de tendances et de projections concernant la génération et le traitement des déchets contenant de l'amiante jusqu'en 2050 ;
- L'examen de la gestion des déchets contenant de l'amiante au sein de l'UE et l'identification des meilleures pratiques ;
- La cartographie des technologies existantes et émergentes de traitement des déchets contenant de l'amiante, y compris la description des obstacles à la commercialisation, les perspectives et les opportunités d'intégration de ces technologies.

Les informations ont été extraites grâce à l'examen de 112 articles scientifiques et rapports de littérature grise — y compris des livrables de projets fondés par l'UE — publiés depuis 2018. Des experts ont été consultés par le biais de deux enquêtes en ligne et de 17 entretiens semi-directifs. Un atelier s'est tenu en juin 2023 afin de traiter des résultats préliminaires. L'atelier et la consultation d'experts avaient pour but de recueillir les points de vue des différentes parties prenantes, de compléter et de recouper les informations trouvées dans la littérature et de collecter des informations sur les technologies de traitement les plus avancées concernant les déchets contenant de l'amiante. Les résultats des entretiens ont été interprétés selon une analyse thématique. Treize conclusions et cinq recommandations ont été formulées sur la base des résultats :

Conclusion 1. Il n'existe pas de données exhaustives et fiables sur la production, l'élimination et le traitement des déchets contenant de l'amiante dans tous les États membres. Aucune statistique n'est collectée au niveau de l'UE sur les déchets contenant de l'amiante ; ceux-ci sont communiqués à Eurostat tous les deux ans, en même temps que les statistiques relatives aux autres déchets minéraux. C'est pourquoi il n'est pas possible de savoir quelles quantités de déchets contenant de l'amiante ont déjà été produites au sein de l'UE, bien que certaines estimations puissent être faites. Les États membres appliquent différentes méthodes pour la collecte et la communication des données sur les déchets contenant de l'amiante, ce qui rend difficile la comparaison des données.

Recommandation 1. Il est nécessaire de disposer d'une **orientation ou d'une méthodologie au niveau de l'UE pour la collecte et la gestion des données** afin de garantir que les données des États membres sont cohérentes, homogènes et fiables. Obliger les États membres à communiquer à Eurostat des données sur les déchets contenant de l'amiante séparément des autres déchets minéraux améliorerait la qualité et la fiabilité de ces données.

Conclusion 2. Jusqu'à l'interdiction de l'amiante au sein de l'UE en 2005, les États membres consommaient beaucoup d'amiante, dont la majeure partie était incorporée dans des matériaux de construction. C'est pourquoi **les déchets d'amiante sont principalement générés par les travaux de démolition et de rénovation.** Presque 97 % des déchets d'amiante sont déclarés comme « matériaux de constructions contenant de l'amiante », et 2 % supplémentaires signalés comme « matériaux d'isolation contenant de l'amiante », ce qui représente 99 % de tous les déchets contenant de l'amiante générés dans les États membres pendant les dix dernières années ou plus.

Conclusion 3. D'après les estimations de l'équipe chargée de l'étude, seule une fraction de l'amiante a été retirée des bâtiments dans l'UE. De grandes quantités d'amiante subsistent dans les bâtiments publics et résidentiels et sont voués à finir sous forme de déchets. La stratégie « Vague de rénovation pour l'Europe » vise à doubler, voire plus, le taux de rénovation de bâtiments d'ici à 2030 et jusqu'en 2050, en mettant l'accent sur les rénovations profondes. Par conséquent, les quantités de déchets contenant de l'amiante produites dans les États membres devraient augmenter, étant donné que les travaux de rénovation visant à accroître l'efficacité énergétique des bâtiments sont généralement effectués sur les murs, les toitures, les sols, ainsi que sur les systèmes techniques et installations électriques obsolètes, où l'amiante est le plus souvent présent.

Conclusion 4. Il existe des différences significatives entre les États membres en ce qui concerne les éléments qui déclenchent l'obligation de rechercher l'amiante dans les bâtiments. Ces déclencheurs incluent, par exemple, la démolition, la construction ou la rénovation au cours desquelles une exposition à l'amiante est susceptible de se produire ; toute construction ou rénovation ; le changement de propriétaire d'un bâtiment ; un contrat de location ou une exigence générale selon laquelle tous les bâtiments doivent faire l'objet d'un dépistage de l'amiante avant une certaine date. Par conséquent, dans certains États membres, les parties prenantes (y compris les propriétaires de bâtiments) sont mieux renseignées sur la présence d'amiante dans les bâtiments. C'est donc une première étape pour élaborer un plan de gestion adéquat.

Conclusion 5. La plupart des États membres ne semblent pas avoir d'objectifs ou de stratégies spécifiques de retrait de l'amiante des bâtiments en dehors des cas de démolition (et de rénovation). Certains pays fournissent, ou ont fourni par le passé, une aide financière pour le désamiantage, mais ces programmes ont tendance à être limités dans leur portée (par exemple, le financement du désamiantage des écoles) et dans le temps. Dans certains pays, les incitations à retirer les matériaux contenant de l'amiante des bâtiments sont donc limitées, sauf dans les cas de démolition et de rénovation.

Conclusion 6. Actuellement, la principale option d'élimination de déchets contenant de l'amiante est l'enfouissement. Les déchets contenant de l'amiante sont généralement acceptés dans les décharges pour déchets dangereux et/ou dans certaines décharges pour déchets non dangereux (en fonction de la disponibilité dans les États membres concernés). Les pratiques spécifiques d'enfouissement des déchets non dangereux varient selon les États membres et peuvent inclure des exigences concernant le conditionnement des déchets contenant de l'amiante destinés à l'enfouissement, les secteurs ou les cellules dans lesquels ils peuvent être déposés, le revêtement de ces cellules, etc.

Conclusion 7. Environ la moitié des États membres de l'UE ont mis en place des documents d'information pour la gestion des déchets contenant de l'amiante. La disponibilité d'un tel document augmente les chances que les parties prenantes soient conscientes des obligations légales et respectent les procédures correctes et les bonnes pratiques lors du retrait et de l'élimination des déchets contenant de l'amiante.

Recommandation 2. Il est nécessaire d'**élaborer des orientations au niveau de l'UE sur la gestion des déchets contenant de l'amiante,** y compris l'option du recyclage lorsque les technologies existent. La description des meilleures pratiques pourrait être ajoutée au protocole et aux lignes directrices sur la gestion des déchets de construction et de démolition. Une meilleure coordination au niveau de l'UE et la promotion des meilleures pratiques permettraient aux États membres dont les approches sont peu ou pas développées de bénéficier de celles des États membres dont les pratiques sont plus avancées en matière d'identification et de gestion des déchets contenant de l'amiante.

Conclusion 8. La capacité d'enfouissement risque de devenir un problème pour un certain nombre d'États membres. Les estimations de l'équipe chargée de l'étude montrent que, dans certains États membres, la capacité restante des décharges pour déchets dangereux et non dangereux est insuffisante pour les déchets contenant de l'amiante qui seront générés si tout l'amiante doit être retiré des bâtiments au fil du temps. Les estimations n'anticipent pas l'augmentation des capacités d'enfouissement, mais elles montrent quels pays auraient besoin d'une expansion substantielle de leurs capacités d'enfouissement pour permettre l'élimination des déchets d'amiante restants, tout en évitant le transport à longue distance à travers l'UE, qui est coûteux et polluant.

Conclusion 9. Dans l'UE, la capacité de valorisation des déchets contenant de l'amiante est actuellement quasi inexistante. Il n'existe qu'une seule installation industrielle de valorisation des déchets d'amiante, qui utilise la vitrification par torche à plasma et est habilitée à traiter 8 000 tonnes de déchets d'amiante par an. Le coût de la valorisation est environ 10 à 20 fois supérieur au coût moyen d'élimination dans l'UE et cette technologie consomme beaucoup d'énergie. En effet, l'installation ne fonctionne que durant les six mois d'été afin de faire face aux prix de l'énergie. Son coût est donc dépendant des prix de l'énergie et s'accompagne d'une forte empreinte environnementale.

Conclusion 10. La recherche sur le traitement des déchets d'amiante s'est concentrée principalement sur le traitement thermique, suivi par les technologies de traitement chimique. L'examen des publications scientifiques a montré que la technologie de traitement la plus étudiée était le traitement thermique, le traitement chimique n'ayant fait l'objet que de quelques études. Cependant, le nombre de brevets pour les technologies de traitement chimique était proche de celui des procédés de traitement thermique. Cela montre que ce sont ces deux technologies qui reçoivent le plus d'attention de la communauté scientifique.

Conclusion 11. Plusieurs technologies de traitement des déchets contenant de l'amiante apparaissent dans l'UE et pourraient être mises en œuvre à l'échelle industrielle dans un avenir proche. L'analyse documentaire et la consultation des parties prenantes ont permis d'identifier un certain nombre de technologies de traitement susceptibles d'être mises en œuvre à l'échelle industrielle dans certains États membres au cours des prochaines années. Toutefois, les fournisseurs de ces technologies signalent que de nombreux obstacles entravent les efforts de mise en œuvre, notamment les risques financiers dus aux investissements importants nécessaires à la construction des installations (CAPEX), les coûts élevés du traitement (OPEX) et l'environnement réglementaire.

Conclusion 12. Les opérations de valorisation et d'élimination des déchets contenant de l'amiante ont des impacts environnementaux, sociaux et économiques différents, qu'il convient d'équilibrer avec soin. L'enfouissement est considéré comme une pratique établie, avec un contrôle éprouvé des risques pour la santé humaine et l'environnement. Néanmoins, l'héritage de l'amiante demeure et est laissé aux générations futures qui devront s'occuper des sites d'enfouissement, où la sécurité totale ne peut être garantie à perpétuité. Qu'elles soient existantes ou émergentes, les technologies de valorisation des déchets contenant de l'amiante, ont différents impacts environnementaux négatifs, la plupart liés à une haute consommation énergétique. Ces incidences négatives sur l'environnement doivent être mises en balance avec les avantages découlant de la production de matériaux secondaires (et donc d'une circularité accrue), de la possibilité d'atténuer les émissions de polluants et de gaz à effet de serre grâce à des mesures de réduction et, surtout, de la destruction des fibres d'amiante jusqu'à leur limite de détection.

Conclusion 13. Un certain nombre de mesures peuvent être mises en œuvre au niveau de l'UE et des États membres afin de stimuler le développement et la mise en œuvre des solutions de recyclage des déchets contenant de l'amiante. Celles-ci incluent entre autres des incitations fiscales, la certification des produits finis, la standardisation des opérations, la diffusion des meilleures pratiques. L'adoption ou la modification de la législation nationale afin de permettre le recyclage des déchets contenant de l'amiante et l'établissement de critères à l'échelle de l'UE concernant ce qui est considéré comme une solution de traitement durable et techniquement réalisable peuvent également jouer un rôle important.

Recommandation 3. L'élaboration, **au niveau de l'UE, d'un cadre pour les critères de « fin de traitement » des matériaux secondaires obtenus par la valorisation des déchets contenant de l'amiante** pourrait accroître la confiance dans les produits finis et permettre à ces produits de circuler librement dans le marché unique. Ces normes pourraient être complétées par des normes relatives aux opérations de valorisation qui assureraient la fiabilité et la sécurité du processus par le biais de tests, de contrôles, d'enregistrements et de rapports réguliers.

Recommandation 4. La Commission européenne pourrait envisager **d'inclure les produits recyclés ou à contenu recyclé dans l'annexe III de la Directive 2006/112/CE relative au système commun de taxe sur la valeur ajoutée** afin de permettre l'application d'une TVA réduite. Cela pourrait augmenter la demande de produits fabriqués à partir de matériaux secondaires, y compris des matériaux valorisés par le traitement des déchets contenant de l'amiante.

Recommandation 5. La Commission européenne pourrait envisager de développer **des critères d'évaluation pour les technologies de traitement des déchets contenant de l'amiante** afin d'aider les États membres à évaluer si une technologie répond aux principes généraux de protection de l'environnement, tels qu'ils sont définis dans la directive cadre sur les déchets et dans d'autres législations environnementales.

1 Introduction and structure of the report

In November 2022, RPA Europe, RPA Prague, the Danish Technological Institute (DTI) and ARCADIS were commissioned a study to investigate 'asbestos waste management practices and technologies in Europe and beyond'. The purpose was to verify whether the waste hierarchy is applied — or could be applied — to this hazardous waste stream according to the mandate established by Article 11(6) of the 2018 amendment to Directive 2008/98/EC (the Waste Framework Directive or WFD). The study also assesses the potential for reducing landfilling and increasing recycling of asbestos waste rendered inert, also through the gaps assessment of asbestos waste management in Europe.

This report presents the findings of the study. More precisely:

- Section 2 lays out the methodology used for the literature review and the stakeholder consultation.
- Section 3 presents the findings of the literature review and the stakeholder consultation on asbestos waste generation in the European Union (EU). It looks at the main sources of asbestos waste, the generation, disposal, imports and exports of asbestos waste in all Member States, and trends and projections of future generation of asbestos waste.
- Section 4 presents the findings of the literature review and the stakeholder consultation on the asbestos waste management practices and legislation in the EU and proposes the best practice for asbestos waste management.
- Section 5 presents an overview of the existing and emerging asbestos waste treatment technologies, including disposing of asbestos waste in landfills. The section also reviews asbestos waste treatment technologies under research. The existing and emerging asbestos waste treatment technologies are compared on the basis of their environmental, social and economic impacts.
- Section 6 analyses how asbestos waste management, including recycling, can be improved. It reviews barriers that hinder the commercialisation of asbestos waste treatment technologies, and opportunities that may help to improve the recycling of asbestos-containing waste. The section also proposes measures to improve the management of asbestos waste in the EU.
- Section 7 provides a foresight analysis on the potential for future development and implementation of asbestos treatment technologies.
- Section 8 provides conclusions and recommendations.

2 Methodology

2.1 Literature review strategy

The investigation has been guided by the following research questions:

- RQ1: What is the current situation of asbestos waste management in the EU and what are the future trends and projections?
- RQ2: What are the gaps in EU legislation on asbestos waste management?
- RQ3: What are the existing asbestos waste treatment/disposal installations in Member States, their treatment/disposal costs and capacities?
- RQ4: What are the existing and emerging asbestos waste treatment technologies and what are their environmental, social and economic impacts?
- RQ5: How can the current asbestos waste management practices, including recycling, be improved?
- RQ6: What is the potential for future development and implementation of asbestos treatment technologies and the feasibility for restriction of asbestos waste disposal to landfill (*Foresight analysis*)?

RQ1: What is the current situation with regard to asbestos waste management in the EU and what are the future trends and projections?

The first part of the question looked at asbestos waste statistics and management practices in each Member State (MS). To ensure that the most relevant and accurate information was collected, the search was carried out in the language of each MS.

Statistics on asbestos waste are not available at EU level. Eurostat holds data on waste generation and treatment by waste category. However, quantities of asbestos waste are aggregated with other mineral wastes (items 42 and 43 of Regulation No 2150/2002 on waste statistics[1]), which include waste codes 12.2 (asbestos waste), 12.3 (waste of naturally occurring minerals) and 12.5 (various mineral wastes), as per the 'Guidance on classification of waste according to EWC-Stat categories'.[2] Exchanges with Eurostat have confirmed that it is very difficult to determine how much of it is asbestos, how much of it corresponds to construction and demolition waste (CDW) and which part to other uses (automotive sector, packaging, equipment, insulation, etc.).

Therefore, the search focused on statistics available on competent authorities' websites, in the format of annual waste reports, other type of reports, databases, etc. This has ensured that the information is the most accurate, reliable and recent. Only when the information on the competent authority's website could not be identified or waste statistics were incomplete (e.g., categorisation of asbestos waste by European List of Wastes (LoW) or any other classification system not available), the search was performed on Google search engine using predefined search criteria. Finally, when good quality statistics on asbestos waste could not be identified via search on Google, the study team contacted the competent authorities of the relevant country to obtain the necessary data.

Statistics on **shipments of waste** from Eurostat have also been analysed to understand the exports and imports of waste containing asbestos by Member States. Waste streams assigned category Y36 -

[1] European Parliament (2002). Regulation (EC) No 2150/2002 of the European Parliament and of the Council of 25 November 2002 on waste statistics. *Official Journal of the European Union*, 332. https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32002R2150.

[2] Eurostat (2010). *Guidance on classification of waste according to EWC-Stat categories.* https://ec.europa.eu/eurostat/documents/342366/351806/Guidance-on-EWCStat-categories-2010.pdf/0e7cd3fc-c05c-47a7-818f-1c2421e55604.

Asbestos (dust and fibres) as per Annex I of the Basel Convention as well as European waste codes relevant to asbestos waste (06 07 01*, 06 13 04*, 10 13 09*, 15 01 11*, 16 01 11*, 16 02 12*, 17 06 01*, 17 06 05*) have been investigated.

The methodology for estimating **future trends and projections** is presented in Annex 2. The estimates also looked at the remaining capacity of landfills in Member States and what proportion of the remaining capacity may need to be used for disposing of asbestos waste that is yet to be generated.

To search for **management practices** in each Member State, the study team looked for documents such as guidelines, good/best practices, rulebooks and/or instructions covering all asbestos waste management steps, such as removal, collection, transportation, storage, treatment and/or disposal. The information on environmental considerations and health and safety precautions was also sought. Identified documents were screened by the study team to identify what steps of asbestos waste management were covered in the document.

To identify **best practices**, the study team used the theory of 'smart practices' by Bardach[3], often applied in policy research. According to Bardach (2004), smart practices cover smart or interesting ideas that 'work' in a particular domain and exploit the available resources and opportunities in an inventive way. Therefore, 'smartness' and applicability of the practice are the focus of evaluation. Bardach's 'smart practices' approach has been applied in various sectors for the analysis of policies, services, etc. Based on Bardach's theory, Ongaro[4] developed a protocol for the evaluation of 'smart practices' that will be used in this study. Figure 2-1 provides an overview of the main steps in the evaluation of smart practices.

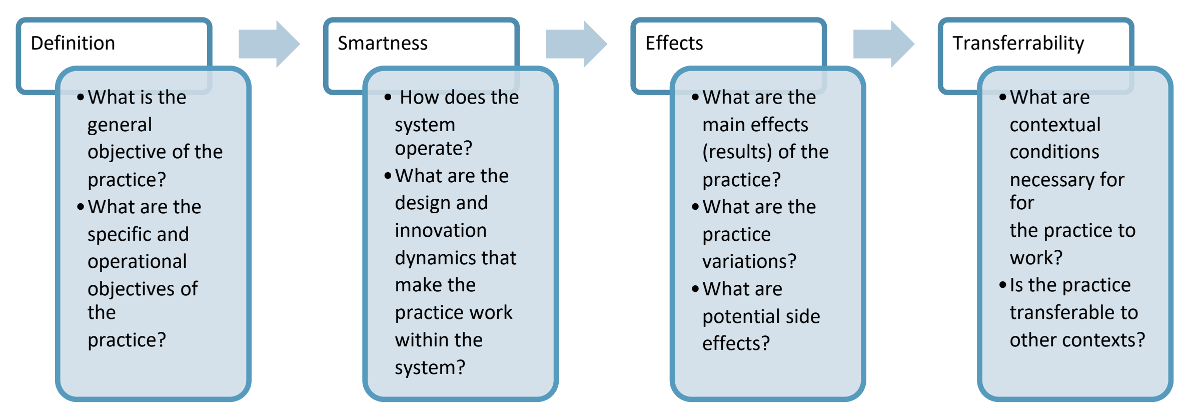

Figure 2-1: Identification of smart practices, adopted from Ongaro, 2009[5]

As shown in Figure 2-1, the Ongaro protocol contains four stages:

1. In the first stage 'Definition', the function (i.e., what the practice is designed for) is determined for all collected practices. It enables the grouping of practices according to their functions.

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[3] Bardach, E. (2004). The extrapolation problem: How can we learn from the experience of others? *Journal of Policy Analysis and Management, 23*(2), 205-220.

[4] A protocol developed for the evaluation of 'smart practices', which will be used in this study to identify best practices. Based on: Ongaro, E. (2009). A protocol for the extrapolation of 'best' practices: How to draw lessons from one experience to improve public management in another situation. In European Public Sector Award 2009, Final Symposium and Ceremony, Maastricht. http://epsa2009.eu/files/Symposium/An%20approach%20to%20the%20extrapolation%20of%20practices_EOngaro.pdf.

[5] Ibid.

2. In the second stage 'Smartness', the features that make the practice smart or best are defined along with the context in which the practice occurs.

3. Following the description of smartness and its context, the 'Effects' of the practice are identified. They cover intended effects (i.e., the results that the practice is supposed to achieve) and possible deviations from the expected results in terms of variation in implementation (e.g., breakdowns during implementation or satisfactory implementation). Then possible side effects are identified, and the likeliness of negative outcomes is evaluated.

4. Finally, the 'Transferability' stage involves reflecting on how much a practice depends on specific political, technical, social, cultural, economic and other conditions and whether it could be successfully transferred to other settings.

The study team converted the Ongaro protocol into a quantitative best practices checklist with a scoring system for each element. A quantitative score has been assigned to the criteria 'smartness', 'effectiveness' and 'transferability' on a scale from 0 to 3, where 0 corresponds to insufficient performance and 3 corresponds to the best performance. For instance, the element "transferability" of a practice can be rated as 0 – the practice cannot be used by authorities and stakeholders in other countries; 1 – the practice can be used only by authorities and stakeholders of a limited group of countries under specific conditions; or 3 – the practice can be transferred to authorities and stakeholders of other countries.

RQ2: What are the gaps in EU legislation on asbestos waste management?

The work included a summary of the relevant EU legislation and the development of an overview of national practices in EU Member States. These two steps were seen as a useful starting point for further discussions on the obstacles and potential opportunities to increase the recycling of the relevant wastes. The key sources of information on national legislation, guidance and practices included the consultation exercise for this study, legislation, guidance documents and other literature identified through desk research and other sources of information, including the European Commission's (EC) survey called 'Exposure to asbestos in buildings' (July 2022).

RQ3: What are the existing asbestos waste treatment/disposal installations in Member States, their treatment/disposal costs and capacities?

The search of asbestos waste disposal facilities was carried out using predefined search criteria. The study team aimed to identify the information on asbestos disposal facilities by searching the waste section of the competent authority's website. Around half of the Member States had information on asbestos waste disposal installations, although only a handful had some information on capacities of such installations or costs for disposing of asbestos-containing waste (ACW). Several countries provided maps or lists of disposal installations through different sources including competent national or regional authorities' websites, waste management plans/reports, environment agencies, national and regional cadastre and mapping authorities, and research institutions. However, a comprehensive picture of all disposal installations accepting ACW, their capacities and costs could not be drawn. Nevertheless, for countries where such information is available and accessible, the information has been provided in the 'Country factsheets' listed in Annex 1.

RQ4: What are the existing and emerging asbestos waste treatment technologies and what are their environmental, social and economic impacts?

A literature review was carried out to identify existing and emerging asbestos waste treatment technologies. An initial search was performed to answer the first part of the research question, i.e., to identify existing and emerging asbestos waste treatment technologies. The second part of the question was answered when such technologies were identified, i.e., by looking for further information on each technology through literature review and stakeholder consultation.

Asbestos waste treatment technologies have been reviewed by several reports and academic papers (listed in the table below). These literature sources cover technologies that have been investigated and/or used to treat asbestos waste up to 2018. Hence, the literature search has focused on technologies that are being researched or have been implemented since 2018. However, the searches on two grey literature sources – EU Cordis and EC Life Public Database – have not been restricted to a date range. The purpose of this was to check what technologies had been supported by the European Union, which ones took off and are currently being applied for the treatment of asbestos waste, and which technologies did not mature (and why).

Table 2-1: List of literature sources on asbestos waste treatment technologies

Author	Year	Name of the publication	Type of publication
OVAM	2016	State of the art: asbestos – possible treatment methods in Flanders: constraints and opportunities.[6]	Report
Spasiano, D., & Pirozzi, F. J. J. O. E. M.	2017	Treatments of asbestos containing wastes[7]	Peer-review publication
Bureau KLB	2018	Practicable sustainable options for asbestos waste treatment[8]	Report
Paolini, V., Tomassetti, L., Segreto, M., Borin, D., Liotta, F., Torre, M., & Petracchini, F.	2018	Asbestos treatment technologies[9]	Peer-review publication

For evidence synthesis, we have used a rapid review, based on the systematic review in environmental management developed by the Collaboration for Environmental Evidence (CEE)[10]. Rapid Review is a methodology that utilises components and standards of a systematic review where possible and has been developed for time sensitive evidence synthesis. In rapid reviews, methods of systematic review are typically adapted to take less than six months and are more relevant to short timescales demanded by some 'policy windows' and emergency decision-making. The literature search looked at academic publications and grey literature sources. The data sources are presented in the table below.

Table 2-2: List of literature sources on asbestos waste treatment technologies

Literature/Data type	Data sources
Grey literature	EU Cordis EC Life Public Database Lens Espacenet Google Snowballing from reference lists
Peer-reviewed research publications	Dimensions Snowballing from reference lists

[6] OVAM (2016). *State of the art: asbestos – possible treatment methods in Flanders: constraints and opportunities.* https://www.dnature.nl/wp-content/uploads/2020/07/State-of-the-art-asbestos-waste-treatement.pdf.

[7] Spasiano, D., & Pirozzi, F. J. J. O. E. M. (2017). Treatments of asbestos containing wastes. *Journal of environmental management*, *204*, 82-91.

[8] Bureau KLB (2018). *Practicable sustainable options for asbestos waste treatment.* https://www.asbeter.com/documents/KLB%20assessment-of-asbestos-waste-treatment-techniques.pdf.

[9] Paolini, V., Tomassetti, L., Segreto, M., Borin, D., Liotta, F., Torre, M., & Petracchini, F. (2019). Asbestos treatment technologies. *Journal of Material Cycles and Waste Management*, *21*(2), 205-226.

[10] Collaboration for Environmental Evidence (2022). *Guidelines and Standards for Evidence Synthesis in Environmental Management.* https://environmentalevidence.org/information-for-authors/.

The identified articles were screened against predetermined eligibility criteria, which are presented in the table below.

Table 2-3: Inclusion/eligibility criteria. Adapted from: CEE, 2022[11]			
Population	**Intervention/Effect**	**Comparator**	**Outcome**
Asbestos waste	Treatment	No treatment	Non-hazardous material
All types of asbestos waste: building materials containing asbestos, asbestos cement, brake pads, pipes containing asbestos, etc.	All types of treatment and pre-treatment: thermal, chemical, biological, mechanical, thermochemical, biochemical, mechanochemical, etc., excluding landfilling without any pre-treatment	Landfilling without pre-treatment	Non-hazardous waste, recyclates, non-hazardous end-products

The search strategy has been carefully planned to ensure that most relevant studies are found. The initial search terms have been generated from the research question elements and by looking at the review articles and reports listed in the Table 2-1. In addition, identifying search terms for building the search string also required drawing upon the analysis of titles and abstracts of already identified publications on asbestos waste treatment technologies to consider how authors might use different terminologies to describe their research. Search terms used in the search string are presented in the table below together with Boolean operators.

Table 2-4: Search terms					
	Term 1	**AND**	**Term 2**	**AND**	**Term 3**
	asbestos waste		treatment		technique
OR	asbestos containing	OR	pretreatment	OR	technology
OR	containing asbestos	OR	pre-treatment	OR	process
OR	asbestos cement	OR	recycling		
OR	cement asbestos	OR	destruction		
		OR	stabilisation		
		OR	stabilization		
		OR	inertisation		
		OR	inertization		
		OR	deterioration		

The following search string has been created for searching peer-reviewed publications and grey literature sources:

("asbestos waste" OR "asbestos containing" OR "containing asbestos" OR "asbestos cement" OR "cement asbestos") AND (treatment OR pretreatment OR pre-treatment OR recycling OR destruction OR stabilisation OR stabilization OR inertisation OR inertization OR deterioration) AND (technique OR technology OR process)

The search for peer-reviewed publications has been carried out in Dimensions. The overview of the search results can be found in Table 2-5. The screening of the search results followed the process shown in Figure 2-2. First, articles were screened at title and abstract level against predetermined inclusion criteria (Table 2-4). The remaining articles were screened at full text and all full text exclusions were reported with reasons, i.e., which inclusion criteria the article did not meet.

[11] Ibid.

Unobtainable articles were also logged. In total, 51 peer-reviewed publications met the inclusion criteria.

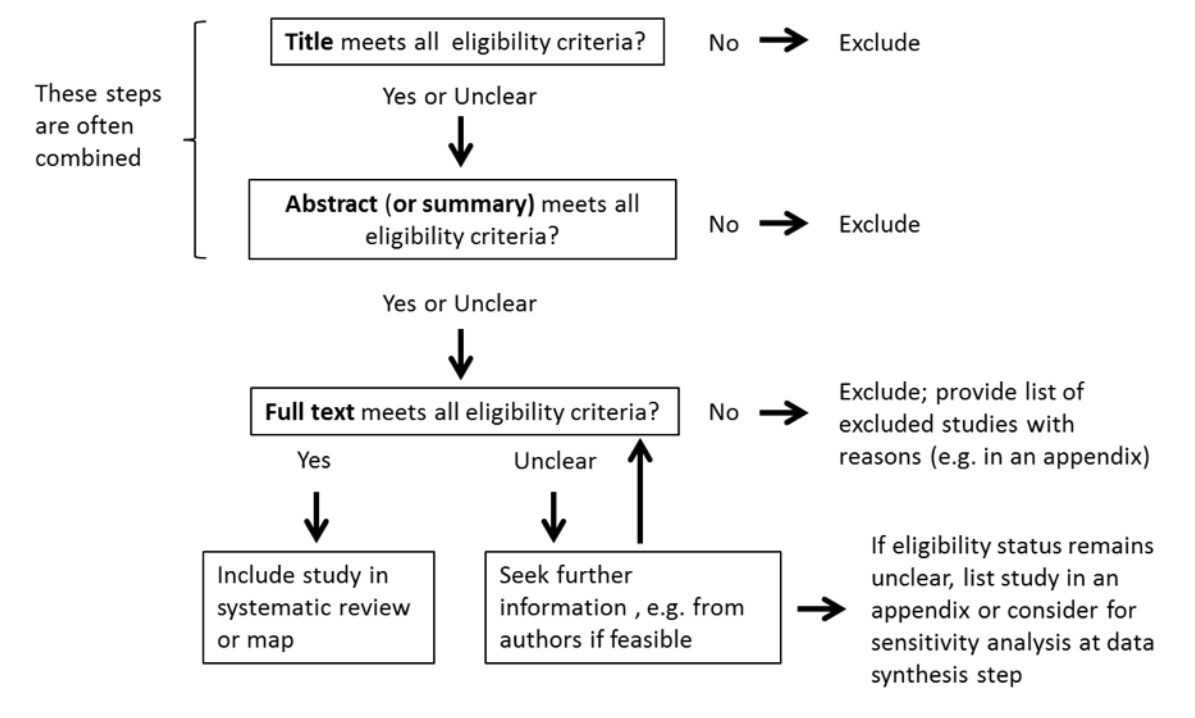

Figure 2-2: The eligibility screening process for Systematic Reviews or Systematic Maps. Source: CEE, 2022

The search for grey literature sources was carried out in Google and two European databases. For the search in Google, the same search string and the date range were used as for peer-reviewed publications. However, the search was limited to PDF file type to ensure that only grey literature with the highest level of publication control and credibility (1st tier publications) were found and included (Figure 2-3). Nevertheless, the screening of search results in Google showed that the majority of literature sources were not relevant and did not meet the inclusion criteria. After screening against the inclusion criteria, only seven relevant grey literature sources were taken for further analysis.

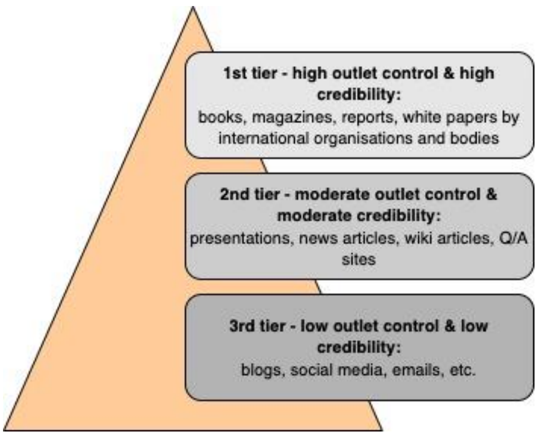

Figure 2-3: Classification of grey literature sources by outlet control and credibility according to Garousi et al. (2019)[12]

[12] Garousi, V., Felderer, M., & Mäntylä, M. V. (2019). Guidelines for including grey literature and conducting multivocal literature reviews in software engineering. *Information and Software Technology, 106,* 101-121.

Relevant EU funded past and current research projects on asbestos waste treatment technologies have been searched for in the EU CORDIS database and in the EC LIFE projects database. The same search string was used in the EU Cordis database. However, due to a different language for searching, the search string had to be adapted for EC LIFE projects database (as seen in Table 2-5). The search found 17 results in the CORDIS database, while 20 results have been identified in the LIFE project database. The search was also carried out using a simplified search string 'asbestos AND waste', which returned more results (46 in CORDIS and 21 in EC LIFE). However, the initial screening revealed that most search results did not match the inclusion criteria and were not relevant for asbestos waste treatment. Searching for projects with more refined search strategy returned fewer, but more relevant results.

The screening of the results showed that most projects were relatively old, ranging from 1993 to 2015 in the EU Cordis database and from 1996 to 2020 in the EC LIFE projects database. After screening against the inclusion criteria, 7 EU Cordis projects and 3 EC LIFE projects were taken for further analysis.

Finally, patents on asbestos waste treatment technologies were searched on Lens and Espacenet platforms using the same search string as for peer-reviewed publications. The search identified 835 patents on Espacenet and 264 patents on Lens (see Table 2-5). After the results were screened against the inclusion criteria and duplicates were removed, the total of 44 patents were taken for further analysis, 29 from Espacenet and 15 from Lens.

The search on Google engine returned 173 results, seven of which were relevant for the study. The results included: four scientific papers, one journal article, a guide on asbestos waste management and a company website.

Table 2-5: Search results for peer-reviewed research publications and grey literature						
Search	**Literature type**	**Database**	**Search string**	**Search options**	**Search results**	**After screening**
1	Peer-reviewed publications	Dimensions	("asbestos waste" OR "asbestos containing" OR "containing asbestos" OR "asbestos cement" OR "cement asbestos") AND (treatment OR pretreatment OR pre-treatment OR recycling OR destruction OR stabilisation OR stabilization OR inertisation OR inertization OR deterioration) AND (technique OR technology OR process)	Search in: Full data Date range: 2018-2023 Fields of research: 40 Engineering OR 33 Built Environment and Design OR 41 Environmental Sciences OR 37 Earth Sciences OR 34 Chemical Sciences	2,056	51
3	Grey literature	Google	("asbestos waste" OR "asbestos containing" OR "containing asbestos" OR "asbestos cement" OR "cement asbestos") AND (treatment OR pretreatment OR pre-treatment OR recycling OR destruction OR stabilisation OR stabilization OR inertisation OR inertization OR deterioration) AND (technique OR technology OR process)	Date range: 01/01/2018 – 07/04/2023 File type: PDF	173	7
2	Grey literature	EU Cordis	("asbestos waste" OR "asbestos containing" OR "containing asbestos" OR "asbestos cement" OR "cement asbestos") AND (treatment OR pretreatment OR pre-treatment OR recycling OR destruction OR stabilisation OR stabilization OR inertisation OR inertization OR deterioration) AND (technique OR technology OR process)	Date range: no date restrictions	17	7
3	Grey literature	EC LIFE Public Database	asbestos AND waste AND (treatment OR pretreatment OR recycling OR destruction OR stabilisation OR deterioration) AND (technique OR technology OR process)	Date range: no date restrictions	20	3
4	Grey literature	Lens (patents)	("asbestos waste" OR "asbestos containing" OR "containing asbestos" OR "asbestos cement" OR "cement asbestos") AND (treatment OR pretreatment OR pre-treatment OR recycling OR destruction OR stabilisation OR stabilization OR inertisation OR inertization OR deterioration) AND (technique OR technology OR process)	Date range: 01/01/2018 – 05/04/2023	264	15
5	Grey literature	Espacenet (patents)	("asbestos waste" OR "asbestos containing" OR "containing asbestos" OR "asbestos cement" OR "cement asbestos") AND (treatment OR pretreatment OR pre-treatment OR recycling OR destruction OR stabilisation OR stabilization OR inertisation OR inertization OR deterioration) AND (technique OR technology OR process)	Date range: 01/01/2018 – 05/04/2023	835	29

The identified technologies have been grouped based on the category of treatment (thermal, chemical, biological, etc.) and the type of process (vitrification, microwave, hydrothermal, etc.). Further literature search looked at more advanced and promising asbestos waste treatment technologies (based on the outcome of the literature review and stakeholder consultation) and their environmental, social and economic impacts. Relevant stakeholders, including the technology providers, were identified for further consultation. In addition, the Expert Advisory Board was consulted.

RQ5: How can the current asbestos waste management practices, including recycling, be improved?

The analysis of measures to improve asbestos waste management first looked at the main barriers that hinder the implementation of asbestos waste treatment and recycling technologies, identified through the consultation activities and supported by the literature search. This was followed by the overview of the opportunities to improve the management of asbestos waste in line with the 'waste hierarchy'. Based on the identified barriers and opportunities, a number of measures were proposed that could help to overcome the main obstacles and improve the management of asbestos waste, including recycling.

RQ6: What is the potential for future development and implementation of asbestos treatment technologies and the feasibility for restriction of asbestos waste disposal to landfill (Foresight analysis)?

The foresight analysis investigated three different scenarios. Scenario exercises are amongst the most common tools in strategic foresight, and they are most useful for policymaking on controversial or complex topics. A scenario is a description of how things may happen in the future. Asking 'what if' questions is a useful technique for scenario thinking, which can guide the foresight brainstorming activity for exploring possible futures.[13]

The foresight analysis was based on relevant megatrends, European strategies and policies, technological readiness level of the most advanced asbestos waste treatment technologies, existing barriers for commercialisation and the implementation of the proposed measured to improve asbestos waste management.

The maturity of the systems was assessed by means of assigning Technology Readiness Levels (TRLs). The TRL scale was originally defined by NASA in the 1970s as a tool to measure or indicate the maturity of a given technology, from a paper sketch to its entry into the market. Generally, new technologies go through the various stages of the TRL scale in their life cycle. During the research and development phases, it is possible to have iterations among different TRL levels. Therefore, the TRL scale also helps to evaluate the project progress.[14]

The TRL scale comprises of nine levels (TRL1 to TRL9). According to the 'Guiding notes to use the TRL self-assessment tool'[15], if the technology reaches TRL3, it can be concluded that the new technology is feasible from a scientific point of view. If it reaches TRL5, it can be concluded that the new technology is feasible from a technological point of view and if it reaches TRL7, it can be concluded that the new technology is reliable from a technological point of view. In TRL8, the technology is ready for implementation into an already existing technology or technology system and, once the technology system has been proven during operation, it can be considered a commercial technology and can be assigned TRL9. The table below shows the TRL matrix for assigning TRL for an industrial process.

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[13] European Parliament Panel for the Future of Science and Technology (STOA) (2021). *Guidelines for foresight-based policy analysis.* https://www.europarl.europa.eu/stoa/en/document/EPRS_STU(2021)690031.

[14] APRE, CDTI (2022). *Guiding notes to use the TRL self-assessment tool.* https://horizoneuropencpportal.eu/sites/default/files/2022-12/trl-assessment-tool-guide-final.pdf.

[15] Ibid.

Table 2-6: The TRL matrix for the assessment of TRL of an industrial process, adopted from Horizon Europe NCP Portal[16]	
TRL	**Description**
TRL3	Laboratory experiments are designed to verify that the conceptual process works as expected
TRL4	Process components are validated individually and could be integrated in an ad hoc manner at lab scale
TRL5	Integrated validation of the process to produce small outputs or short batches of the end product
TRL6	Development of a pilot scale testing plant or unit (1/100th of commercial scale) including engineering scale equivalents of all the operations that will be required at scale
TRL7	Successful demonstration of the continuous operation of the pilot plant/unit during a relevant time frame
TRL8	Demonstration plant is constructed (1/10th of commercial scale) and operated in continuous mode, including working outside normal parameters
TRL9	Commercial plant/unit set up and running for full range of operating conditions

The study team, considering the information collected during the interviews and from the literature review, assessed the advanced asbestos waste treatment technologies against the criteria in the table above and assigned the most relevant TRL for the technology. The TRL was assigned for the process group and not individual companies.

2.2 Stakeholder consultation

The stakeholder consultation consisted of the following activities:

- Two targeted stakeholder surveys;
- The workshop;
- Semi-structured interviews.

Following 'The six tests for stakeholder identification' in the European Commission's Better Regulation Toolbox (Tool #52),[17] the study team identified the following groups of key stakeholders relevant for the study:

- **National and regional authorities** responsible for waste management in Member States, including drafting waste prevention plans and implementing legislation.
- **Local and municipal authorities** responsible for the local waste management, including waste collection and supervision of landfills and other disposal facilities and collection centres.
- **Companies involved in hazardous waste management**. These include companies that work in different phases of asbestos waste management:
  - Dismantling and collection of asbestos waste;
  - Transport of asbestos waste to the collection centres and disposal locations;
  - Management of disposal facilities such as landfills; and
  - Management of recycling facilities.

[16] Horizon Europe Open Portal (n.d.). *TRL Assessment.* https://horizoneuropencpportal.eu/store/trl-assessment.

[17] European Commission (2021*). Better Regulation Toolbox*. https://ec.europa.eu/info/law/law-making-process/planning-and-proposing-law/better-regulation-why-and-how/better-regulation-guidelines-and-toolbox_en.

- **Demolition companies.** This target group includes contractors and suppliers working in the construction and demolition (C&D) sector and dealing first hand with the asbestos containing waste generated during renovation and demolition work.
- **Technology providers**. Companies that are currently trialling new technologies for asbestos waste inertisation and recycling, companies that have patented technologies, industry plants that are using these technologies, and providers of equipment to analyse and detect asbestos.
- **European and national industry associations** representing businesses and associations involved in hazardous waste management.
- **NGOs** dealing with waste management issues.
- **Research and academia** that are conducting studies on relevant aspects of asbestos waste management.

In order to gather more in-depth information from relevant groups of stakeholders, a **targeted survey** focusing on asbestos waste statistics and management practices and a **parallel survey** on the existing and emerging asbestos waste treatment technologies ran from 1 March to 7 April 2023. Invitations to participate in the survey were disseminated via email and posted on LinkedIn. Prior to dissemination of the questionnaires to key stakeholders, the approval by the Commission was sought.

The **workshop** "Asbestos waste management practices and treatment technologies" took place online on Webex on 15 June 2023. It aimed to exchange knowledge and ideas about the current policies and legislative landscape, practices and treatment technologies in the field of asbestos waste management. It brought together stakeholders from Member State competent authorities, waste management companies, C&D businesses, waste treatment technology providers, non-governmental organisations, and research institutions with knowledge and practical experience on asbestos waste management practices and asbestos waste treatment technologies in the EU. More details about the workshop can be found in the Workshop Report in Annex 9.

Following the workshop, the study team arranged **semi-structured interviews** to validate and complement the findings of the literature review, stakeholder surveys and the workshop and to fill in any potential remaining gaps. The total of 18 interviews took place over a period of four months (from June to October 2023), including interviews with technology providers, representatives of industry associations, national and regional authorities, academics and more.

3 Asbestos waste generation in the EU

3.1 Introduction

Understanding the main sources and past and future quantities of asbestos waste in Member States can play an important role in the development of future strategies and policies on asbestos waste management in the EU. As there are no obligations for Member States to report asbestos waste generation at European level, such statistics are only available at a Member State level. This section of the report looks at quantities of asbestos waste generated, treated, landfilled, imported and exported in Member States. It reviews the most common sources of asbestos waste and where asbestos is commonly found in buildings. Finally, future projections of potential quantities of asbestos waste generated in Member States are presented.

3.2 Main sources of asbestos waste

Asbestos containing materials are present in buildings due to extensive use of asbestos before it was banned in the EU in 2005 (see Section 4.2.1 for more details on the ban). Hence, **building maintenance, renovation and demolition activities are the main sources of ACW**. Throughout the 20th century, asbestos-containing products (ACPs) were also widely used in the shipbuilding industry for insulation, fireproofing and soundproofing.[18] Therefore, **ship dismantling and recycling is also a relevant source of asbestos waste**. Asbestos waste also comes from different types of ACPs, e.g., automotive parts, such as brake pads and clutches, textiles and paper products.[19]

According to the limits for carcinogenic substances defined in Annex III of the Waste Framework Directive, waste containing asbestos is classified as hazardous if the mass content of asbestos in the waste exceeds 0.1%. The European Waste Catalogue (EWC) – the hierarchical list of waste descriptions established by the Commission decision 2000/532/EC[20] – features eight types of asbestos waste, all of which are classified as hazardous (Table 3-1).

Table 3-1: Asbestos waste codes in the European Waste Catalogue. Source: Eurostat (2010)

European LoW code (hazardous waste)	Definition
06 07 01*	Wastes containing asbestos from electrolysis
06 13 04*	Wastes from asbestos processing
10 13 09*	Wastes from asbestos-cement manufacture containing asbestos
15 01 11*	Metallic packaging containing a dangerous solid porous matrix (for example asbestos), including empty pressure containers
16 01 11*	Brake pads containing asbestos
16 02 12*	Discarded equipment containing free asbestos
17 06 01*	Insulation materials containing asbestos
17 06 05*	Construction materials containing asbestos

18 Kazan-Allen, L. (2018, May). *Profiles of some Hazardous Industries.* International Ban Asbestos Secretariat. http://ibasecretariat.org/prof_hazard_ind.php

19 Schindler, S. (2016). *Asbestos – Not a problem of the past.* European Trade Union Institute. https://www.etui.org/topics/health-safety-working-conditions/hesamag/construction-workers-at-the-mercy-of-social-dumping/asbestos-not-a-problem-of-the-past.

20 European Commission (2000). Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste (notified under document number C(2000) 1147). *Official Journal of the European Union*, 226. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02000D0532-20231206.

Figure 3-1 below shows the proportion of ACW per European LoW code[21] in 13 Member States[22] in 2020. Similar tendencies have been observed for other years. Construction waste containing asbestos makes up the largest proportion of ACW, followed by insulation materials containing asbestos, even though the latter only makes up around 2% of all ACW. Hence, the C&D industry is the largest producer of ACW in the EU.

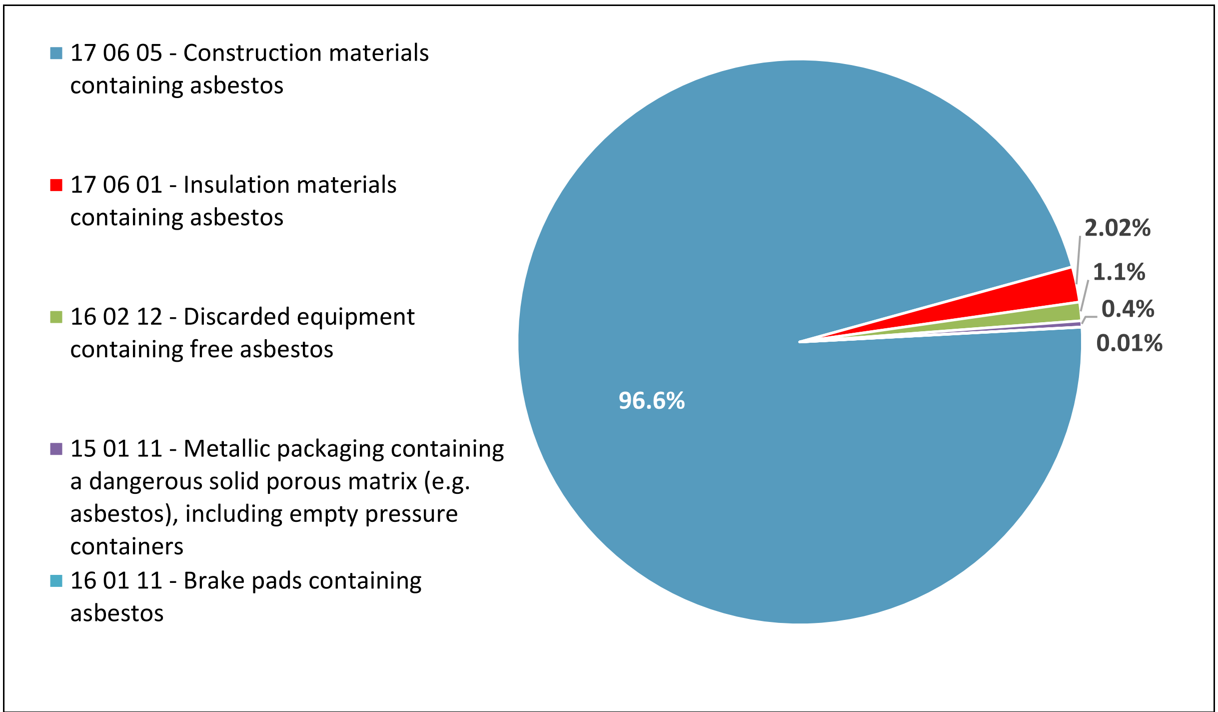

Figure 3-1: Proportion of ACW per EWC in 13 Member States in 2020. Source: data on ACW from Member States

3.2.1 Asbestos in buildings and infrastructure

Around 70-90% of raw asbestos was used to produce asbestos cement products[23]. In existing buildings, asbestos is mostly found in asbestos cement roofs, which can contain between 10% and 20% of raw asbestos. Other products, containing around 15% of raw asbestos, are wall sheets, sewage pipes, outdoor goods, hot water pipe insulation, drinking water tanks, separation panels and ventilation ducts. Some products, in particular sprayed asbestos materials generally used for sound and fireproofing, can contain from 5% to 95% of raw asbestos. Vinyl asbestos flooring and asbestos fabrics used as fireproof sealing materials are also common in existing buildings.[24] Table 3-2 lists internal and external parts of industrial and residential buildings, where asbestos can be found.

[21] Three asbestos-specific LoW codes are not shown in the graph (06 07 01*, 06 13 04*, and 10 13 09*) because the Member States considered did not record any waste generated under these codes in 2020.

[22] The Member States are Croatia, Czech Republic, Denmark, Estonia, Finland, Germany, Italy, Latvia, Lithuania, Luxembourg, Slovakia, Slovenia, and Sweden.

[23] World Health Organisation (WHO) (2014). *Chrysotile asbestos*. https://www.who.int/publications/i/item/9789241564816

[24] Maduta, C., Kakoulaki, G., Zangheri, P. and Bavetta, M., (2022). *Towards energy efficient and asbestos-free dwellings through deep energy renovation.* European Commission Joint Research Centre. https://publications.jrc.ec.europa.eu/repository/handle/JRC129218.

Table 3-2: Overview of places where asbestos can be found in industrial and residential properties. Source: HSE[25]	
What	**Description**
Sprayed coatings on ceilings, walls, beams and columns	This contains up to 85% asbestos and breaks up very easily. It is one of the most dangerous materials containing asbestos.
Asbestos cement (water tanks, roof slates, panels, gutters and downpipes, soffits, flue)	Asbestos cement is mainly a mixture of chrysotile (white asbestos) and cement, moulded and compressed to produce a range of asbestos cement products.
Loose fill insulation	It was used to insulate industrial and domestic premises so can be found in between cavity walls, under floorboards and in loft spaces.
Lagging on boilers and pipes	This type of asbestos has many different appearances but is mostly a fibrous material which flakes and powders easily.
Asbestos Insulating Board (AIB)	Normal building items such as wall panels boards, bath panels, ceiling tiles and plasterboard. It is difficult to tell the difference between asbestos insulating board items and non-asbestos materials.
Floor tiles, textiles, composites and paper	Asbestos floor tiles were once a popular choice for flooring and are now often hidden under carpets. Textiles can be found in fuse boxes behind the actual fuse. Old fire blankets and heat resistant gloves can also be made out of asbestos textiles. Asbestos composites can be found in toilet cisterns and seats, windowsills, and bath panels. Asbestos paper was used for lining under tiles and inside metal cladding.
Asbestos rope seals and gaskets	Asbestos rope seals and gaskets can be found in gas or electric heating appliances
Textured decorating coatings on walls and ceilings, e.g., Artex	Textured coatings were used to produce decorative finishes on ceilings and walls. In the past, they have had various trade names such as 'Artex'.
AIB partition walls, interior and exterior window panels, around boiler, behind fire and airing cupboards	Normal building items such as wall panels boards, bath panels, ceiling tiles and plasterboard. It is difficult to tell the difference between asbestos insulating board items and non-asbestos materials.
Sprayed insulation coating boiler	Insulation on the underside of roofs and sometimes sides of buildings and warehouses. Also used as fire protection on steel and reinforced concrete beams/columns and on underside of floors.
Roofing felt	Asbestos roofing felt was often used for garage roofs, outbuildings etc.

Most regions in central Europe have over 120 kg of asbestos per dwelling on average. Belgium, Denmark, Finland, Czechia, Cyprus, Slovakia, Hungary and the Baltic countries show high asbestos content in dwellings with several regions in Belgium, Slovakia, Cyprus and the Baltic countries having above 240 kg of asbestos per dwelling on average. Regions from Romania, Croatia and Ireland are less vulnerable with an average below 60 kg of asbestos per dwelling (Maduta et al., 2022). The widespread use of **asbestos cement roofs** in many Eastern and Central European countries is considered the biggest concern.

3.3 Quantities of asbestos waste

Asbestos waste statistics at the EU level do not exist. Eurostat holds data on waste generation and treatment by waste category, but quantities of asbestos waste are aggregated with other mineral

25 https://www.hse.gov.uk/asbestos/building.htm

wastes. The search of asbestos waste at the national level has revealed that data are publicly available, albeit not in all Member States and not to the same level of granularity. For instance, countries such as Denmark, Italy, Lithuania, Luxembourg and Slovenia have comprehensive databases, where quantities of asbestos waste are logged by the LoW codes and by disposal/recovery operations as per Waste Framework Directive. Other countries have aggregated data for all ACW, or asbestos waste is recorded together with other mineral waste. In addition, some countries have datasets for long periods of time (e.g., 10-15 years), whereas others have datasets only for a few years or a year.

The sections below provide an overview of the asbestos waste statistics situation in each Member State. The country factsheets with detailed information on asbestos waste sources and quantities can be found in Annex 1.

3.3.1 Asbestos waste statistics in the EU Member States

Publicly available asbestos waste statistics could initially be found for nineteen Member States: thirteen MSs had the information available on the competent authorities' portals, whereas six MSs had the statistics on websites of other institutions. Mostly, data on asbestos waste was available in a waste report or in a database (i.e., Excel). Asbestos waste statistics could not be found on publicly available sources for Finland, Greece, Ireland, Latvia, Malta, Slovakia, Spain and Sweden. However, competent authorities from three Member States (Finland, Latvia and Sweden) provided some data through the targeted survey. The study team contacted via email national and regional authorities from Member States for which no data was found, as well as from some Member States where the data was not comprehensive (Belgium, Bulgaria, Cyprus, Estonia, Finland, France, Greece, Ireland, Malta, Netherlands, Romania, Slovakia, Spain and Sweden). Competent national or regional authorities replied providing data for: Flanders, Wallonia, Bulgaria, France, Finland, Malta, Netherlands, Slovakia and Sweden.

In the end, the study team was able to **collect statistics for 24 Member States**:

- 11 Member States (Croatia, Denmark, Estonia, Germany, Hungary, Italy, Latvia, Lithuania, Luxembourg, Slovakia, Slovenia) had comprehensive datasets, meaning that they included data on ACW generated and disposed of, classified by LoW codes and covering a long period of time (around 10 years).
- 13 Member States (Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Finland, France, Malta, Netherlands, Poland, Portugal, Romania, Sweden) had less comprehensive data, meaning that either the waste was not classified by LoW codes, the data did not cover a long period of time (only 3-4 years), only generated or disposed of quantities were recorded or a combination of the three.

Relevant information could not be obtained for three Member States: Greece, Ireland and Spain[26].

Austria

In Austria, data on asbestos waste is published in a waste report, more specifically, in the 'Inventory of waste management in Austria - Status Report 2023'[27], available on the portal of the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology (BMK). In the report, statistics on asbestos waste are provided using classification according to ÖNORM S 2100 (as amended in 2005). Data on asbestos waste generation is available for years 2004, 2009-2021, and for

[26] For Spain, the study team found only fragmented data from some autonomous communities.
[27] BMK (2023). *The inventory of Waste management in Austria - Status report 2023.* https://www.bmk.gv.at/themen/klima_umwelt/abfall/aws/bundes_awp/bawp2023.html.

asbestos waste disposal – for years 2008-2021. The quantities of asbestos waste generated and disposed of in Austria can be found in the graph below.

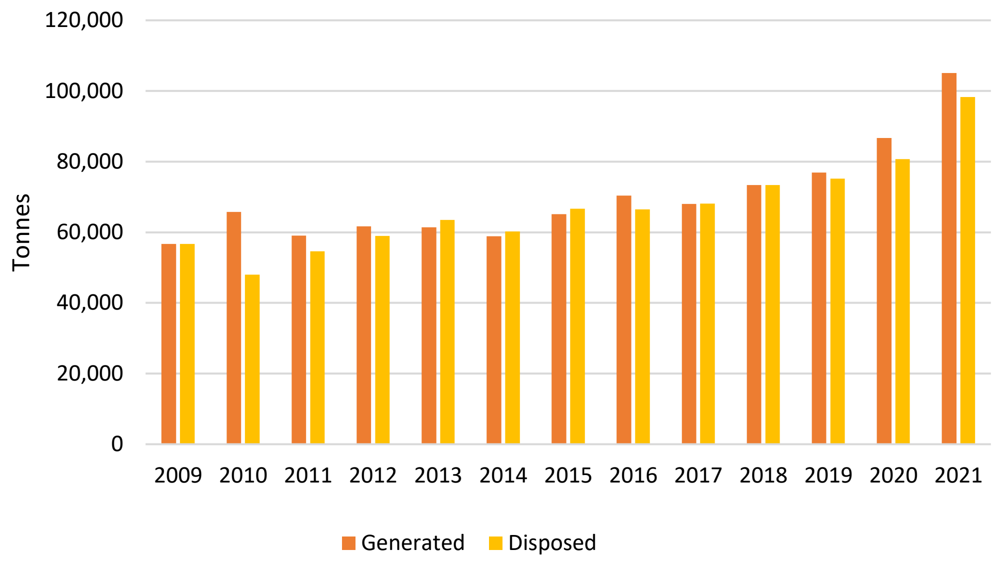

Figure 3-2: Quantities of asbestos waste generated and disposed of in Austria between 2009 and 2021. Source: BMNT (2017), BMK (2021)

It can be seen from the above that the quantities of asbestos waste generated and disposed of in Austria have been steadily increasing year on year with the highest quantities generated and disposed in year 2021. The highest quantities of asbestos waste between 2009-2021 came from asbestos cement (Table 3-3).

Table 3-3: Quantities of asbestos waste generated in Austria between 2009-2021 by ÖNORM S 2100 classification code. Source: BMNT (2017), BMK (2021)

Waste code	Type of ACW	Quantities (tonnes)	
		Generated	Disposed of
31412	Asbestos cement	852,500	851,080
31437	Asbestos waste, asbestos dust	70,840	64,810
	Total	**923,340**	**915,890**

Pursuant to Article 16(1) of the Waste Management Act 2002, as amended, the depositing of hazardous waste on overground landfill sites is prohibited. Pre-treated asbestos waste, however, can be deposited in landfills designed for non-hazardous waste in structurally separate compartments. In 2015, for example, around 66,700 tonnes of asbestos waste were deposited in this way. Underground storage sites are not currently operated in Austria[28].

Belgium

In Belgium, data on asbestos waste disposed of in Wallonia, Flanders and Brussels can be found in the reports 'Rates and capacities for dumping and incineration'[29], available on the website of the Public Waste Agency of Flanders (OVAM). Data on asbestos waste disposal is available for years 2012-2021.

[28] BMNT (2017). *Federal Waste Management Plan 2017.* https://www.bmk.gv.at/en/topics/climate-environment/waste-resource-management/waste-management/fed-waste-mgt-plan.html.

[29] OVAM (n.d.). *Rates and capacities for dumping and incineration.* https://ovam.vlaanderen.be/tarieven-en-capaciteiten-voor-storten-en-verbranden?p_l_back_url=%2Fzoeken%3Fq%3Dtarieven%2Ben%2Bcapac.

In the report, statistics on asbestos waste are not classified according to the LoW, but a distinction between ‘asbestos cement waste’ and ‘other asbestos-containing waste’ is made. The quantities of asbestos waste disposed of in Belgium can be found in the graph below.

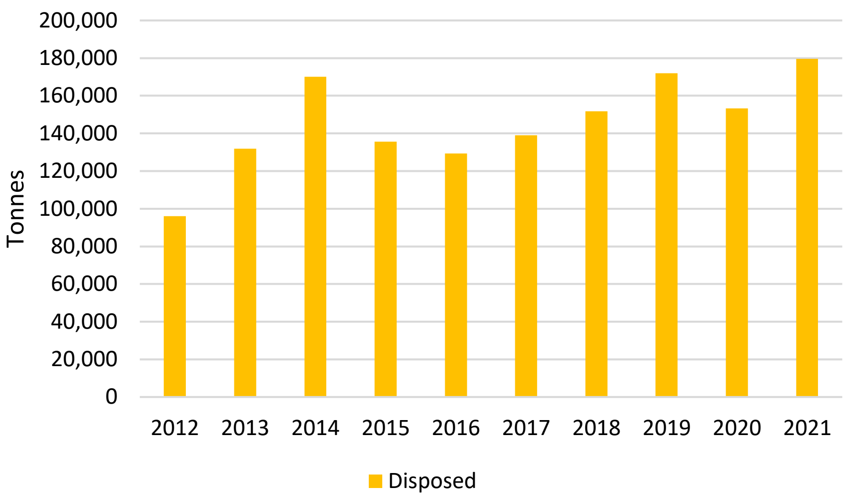

Figure 3-3: Quantities of asbestos waste disposed of in Belgium between 2012 and 2019. Source: OVAM (2012) – OVAM (2021)

The highest quantities of asbestos waste disposed of between 2012-2021 was asbestos cement (Table 3-4).

Table 3-4: Quantities of asbestos waste disposed of in Belgium between 2012-2021. Source: OVAM (2012) – OVAM (2021)

Type of ACW	Quantities (tonnes) Disposed of
Asbestos cement waste	1,258,500
Other asbestos-containing waste	160,231
Total	**1,458,731**

ACW is landfilled in hazardous and non-hazardous waste landfills in Flanders (in 2021 there were six working landfills accepting asbestos waste)[30]. In Wallonia, 11 facilities specifically for asbestos-cement waste were active in 2023[31].

Bulgaria

In Bulgaria, asbestos waste statistics are not available on the competent authority’s portal. However, the ‘National asbestos profile of Bulgaria’[32] has been published in 2015 by the National Centre of Public Health and Analyses. Although quantities of asbestos waste disposed of in Bulgaria are provided in the report (Table 3-5), it is not clear for what period.

[30] Ibid.

[31] Wallonia Geoportal (2023). *Walloon Waste-Resources Plan - Industrial waste management sites.* https://geoportail.wallonie.be/catalogue/4e62a4b4-c8dc-421d-8ef0-e35d16d0e1db.html.

[32] Vangelova, K., Dimitrova, S., & Dimitrova, I. (2015). *National asbestos profile of Bulgaria.* https://ncpha.government.bg/uploads/pages/3001/National%20Asbestos%20Profile_Bulgaria_2015-en.pdf.

Table 3-5: Quantities of asbestos waste disposed of in Bulgaria by the European LoW code (time period unknown). Source: National Centre of Public Health and Analyses (2015).		
LoW Code	**Type of ACW**	**Quantities (tonnes)**
06 07 01	Asbestos waste from chlor-alkali electrolysis	68,050
16 01 11	Asbestos-containing brake pads	22,860
16 02 12	Used Technical equipment and devices containing asbestos	360
17 06 01	Insulating material containing asbestos	1,253,910
17 06 05	Asbestos containing building materials	184,570
17 06 01	Insulating material containing asbestos	64,600
17 06 05	Asbestos-containing building materials	
16 01 11	Asbestos-containing brake pads	189,340
17 06 01	Insulating material containing asbestos	
No data	No data for the source	7,255,940
	Total	**9,039,630**

In Bulgaria, over 9 million tonnes of ACW had been disposed of up to 2015. Although some data on ACW had been recorded based on the LoW codes, the majority of ACW has not been logged according to this classification. In addition, in some instances, aggregated quantities of asbestos waste have been recorded, for example, 17 06 01 and 17 06 05 or 16 01 11 and 17 06 01.

Another set of data obtained for Bulgaria through the stakeholder consultation from the Executive Environment Agency shows quantities of ACW generated and disposed of for years 2017-2021. Statistics were provided only for 'asbestos-containing waste', with no LoW classification.

The quantities of asbestos waste generated and disposed of in Bulgaria can be found in the graph below.

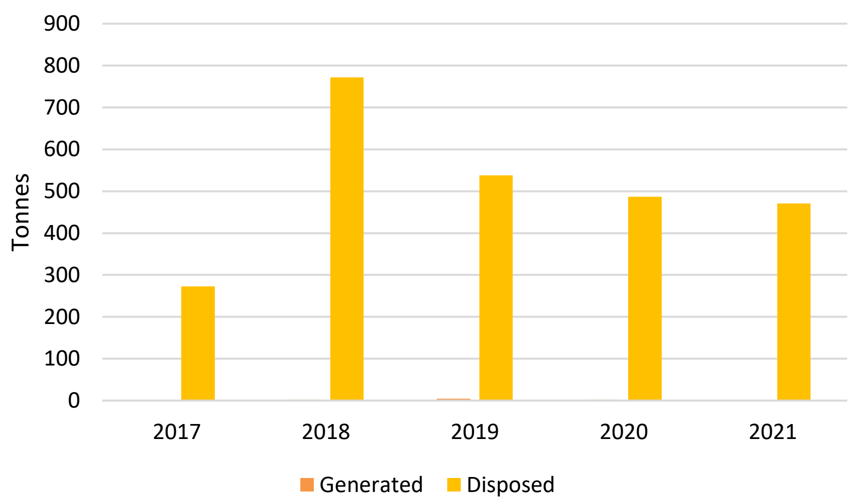

Figure 3-4: Quantities of asbestos waste generated and disposed of in Bulgaria between 2017 and 2021. Source: Executive Environment Agency, 2023

For generated waste, the quantities do not include codes from the 17th group 'Construction and demolition waste (including soil excavated from contaminated sites)' because no monthly reporting is kept for these codes and no annual reports are provided. On the other hand, the information on the disposal of ACW includes codes from the 17th group. According to Art. 44, para. 3 of the Waste Management Act, waste documentation is kept only for a period of 5 years.[33]

There are huge discrepancies between data published in the National asbestos profile and data provided by the competent authorities. Whereas the profile states millions of tonnes of asbestos waste disposed of (unclear for which period), the statistics provided by the Executive Environment Agency only reports hundreds of tonnes disposed of per year, which for the country of this size is presumably very low. According to the interviewed expert from Bulgaria, there was no asbestos removal programme in the country, which would explain high quantities of asbestos waste reported in the profile. Hence, the asbestos waste statistics for the country can be flagged as unreliable.

Croatia

In Croatia, statistics on asbestos waste are published in annual waste reports 'Construction waste and waste containing asbestos'[34], available on the portal of the Ministry of Economy and Sustainable Development. In the report, statistics on the construction waste containing asbestos are provided using the European LoW classification (codes 17 06 01 and 17 06 05). Data on asbestos waste generation is available for the period 2008-2021, and for disposal and export – for the period 2011-2021. The quantities of asbestos waste generated, disposed of and exported can be found in the figure below.

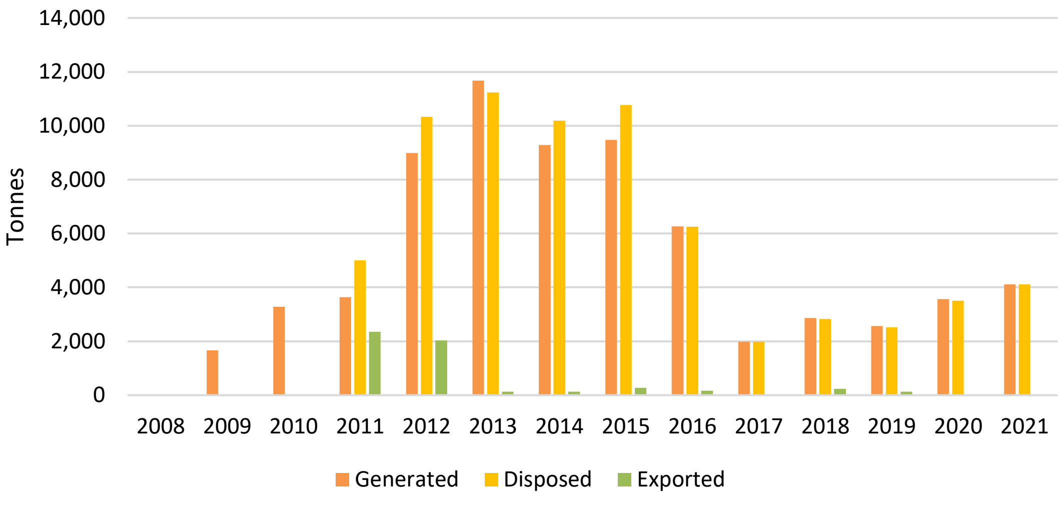

Figure 3-5: Quantities of asbestos waste generated, disposed of and exported in Croatia between 2008 and 2020. Source: HOAP

The statistics show that the peak of asbestos-containing construction waste generation and disposal was between 2012 and 2016. The disposal of asbestos waste from construction was free of charge for natural persons until the end of June 2016, i.e., it was financed by the Environmental Protection and Energy Efficiency Fund (EPEEF), while legal entities settled the costs themselves. Since the entry into force of the Ordinance on construction and demolition waste and asbestos waste (OG 69/16), the asbestos waste management system was more closely regulated and EPEEF obligations in financing

[33] Consultation with stakeholders.

[34] Ministry of Economy and Sustainable Development (2023). *Waste management. Reports.* https://www.haop.hr/hr/tematska-podrucja/otpad-registri-oneciscavanja-i-ostali-sektorski-pritisci/gospodarenje-otpadom-0

the system decreased.[35] This would explain the sharp drop in the generation and disposal of asbestos waste in 2017. However, although there was a sharp decrease in the generation of ACW in 2017, the quantities have been increasing steadily since 2018. Table below shows quantities of ACW by the European LoW code. Approximately 5,500 tonnes of asbestos-containing construction waste have been exported.

Table 3-6: Quantities of asbestos waste generated, disposed of and exported in Croatia between 2008-2021 by European LoW code. Source: HOAP

LoW Code	Type of ACW	Quantities (tonnes)				
		Generated		Disposal operations		Exported
		2008-2015	2016-2021	2011-2015	2016-2021	2011-2021
17 06 01	Insulation materials containing asbestos	48,003	558	47,532	441	5,482
17 06 05	Construction materials containing asbestos		20,797		20,762	
	Total	**69,358**		**68,735**		**5,482**

To dispose of construction waste containing asbestos (17 06 01 and 17 06 05), cassettes (in which the waste is disposed of) were built in 18 selected waste disposal sites (D5 process: waste disposal at a specially prepared landfill). The total capacity of all 18 built cassettes is about 87,100 m^3 (or approximately 140,000 tonnes).[36] According to the Waste Management Plan of the Republic of Croatia for the period 2017-2022, about 40% of total landfill capacity for asbestos waste was used at the end of 2015. This represents approximately 50,000 tonnes of asbestos waste. From 2016 to 2021, around 21,000 tonnes of ACW had been deposited in these cassettes. Hence, since 2022, the remaining capacity of these designated areas for ACW was around 50% or 70,000 tonnes.

Cyprus

In Cyprus, statistics on ACW can be found in the 'Waste Management Plan (for other waste streams) 2016-2022'[37] published in 2016 and available on the portal of the Department of the Environment under the Ministry of Agriculture, Rural Development and Environment. Aggregated data on ACW collected and managed in Cyprus is available for years 2009-2014, although in years 2009, 2013 and 2014, no asbestos waste was collected or managed (Figure 3-6).

[35] Government of the Republic of Croatia (2017). *Waste management plan of the Republic of Croatia for the period 2017-2022.* https://mingor.gov.hr/UserDocsImages/UPRAVA-ZA-PROCJENU-UTJECAJA-NA-OKOLIS-ODRZIVO-GOSPODARENJE-OTPADOM/Sektor%20za%20odr%C5%BEivo%20gospodarenje%20otpadom/Ostalo/management_plan_of_the_republic_of_croatia_for_the_period_2017-2022.pdf.

[36] Ministry of Economy and Sustainable Development (2022). *Provisional data on construction waste management in 2021.* https://www.haop.hr/sites/default/files/uploads/dokumenti/021_otpad/Izvjesca/ostalo/Privremeno%202021_05%20final_0.pdf.

[37] Department of Environment (n.d.). *Waste management strategy.* http://www.moa.gov.cy/moa/environment/environmentnew.nsf/page20_gr/page20_gr?OpenDocument.

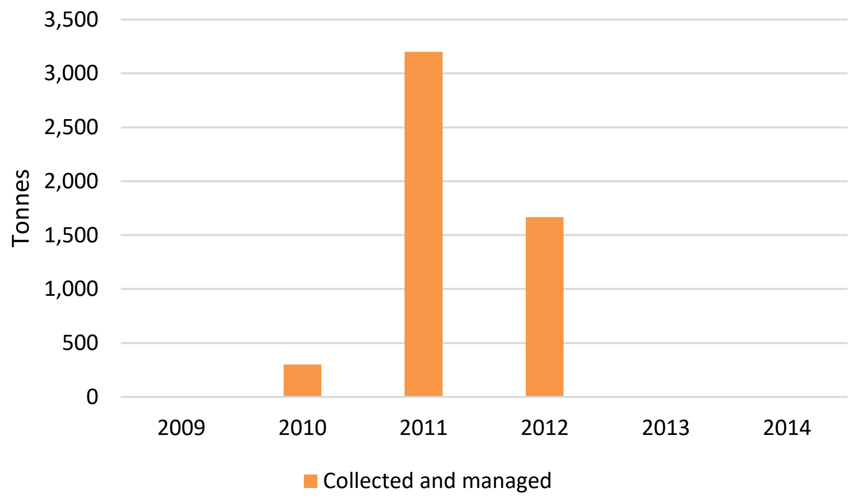

Figure 3-6: Quantities of asbestos waste collected and managed in Cyprus between 2009 and 2014. Source: MOA

Czech Republic

In Czech Republic, statistics on asbestos waste is available on the portal of the Czech Statistical Office.[38] The ACW is classified by the European LoW and quantities of asbestos waste generated are available for years 2013-2021. However, from year 2013 to 2016, only data on asbestos waste generated by enterprises are available on the portal, which can explain much lower quantities generated for these years (Figure 3-7). Data on asbestos waste treatment is not available as data is aggregated with other types of waste.

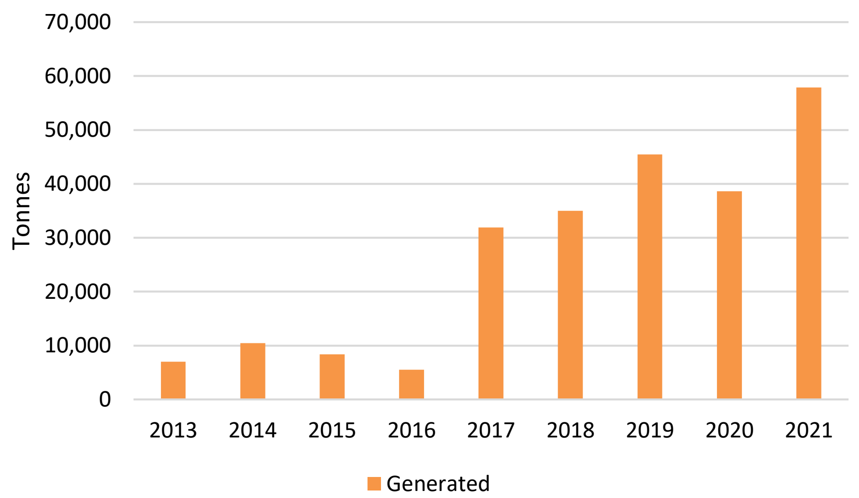

Figure 3-7: Quantities of asbestos waste generated in Czech Republic between 2013 and 2021. Note: for years 2013-2016, only data for asbestos waste generated by enterprises is available. Source: Czech Statistical Office

[38] Czech statistical office (2022). *Production, use and disposal of waste – 2021.* https://www.czso.cz/csu/czso/produkce-vyuziti-a-odstraneni-odpadu-mgyqmwjyr8.

It can be seen from the figure above that the quantities of ACW generated in the country has been steadily growing, although there is a slight dip in year 2020. The highest quantities of asbestos waste came from insulation materials containing asbestos (17 06 01) and construction materials containing asbestos (17 06 05) (Table 3-7).

Table 3-7: Quantities of asbestos waste generated in Czech Republic between 2013-2021 by European LoW code. Source: The Czech Statistical Office

LoW Code	Type of ACW	Quantities (tonnes)
15 01 11	Metallic packaging containing a dangerous solid porous matrix (e.g. asbestos), including empty pressure containers	4,939
16 01 11	Brake pads containing asbestos	145
16 02 12	Discarded equipment containing free asbestos	51
17 06 01	Insulation materials containing asbestos	33,507
17 06 05	Construction materials containing asbestos	201,560
	Total	**240,202**

According to Decree No. 294/2005 Coll., it is possible to store ACW in landfills of category S-OO,[39] subject to compliance with applicable legal regulations. Natural persons are exempted from paying a fee for placing hazardous waste in a landfill and only pay a standard fee for landfilling non-hazardous waste.[40] In 2014, waste of the category 'other' could be deposited at a total of 152 landfills with free capacity exceeding 30 million m^3.[41]

Denmark

In Denmark, statistics on ACW are available on the portal of the Danish Environmental Protection Agency.[42] The ACW is classified by the European LoW and quantities of asbestos waste generated, disposed of and recovered (recorded by disposal/recovery operations as per Waste Framework Directive) are available for years 2011-2020. The quantities of ACW have been steadily growing in Denmark since 2011, with the highest increase between 2019 and 2020 (Figure 3-8).

[39] Landfills of group S-other waste (S-OO) – specified for the category "other" waste, which in turn are divided into subgroups:
- S-OO1 - waste with low biodegradable organic matter content and waste from asbestos under the conditions laid down in the implementing legal regulation.
- S-OO3 - waste with significant biodegradable organic content, waste that may not be evaluated on the basis of their water leachate, and waste from asbestos under the conditions laid down in the implementing legal regulation.

[40] Ministry of the Environment (2022). *Report on the fulfilment of the objectives of the Waste Management Plan of the Czech Republic for the period 2019-2020.* https://www.mzp.cz/C1257458002F0DC7/cz/plneni_narizeni_vlady/$FILE/OODP-Hodnotici_zprava_POH_CR_2019_2020-20220807.pdf.

[41] Ministry of the Environment (2022). *Waste Management Plan of the Czech Republic for the period 2015-2024.* https://www.mzp.cz/C1257458002F0DC7/cz/plan_odpadoveho_hospodarstvi_aj/$FILE/OODP-WMP_CZ_translation-20151008.pdf.

[42] Danish Environmental Protection Agency (n.d.) *Waste statistics.* https://mst.dk/affald-jord/affald/affaldsdatasystemet/find-affaldsdata/affaldsstatistikker/.

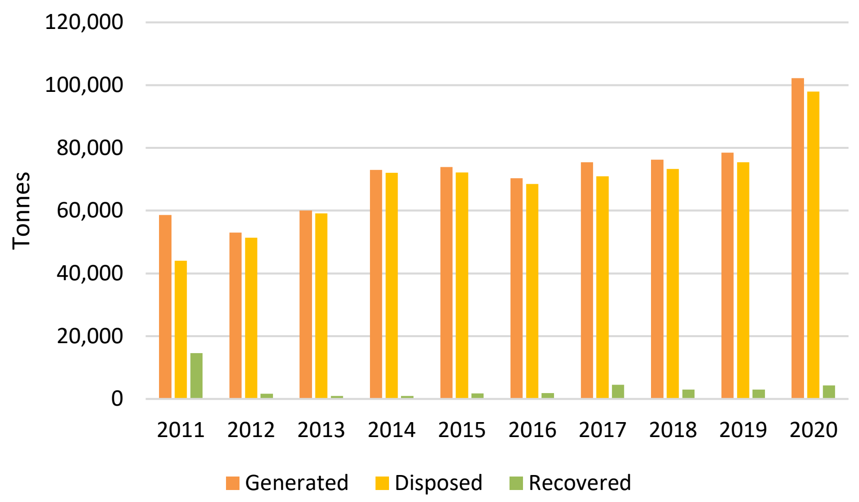

Figure 3-8: Quantities of asbestos waste generated, disposed of and recycled in Denmark between 2011 and 2020. Source: Danish Environmental Protection Agency

Construction materials containing asbestos (17 06 05) made up more than 98% of all ACW in Denmark, followed by metallic packaging containing a dangerous solid porous matrix (e.g., asbestos) (Table 3-8).

Table 3-8: Quantities of asbestos waste generated, disposed of and recovered in Denmark between 2011-2020 by European LoW code. Source: Danish Environmental Protection Agency

LoW Code	Type of ACW	Quantities (tonnes)		
		Generated	Disposal operations	Recovery operations
06 13 04	Wastes from asbestos processing	3	0	2
10 13 09	Wastes from asbestos-cement manufacture containing asbestos	1	1	0
15 01 11	Metallic packaging containing a dangerous solid porous matrix (e.g. asbestos), including empty pressure containers	5,047	876	4,171
16 01 11	Brake pads containing asbestos	499	17	482
16 02 12	Discarded equipment containing free asbestos	4,441	1	4,440
17 06 01	Insulation materials containing asbestos	3,642	3,481	161
17 06 05	Construction materials containing asbestos	707,688	680,446	27,241
	Total	**721,321**	**684,823**	**36,498**

According to the data, approximately 95% of ACW was disposed of, mostly via disposal operations D1[43] (405,687 tonnes) and D5[44] (222,623 tonnes), and the rest was recovered via recovery operations R3[45] (12,459 tonnes) and R12[46] (10,482 tonnes). However, recycling waste containing asbestos is not allowed in Denmark and incineration of ACW is not performed. All waste containing asbestos is landfilled in the country. Therefore, the reports of minor amounts of ACW recovered or incinerated

43 Deposit into or on to land (e.g., landfill, etc.)

44 Specially engineered landfill (e.g., placement into lined discrete cells which are capped and isolated from one another and the environment, etc.)

45 Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes)

46 Exchange of waste for submission to any of the operations numbered R 1 to R 11

may be due to incorrect registration of the waste data (Danish Environmental Protection Agency, 2022).

Estonia

In Estonia, statistics on ACW are available on the Waste Reporting Information System (JATS)[47] through the Estonian Environment Agency. The ACW is classified by the European LoW and quantities of asbestos waste generated and disposed of are available for years 2004-2022. The quantities of asbestos waste generated, disposed of and recovered in Estonia can be found in the graph below.

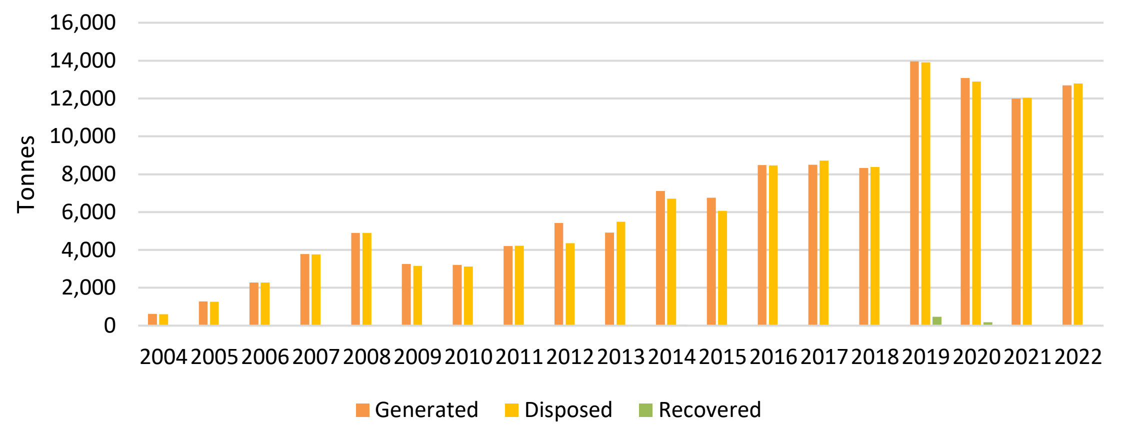

Figure 3-9: Quantities of asbestos waste generated, disposed of and recovered in Estonia between 2004 and 2022. Source: Estonian Environment Agency

It can be seen from the above that the quantities of asbestos waste generated and disposed of in Estonia have been steadily increasing until 2019, decreased in 2020 and 2021 and started increasing again in 2022. Construction materials containing asbestos (17 06 05) was the most common type of asbestos waste in Estonia (Table 3-9).

Table 3-9: Quantities of asbestos waste generated, disposed of and recovered in Estonia between 2004 and 2022. Source: Estonian Environment Agency

LoW Code	Type of ACW	Quantities (tonnes)		
		Generated	Disposal operations	Recovery operations
16 01 11	Brake pads containing asbestos	3	0	1
17 06 01	Insulation materials containing asbestos	9,691	9,663	10
17 06 05	Construction materials containing asbestos	115,090	113,524	787
	Total	**124,783**	**123,187**	**798**

Finland

For Finland, data on asbestos waste disposed of and recovered in the country was provided by competent authorities through the stakeholders' consultation. The ACW is classified by the European LoW and quantities of asbestos waste disposed of and recovered are available for years 2010-2022.

47 https://jats.keskkonnainfo.ee/main.php?page=content&content=summary

The quantities of asbestos waste disposed of and recovered in Finland can be found in the graph below.

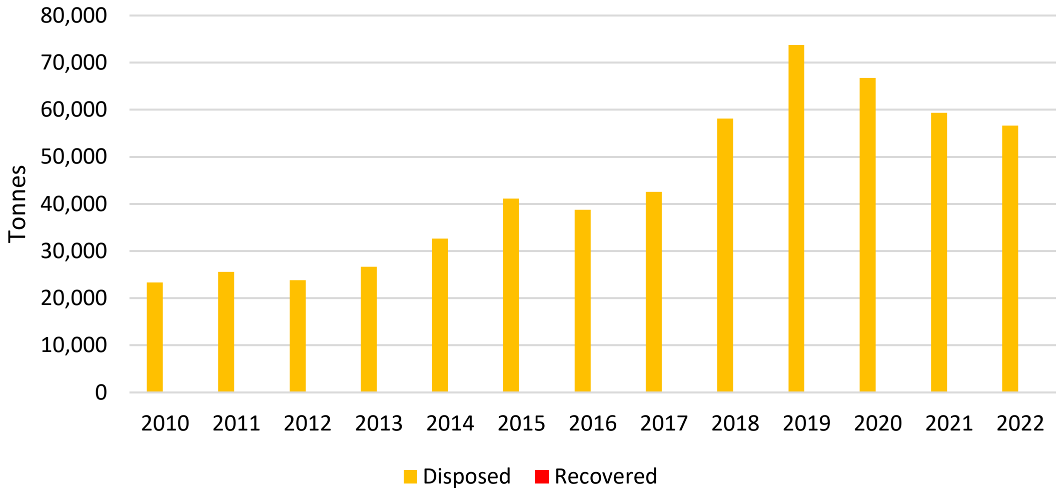

Figure 3-10: Quantities of asbestos waste disposed of and recovered in Finland between 2010 and 2022. Source: Ministry of the Environment

It can be seen from the above that the quantities of asbestos waste generated and disposed of in Finland have been steadily increasing until 2019 but started decreasing in 2020.

The highest quantities of asbestos waste between 2010-2022 came from asbestos cement (Table 3-10).

Table 3-10: Quantities of asbestos waste disposed of and recovered in Finland between 2010 and 2022. Source: Ministry of Environment

LoW Code	Type of ACW	Quantities (tonnes)	
		Disposal operations	Recovery operations
06 13 04	Wastes from asbestos processing	16	0
17 06 01	Insulation materials containing asbestos	70,977	7
17 06 05	Construction materials containing asbestos	498,219	702
	Total	**569,211**	**709**

France

In France, the statistics of ACW are only available for the year 2013, which were published in a report by the Bureau of Geological and Mining Research (Bureau de recherches géologiques et minières [BRGM]) of the French government.[48] According to the report, data on asbestos waste in the country are characterised by a high level of uncertainty. The estimates were obtained adopting a sectoral approach, investigating activities in several economic sectors. In 2013, the estimated average quantity of asbestos waste produced in the country was around 680,000 tonnes (between 400,000 and 930,000 tonnes). However, the total deposit estimated via counting flows captured and recorded in waste

[48] Bureau de recherches géologiques et minières (BRGM) (2017). *Collection of figures on asbestos waste deposits with regard to the treatment channels available. Summary report.* https://www.aleacontroles.com/uploads/tinyBrowser/RP-66047-FR.pdf.

disposal facilities was 330,000 tonnes. The overview of the quantities of asbestos waste treated in France in 2013 is presented in the table below.

Table 3-11: Waste deposit in France, 2013. Source: BRGM (2017)

Installations	Waste	Waste code	Quantity (tonnes)
ISDD(1), ISDND(2), vitrification	All waste excluding asbestos soils	Asbestos specific codes	137,000
		11 non-specific codes	X% of 97,000 (X, the specific percentage of asbestos, is not quantifiable)
	Polluted land including asbestos soils	1 non-specific code	max. 114,000
Former ISDI(3)	Construction		83,000
		Total	**330,000**

(1) Hazardous Waste Storage Facility
(2) Non-Hazardous Waste Storage Facility
(3) Inert Waste Storage

Asbestos waste falling under the codes that specifically relate to asbestos is further segmented by source in the table below. It needs to be noted that the waste code 17 06 03 is not considered asbestos specific code in the European LoW (Eurostat, 2010). The data shows that the most common type of asbestos waste was construction materials containing asbestos (17 06 05).

Table 3-12: Quantities of asbestos waste disposed of in France in 2013 by European LoW code. Source: BRGM (2017)

LoW Code	Type of ACW	Quantities (tonnes)
10 13 09	Wastes from asbestos-cement manufacture containing asbestos	2
16 01 11	Brake pads containing asbestos	57
16 02 12	Discarded equipment containing free asbestos	1,672
17 06 01	Insulation materials containing asbestos	8,562
17 06 03	Other insulation materials made from or containing hazardous substances	2,503
17 06 05	Construction materials containing asbestos	124,333
	Total	**137,129**

Additional data obtained through stakeholder consultations shows that in 2014 the waste generated from materials containing asbestos amounted to 567,231 tonnes.

Germany

In Germany, statistics on ACW are available on the portal of the Federal Statistical Office (Statistisches Bundesamt).[49] ACW is classified by the European LoW and quantities of asbestos waste generated, imported, produced in-house[50] and disposed of are available for years 2005-2021 (Figure 3-11).

49 Destatis (n.d.). *Waste management.* https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Umwelt/Abfallwirtschaft/_inhalt.html.

50 Asbestos waste produced in disposal facilities.

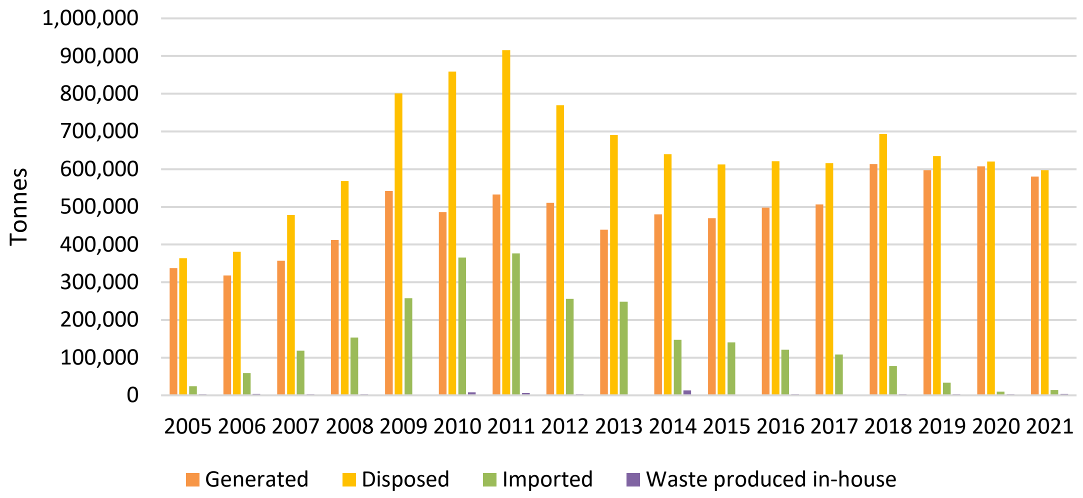

Figure 3-11: Quantities of asbestos waste generated, imported, produced in-house and disposed of in Germany between 2005 and 2021. Source: Federal Statistical Office

Overall, quantities of ACW have been increasing in Germany since 2005, although some years saw a small decrease in asbestos waste generation. Since 2018, quantities produced were relatively stable. Germany has been importing large quantities of ACW throughout this period. However, imports have been decreasing since 2011. Construction materials containing asbestos (17 06 05) was the most common type of asbestos waste in Germany, followed by insulation materials containing asbestos (17 06 01) and discarded equipment containing free asbestos (16 02 12) (Table 3-13).

Table 3-13: Quantities of asbestos waste generated, imported, produced in-house and disposed of in Germany between 2005 and 2021 by European LoW code.[51] Source: Federal Statistical Office

LoW Code	Type of ACW	Quantities (tonnes)			
		Generated	Imported	Produced in-house	Disposed of
06 07 01	Asbestos waste from chlor-alkali electrolysis	0	400	200	600
06 13 04	Wastes from asbestos processing	15,500	0	0	15,500
10 13 09	Wastes from asbestos-cement manufacture containing asbestos	100	0	0	100
15 01 11	Metallic packaging containing a dangerous solid porous matrix (e.g. asbestos), including empty pressure containers	16,800	25,200	0	42,100
16 01 11	Brake pads containing asbestos	300	0	100	500
16 02 12	Discarded equipment containing free asbestos	128,700	200	600	129,800
17 06 01	Insulation materials containing asbestos	118,700	191,600	6,700	316,900
17 06 05	Construction materials containing asbestos	8,007,500	2,291,600	55,900	10,354,900
	Total	**8,287,600**	**2,509,000**	**63,500**	**10,860,400**

51 Note: in some instances, quantities do not add up due to rounding.

Greece

No information was found on ACW generation and disposal in Greece.

Hungary

In Hungary, statistics of ACW are published in the 'National Waste Management Plan 2021-2027'[52] available on the government's portal and prepared by the Ministry of Innovation and Technology. The ACW is classified by the European LoW and quantities of asbestos waste generated, disposed of and recovered (recorded by disposal/recovery operations) are available for years 2010-2018 (Figure 3-12).

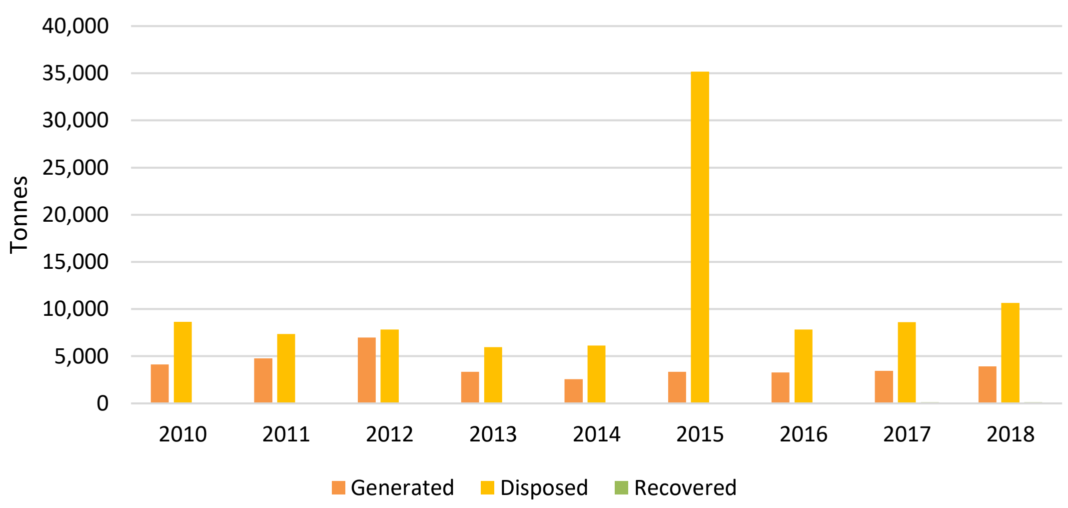

Figure 3-12: Quantities of asbestos waste generated, disposed of and recovery in Hungary between 2010 and 2018. Source: Ministry of Innovation and Technology (2018)

Data shows that the quantities of asbestos waste deposited at landfills were higher than the quantities generated. In addition, the year 2015 saw a huge spike in the quantities of asbestos waste disposed of in specially engineered landfills (D5). Although there is no explanation of what caused this spike in the waste management plan and why quantities landfilled each year exceeded quantities generated, the reason could be the fact that some of asbestos waste might have been stored and waiting for its disposal in the specially engineered landfills or Hungary has imported ACW from other countries. This will be further investigated. Construction materials containing asbestos (17 06 05) was the most common type of asbestos waste in Hungary, followed by metallic packaging containing asbestos (15 01 11) and insulation materials containing asbestos (17 06 01) (Table 3-14).

Table 3-14: Quantities of asbestos waste generated in Hungary between 2010-2018 by European LoW code. Source: Ministry of Innovation and Technology (2018)

LoW Code	Type of ACW	Quantities (tonnes)
06 13 04	Wastes from asbestos processing	5
10 13 09	Wastes from asbestos-cement manufacture containing asbestos	1
15 01 11	Metallic packaging containing a dangerous solid porous matrix (e.g. asbestos), including empty pressure containers	3,628
16 01 11	Brake pads containing asbestos	71

52 Ministry of Innovation (2018). *National Waste Management Plan 2021-2027.* https://cdn.kormany.hu/uploads/document/9/92/921/921c2f798773d4336ee3f45884a662d3018bb3d7.pdf.

Table 3-14: Quantities of asbestos waste generated in Hungary between 2010-2018 by European LoW code. Source: Ministry of Innovation and Technology (2018)		
LoW Code	**Type of ACW**	**Quantities (tonnes)**
16 02 12	Discarded equipment containing free asbestos	55
17 06 01	Insulation materials containing asbestos	1,626
17 06 05	Construction materials containing asbestos	30,499
	Total	**35,885**

According to the Ministry of Innovation and Technology data, in 2018 there were nine landfills in Hungary suitable for disposal of hazardous construction and demolition waste containing asbestos, with a total capacity of 154,340 tonnes per year.[53]

Ireland

The only data found on ACW in Ireland is that the amount of construction and demolition waste containing asbestos disposed of in 2014 was 6,246 tonnes. According to the 'National Hazardous Waste Management Plan 2021 – 2027',[54] there are no landfills in Ireland accepting asbestos waste. All ACW is exported to Northern Ireland, Sweden and Germany.

Italy

In Italy, statistics on ACW are published in the annual 'Special Waste Report' (Rapporto Rifiuti Speciali) by the Italian Institute for Protection and Environmental Research (Istituto Superiore per la Protezione e la Ricerca Ambientale - ISPRA).[55] ACW is classified by the European LoW and quantities of asbestos waste generated, disposed of (recorded by disposal operations) and exported are available for years 2007-2021 (Figure 3-13).

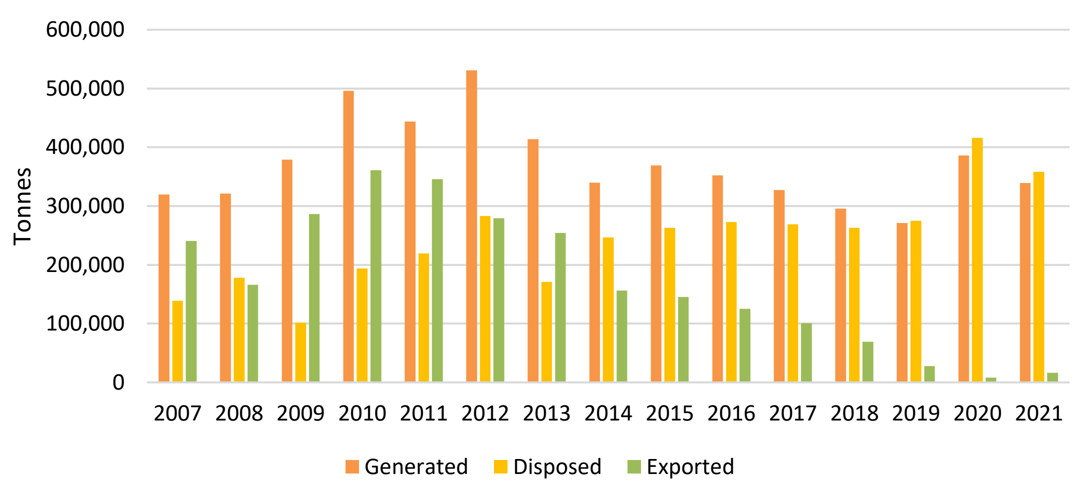

Figure 3-13: Quantities of asbestos waste generated, disposed of and exported in Italy between 2007 and 2021. Source: ISPRA

53 Ibid.

54 Environmental Protection Agency (2021). *National Hazardous Waste Management Plan 2021 – 2027.* https://www.epa.ie/publications/circular-economy/resources/NationalHazardousWasteManagementPlan_2021_2027.pdf.

55 ISPRA (2023). *Special Waste Report - 2023 Edition.* https://www.isprambiente.gov.it/it/pubblicazioni/rapporti/rapporto-rifiuti-speciali-edizione-2023.

Quantities of ACW generated had been decreasing in Italy from 2015 to 2019 but have started to increase since 2019. The quantities of deposited asbestos waste had been steady until 2019, when they started to increase.

Construction materials containing asbestos (17 06 05) was the most common type of asbestos waste in Italy, followed by insulation materials containing asbestos (17 06 01) (Table 3-15).

Table 3-15: Quantities of asbestos waste generated, disposed of and exported in Italy between 2007-2021 by European LoW code. Source: ISPRA

LoW Code	Type of ACW	Quantities (tonnes)		
		Generated	Disposal operations	Exported
15 01 11	Metallic packaging containing a dangerous solid porous matrix (e.g. asbestos), including empty pressure containers	18,389	19,342	5,529
16 01 11	Brake pads containing asbestos	360	338	0
16 02 12	Discarded equipment containing free asbestos	6,194	7,752	13,159
17 06 01	Insulation materials containing asbestos	311,818	158,245	141,112
17 06 05	Construction materials containing asbestos	5,247,946	3,464,428	2,422,924
	Total	**5,584,707**	**3,650,105**	**2,582,724**

According to the 'Special Waste Report' (Rapporto Rifiuti Speciali) by ISPRA published in 2023, in 2021, 17 landfills (13 for non-hazardous waste and 4 for hazardous waste) accepted ACW in Italy. The different types of landfills accepting ACW and their residual capacity as of 31 December 2021 are shown in the table below.

Table 3-16: Types of landfills accepting ACW and residual capacity in 2021. Source: ISPRA

Type of landfill	Number	"Cell" authorised volume (m^3)	Residual capacity as of 31/12/2021 (m^3)
Type a: landfill completely dedicated to asbestos waste	4	2,112,939	219,058
Type b: landfill equipped with dedicated cell	5	1,345,750	497,514
Type c: landfill equipped with a single dedicated cell	8	2,737,500	301,243
Total	**17**	**6,196,189**	**1,017,815**

Latvia

In Latvia, statistics on ACW are available on the portal of the Latvian Environment, Geology and Meteorology Centre (Latvijas Vides, ģeoloģijas un meteoroloģijas centrs).[56] ACW is classified by the European LoW, and quantities of asbestos waste generated, collected, disposed of (Figure 3-14), recovered, imported and exported (Figure 3-15) are available for years 2002-2022.

56 Latvian Environment, Geology and Meteorology Centre (n.d.). *Public access to the national statistical reports "2-Air", "2-Water" and "3-Waste".* https://videscentrs.lvgmc.lv/lapas/parskatu-ievadisana

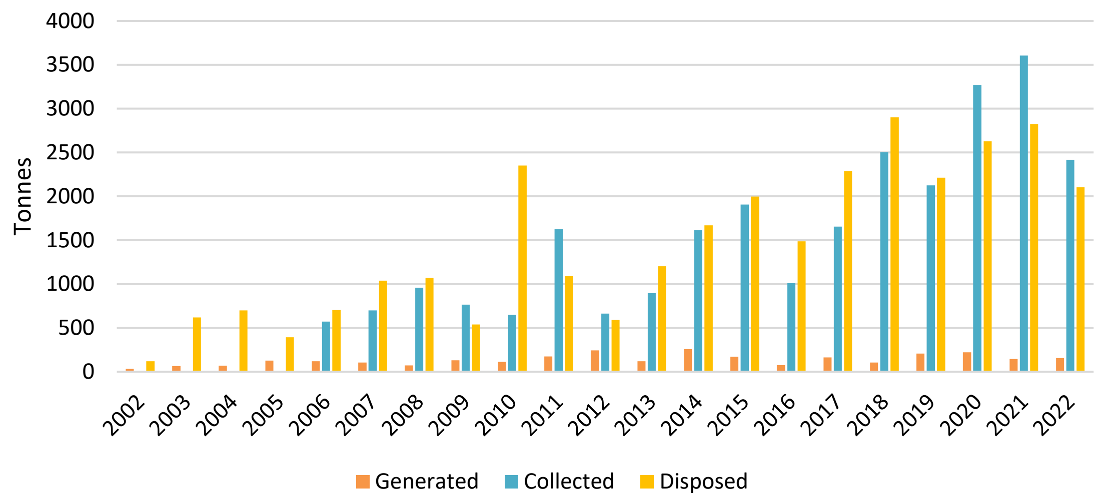

Figure 3-14: Quantities of asbestos waste generated, collected and disposed of in Latvia between 2002 and 2022. Source: Latvian Environment, Geology and Meteorology Centre

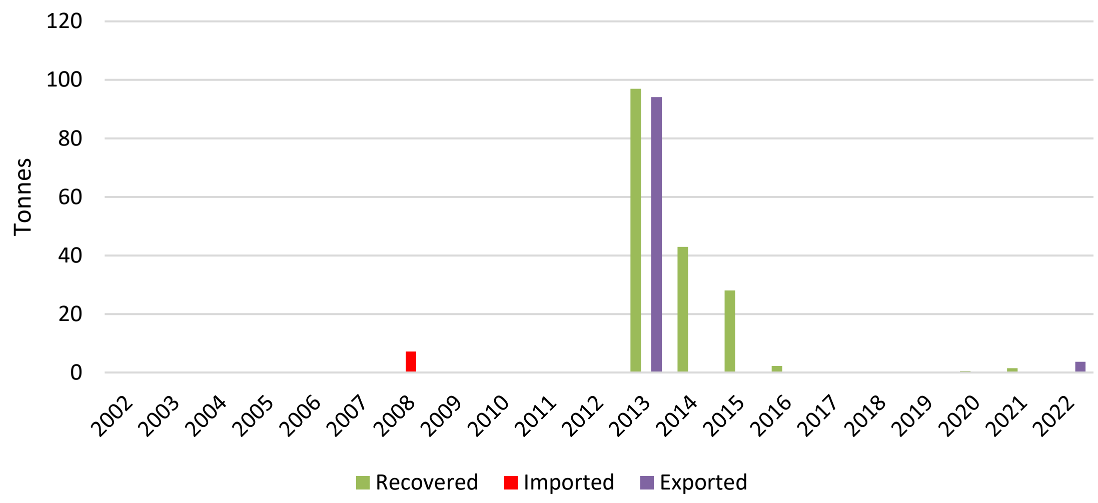

Figure 3-15: Quantities of asbestos waste recovered, exported and imported in Latvia between 2002 and 20212 Source: Latvian Environment, Geology and Meteorology Centre

Overall, quantities of ACW have been growing in Latvia since 2005, although it has been fluctuating each year. Only minor quantities of asbestos waste had been imported and around 100 tonnes had been exported.

Construction materials containing asbestos (17 06 05) was the most common type of asbestos waste in Latvia, followed by insulation materials containing asbestos (17 06 01) and brake pads containing asbestos (16 01 11) (Table 3-17).

Table 3-17: Quantities of asbestos waste generated, collected, disposed of, recovered, imported and exported in Latvia between 2002-2022 by European LoW code. Source: Latvian Environment, Geology and Meteorology Centre							
LoW Code	**Type of ACW**	**Quantities (tonnes)**					
		Generation	**Collection**	**Disposal operations**	**Recovery operations**	**Import**	**Export**
06 13 04	Wastes from asbestos processing	7	1	0	1	0	0
10 13 09	Wastes from asbestos-cement manufacture containing asbestos	10	0	0	0	0	0
15 01 11	Metallic packaging containing a dangerous solid porous matrix (e.g. asbestos), including empty pressure containers	2	0	0	0	0	0
16 01 11	Brake pads containing asbestos	790	665	468	0	0	0
16 02 12	Discarded equipment containing free asbestos	0	0	0	0	0	0
17 06 01	Insulation materials containing asbestos	499	2,435	3,072	39	0	0
17 06 05	Construction materials containing asbestos	1,568	23,839	26,991	132	7	98
	Total	**2,876**	**26,938**	**30,531**	**172**	**7**	**98**

In Latvia, asbestos-containing construction waste and other ACW can be deposited in household waste landfills (in their separate compartments) or in landfills where only ACW is buried without additional inspections, if they comply with relevant sections of landfill regulations (Article 60 of Regulations on landfills).[57] According to the Ministry of Environmental Protection and Regional Development, ACW can be disposed of in seven household waste landfills. In 2002, the only special ACW storage place in Latvia was commissioned with the expected duration of operation of 20 years and the capacity of 220,000 tonnes. The landfill is no longer accepting ACW.

There is no information on the available space in these landfills for ACW. The cost of disposing of asbestos-containing in one of these landfills around 100 EUR/tonne without VAT.

Lithuania

In Lithuania, statistics on ACW are available on the portal of the Lithuanian Environmental Protection Agency.[58] ACW is classified by the European LoW, and quantities of asbestos waste generated, disposed of (Figure 3-16), recovered, processed and exported (Figure 3-17) are available for years

57 Likumi (2011). *Regulations of landfills.* https://likumi.lv/ta/id/242189-atkritumu-poligonu-noteikumi.

58 Lithuanian Environmental Protection Agency (2023). *Summary by waste codes.* https://aaa.lrv.lt/lt/veiklos-sritys/atliekos/atlieku-apskaita/atlieku-apskaitos-duomenys/suvestine-pagal-atlieku-kodus.

2004-2021. Regarding processed ACW, it includes operations D8, D9, D14, R12 and S5[59] and recording data in this way is unique to Lithuania.

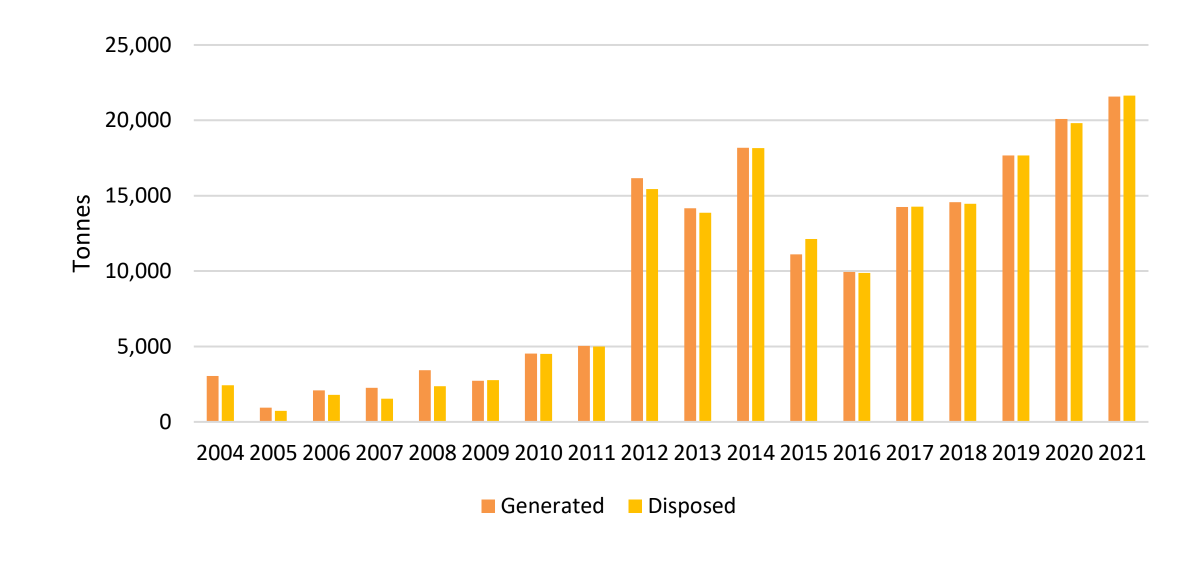

Figure 3-16: Quantities of asbestos waste generated and disposed of in Lithuania between 2004 and 2021. Source: Lithuanian Environmental Protection Agency

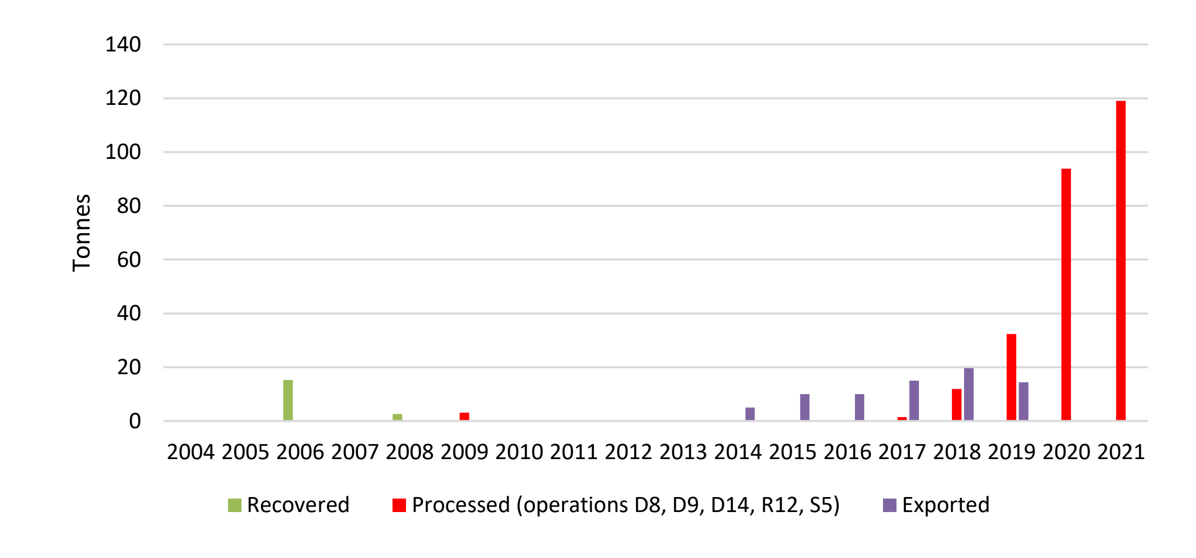

Figure 3-17: Quantities of asbestos waste recovered, processed and exported in Lithuania between 2004 and 2021. Source: Lithuanian Environmental Protection Agency

Quantities of ACW have been growing since 2005, with a significant jump in 2011 and falling in 2015. However, since 2016, quantities of asbestos waste have steadily been growing again. Exports had been taking place between 2014 and 2019, but only for metallic packaging that may contain asbestos (15 01 11). Since 2017, quantities of ACW in processing operations have been sharply increasing. Processing includes operations such as biological (D8) or physico-chemical (D9) treatment of waste resulting in final compounds or mixtures, which are discarded by D1 to D12 operations; repackaging prior to a submission to operations numbered D1 to D13 (D14); exchange of wastes for submission to

59 S5 - preparation of waste for use and disposal, including waste pre-treatment activities. This is an additional classification used by Lithuania, which covers waste management activities that are not included in disposal/recovery operations as per Waste Framework Directive.

operations numbered R1 to R11 (R12); and preparation of waste for use and disposal, which includes pre-treatment activities such as sorting, shredding, drying, mixing, etc. (S5).[60]

Construction materials containing asbestos (17 06 05) was the most common type of asbestos waste in Lithuania, followed by insulation materials containing asbestos (17 06 01) (Table 3-18).

Table 3-18: Quantities of asbestos waste generated, disposed of, recovered, processed and exported in Lithuania between 2004-2021 by European LoW code. Source: Lithuanian Environmental Protection Agency

LoW Code	Type of ACW	Quantities (tonnes)				
		Generation	Disposal operations	Recovery operations	Processing	Export
10 13 09	Wastes from asbestos-cement manufacture containing asbestos	2,115	1,506	0	0	0
15 01 11	Metallic packaging containing a dangerous solid porous matrix (e.g. asbestos), including empty pressure containers	319	16	0	207	74
16 01 11	Brake pads containing asbestos	8	0	0	2	0
17 06 01	Insulation materials containing asbestos	17,730	17,183	2	52	0
17 06 05	Construction materials containing asbestos	161,657	159,787	16	1	0
	Total	**181,828**	**178,493**	**18**	**262**	**74**

The total disposal capacity of the eight regional waste landfills that accept ACW was 164,200 tonnes in 2015. According to experts' estimates, about 1 million tonnes of ACPs were used for the construction of buildings and structures in Lithuania, of which about 96% consisted of slate roofing.[61] The State Audit report on Disposal of Asbestos Containing Products (2015) predicted that it would take more than 100 years to remove the asbestos from the buildings in Lithuania at the disposal rates of that time. However, the quantities of ACW generated until 2021 already exceeded capacities indicated in the report. The State register of waste handlers[62] indicates that more landfills have started accepting ACW since 2015, and currently there are 11 regional waste management centres accepting ACW in their landfills.

The cost to deposit asbestos waste in these landfills varies from around 75 to 145 EUR/tonne with VAT and depends on the regional waste management centre. However, in some landfills, natural persons can deposit 10 to 15 asbestos roofing slates per year or 100 to 300 kg of asbestos waste per year, free of charge.

[60] Register of legal acts (1999). *Regarding the approval of the Waste Management Rules.* https://www.e-tar.lt/portal/lt/legalAct/TAR.38E37AB6E8E6/MuHiZUJPZZ.
[61] National audit office of Lithuania (2015). *Removal of asbestos-containing products.* https://www.valstybeskontrole.lt/LT/Product/23588.
[62] Electronic services of the Ministry of Environment (n.d.). *State register of waste handlers.* https://atvr.aplinka.lt/.

Luxembourg

In Luxembourg, statistics on ACW are published on the Luxembourg Open Data platform.[63] ACW is classified by the European LoW and quantities of asbestos waste generated, disposed of and recovered are available for years 2016-2020 (Figure 3-18). According to the notes in the database, quantities of treated asbestos waste also includes waste that was imported in Luxembourg.

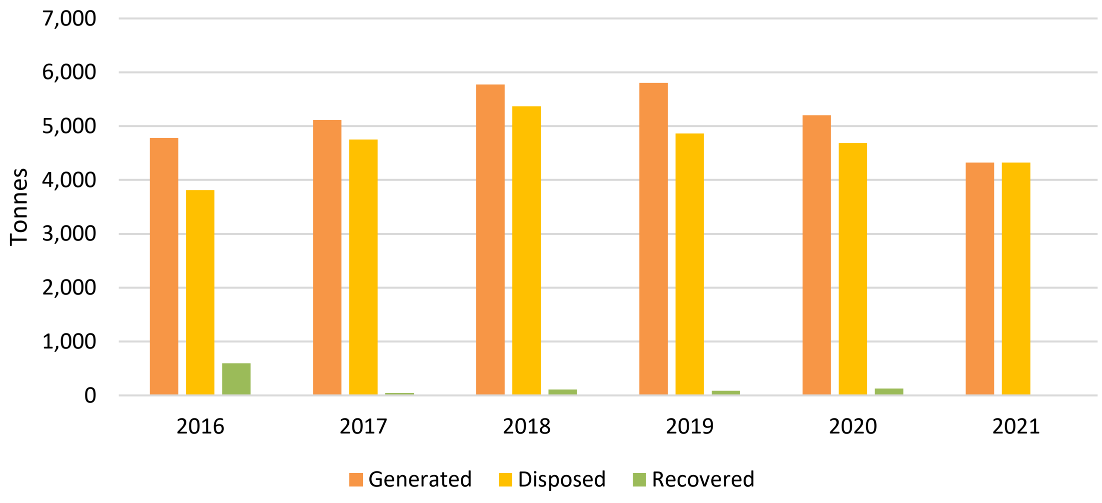

Figure 3-18: Quantities of asbestos waste generated, disposed of and recovered in Luxembourg between 2014 and 2020. Source: The Luxembourg open data platform

Quantities of asbestos waste generated and disposed of in Luxembourg have been relatively steady between 2016 and 2020.

Construction materials containing asbestos (17 06 05) was the most common type of asbestos waste in Luxembourg, followed by insulation materials containing asbestos (17 06 01) (Table 3-19).

Table 3-19: Quantities of asbestos waste generated, disposed of and recovered in Luxembourg between 2016-2020 by European LoW code. Source: The Luxembourg open data platform

LoW Code	Type of ACW	Quantities (tonnes)		
		Generated	Disposal operations	Recovery operations
15 01 11	Metallic packaging containing a dangerous solid porous matrix (e.g. asbestos), including empty pressure containers	2	0	0
16 01 11	Brake pads containing asbestos	4	6	0
16 02 12	Discarded equipment containing free asbestos	0	17	5
17 06 01	Insulation materials containing asbestos	1,207	868	7
17 06 05	Construction materials containing asbestos	25,415	22,591	949
	Total	**26,628**	**23,481**	**960**

63 Data Public (2022). *Aggregate data on waste and resource management.* https://data.public.lu/fr/datasets/donnees-cumulees-concernant-la-gestion-des-dechets-et-des-ressources/.

Malta

For Malta, data on asbestos waste generated and exported in the country was provided by competent authorities through the stakeholders' consultation. The quantities of asbestos waste generated and exported include the amount of waste classified under LoW codes 17 06 01 and 17 06 05. The data is available for years 2012-2021. The quantities of asbestos waste generated and exported in Malta can be found in the graph below.

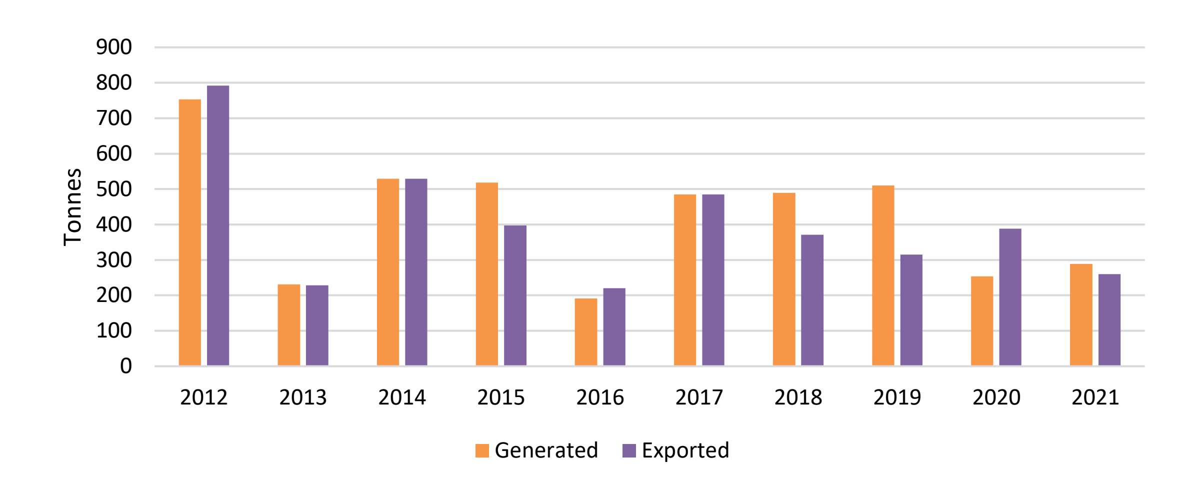

Figure 3-19: Quantities of asbestos waste generated and exported in Malta between 2012 and 2021. Source: Environment & Resources Authority

In Malta, all asbestos waste generated during these years was exported to be landfilled (D5) and no waste was treated locally.

Netherlands

In Netherlands, statistics on ACW was provided by competent authorities through the stakeholders' consultation. Aggregated data for all generated and disposed of ACW is available for years 2009 to 2020 (Figure 3-20).

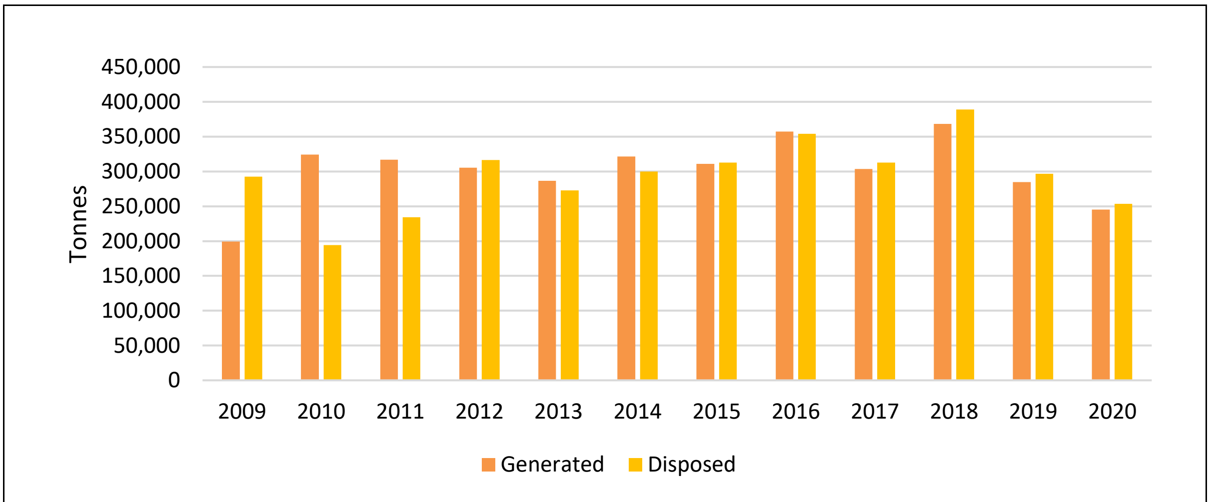

Figure 3-20: Quantities of asbestos waste generated and disposed of in the Netherlands between 2009 and 2020. Source: Ministry of Infrastructure and Water Management

According to the Ministry of Infrastructure and Water Management report 'Waste Processing in the Netherlands: Data 2020'[64], in 2020, 18 landfills accepted ACW in the country.

Poland

In Poland, statistics on ACW are published in the Polish Asbestos Database[65] (the only Member State that has established such database), which is a tool for collecting and processing information about ACPs on territory of Poland and where all local authorities are required to inventory the asbestos containing products. The database is one of the tools for monitoring the implementation of the Programme for Asbestos Abatement in Poland 2009-2032 and it is maintained by the Ministry of Economic Development and Technology. The objective of the programme is to become asbestos-free by 2032 by achieving three main goals: removing and disposing of products containing asbestos, minimising negative health effects of contact with asbestos fibres and eliminating the negative effects of asbestos on the environment. Poland is the only EU Member State to have an overarching asbestos management strategy.

Data on asbestos waste in Poland are collected using 22 product codes. Statistics on asbestos products inventoried, neutralised (stored in landfills) and remaining for neutralisation are recorded. As of October 2023, almost 8.6 million tonnes of ACPs have been inventoried in Poland, of which approximately 1.6 million tonnes have been neutralised. The table below shows quantities of inventoried and neutralised ACPs by product type and the remaining quantities to be neutralised.

Table 3-20: Quantities on inventoried, neutralised and remaining ACPs by product code in Poland. Source: Polish Asbestos Database

Product code	Description	Corresponding LoW code	Quantity (tonnes)			Percent remaining
			Inventoried	Neutralised	Remaining	
W01	Flat asbestos-cement plates used in construction	17 06 05	687,254	212,047	475,207	69%
W02	Corrugated asbestos-cement sheets for construction	17 06 05	7,664,981	1,407,298	6,257,710	82%
W03.1	Asbestos-cement pipes and joints for removal	17 06 05	112,536	8,357	104,180	93%
W03.2	Asbestos-cement pipes and joints to be left in the ground	-	80,512	5,983	74,529	93%
W04	Spray insulations with asbestos-containing agents	17 06 01	30,447	7,758	22,689	75%
W05	Asbestos-rubber friction products	16 01 11	14	9	4	32%
W06	Special yarns, including processed asbestos fibres (protective fabrics and clothing)	15 02 02	158	76	82	52%
W07	Asbestos sealants	17 06 01	362	203	159	44%
W08	Woven and braided tapes, cords and strings	17 06 01	766	92	675	88%

64 Ministry of Infrastructure and Water Management (2022). *Waste processing in the Netherlands, data 2020.*
65 Baza Asbestova (n.d.). *Statistical summary.* https://bazaazbestowa.gov.pl/en/.

Table 3-20: Quantities on inventoried, neutralised and remaining ACPs by product code in Poland. Source: Polish Asbestos Database						
Product code	**Description**	**Corresponding LoW code**	**Quantity (tonnes)**			**Percent remaining**
			Inventoried	**Neutralised**	**Remaining**	
W09	Asbestos and rubber products, except friction products	17 06 01	45	36	9	20%
W10	Paper, cardboard	17 06 01	280	59	221	79%
W11.1	Asbestos-cement covers	17 06 01	11,554	4,754	6,800	59%
W11.2	Asbestos-cement construction fittings (ventilation ducts, windowsills, flue gas covers)	17 06 05	716	276	440	61%
W11.3	Asbestos-cement electrical insulating fittings	16 02 13	4	3	1	19%
W11.4	PVC tiles	17 09 03	91	34	57	63%
W11.5	Fireproof boards	17 06 01	583	40	543	93%
W11.6	Roofing felt, putties and waterproofing compounds	17 09 03	21	1	20	96%
W11.7	Household appliances	20 01 35	5	5	0	0%
W11.8	Work clothes, masks, filters contaminated with asbestos	15 02 02	37	7	30	82%
W11.9	Other not mentioned above	-	5,934	769	5,164	87%
W12.1	Secured roads	-	150	149	0	0%
W12.2	Unsecured roads	-	12	5	6	54%
		Total	**8,596,460**	**1,647,960**	**6,948,528**	81%

In 2008, it was estimated that the total amount of ACW that would be generated in the country by 2032 would be 14.5 million tonnes.[66] Hence, it means that the remaining waste to be neutralised is around 12.9 million tonnes.

Construction materials containing asbestos (17 06 05) is the most common type of asbestos waste in Poland (98%). Four LoW codes used to classify the waste in the database are not asbestos-specific LoW codes (15 02 12*, 16 02 13*, 17 09 03*, and 20 01 35*). Moreover, the second biggest source of ACW recorded is not classified according to the LoW (Table 3-21).

Table 3-21: Quantities of asbestos waste inventoried, neutralised and remaining in Poland as of 06/10/2023 by European LoW code. Source: Polish Asbestos Database				
LoW Code	**Type of ACW**	**Quantities (tonnes)**		
		Inventoried	**Neutralised**	**Remaining**
16 01 11	Brake pads containing asbestos	14	9	4
17 06 01	Insulation materials containing asbestos	44,038	12,942	31,096
17 06 05	Construction materials containing asbestos	8,465,487	1,627,978	6,837,537
15 02 12	Absorbents, filter materials (including oil filters not otherwise specified), wiping cloths,	195	83	112

66 Ministry of Economy (2010). *Programme for Asbestos Abatement in Poland 2009-2032.* https://www.bazaazbestowa.gov.pl/images/do-pobrania/PROGRAM_ENG.pdf.

LoW Code	Type of ACW	Quantities (tonnes)		
		Inventoried	Neutralised	Remaining
	protective clothing contaminated by dangerous substances			
16 02 13	Discarded equipment containing hazardous components other than those mentioned in 16 02 09 to 16 02 12	4	3	1
17 09 03	Other construction and demolition wastes (including mixed wastes) containing dangerous substances	112	34	78
20 01 35	Discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components	5	5	0
No code		86,607	6,907	79,700
	Total	**8,596,460**	**1,647,960**	**6,948,528**

Table 3-21: Quantities of asbestos waste inventoried, neutralised and remaining in Poland as of 06/10/2023 by European LoW code. Source: Polish Asbestos Database

According to the Polish Asbestos Database[67], there are currently 35 operating landfills and two planned landfills for ACW in the country. The total capacity of the 35 operational landfills is 3,037,690 m^3, and the remaining capacity is 2,130,601 m^3.

Portugal

In Portugal, statistics on ACW are published in the 'Management of Construction and Demolition Waste with Asbestos Monitoring Report' (Gestão de Resíduos de Construção e Demolição com amianto Relatório de acompanhamento)[68] on the portal of the Portuguese Environmental Agency. ACW is classified by the European LoW, although quantities of insulation materials containing asbestos (17 06 01) and construction materials containing asbestos (17 06 05) are recorded together. Data on asbestos waste generation is available for years 2015-2021, and for asbestos waste disposal – for years 2014-2021 (Figure 3-21).

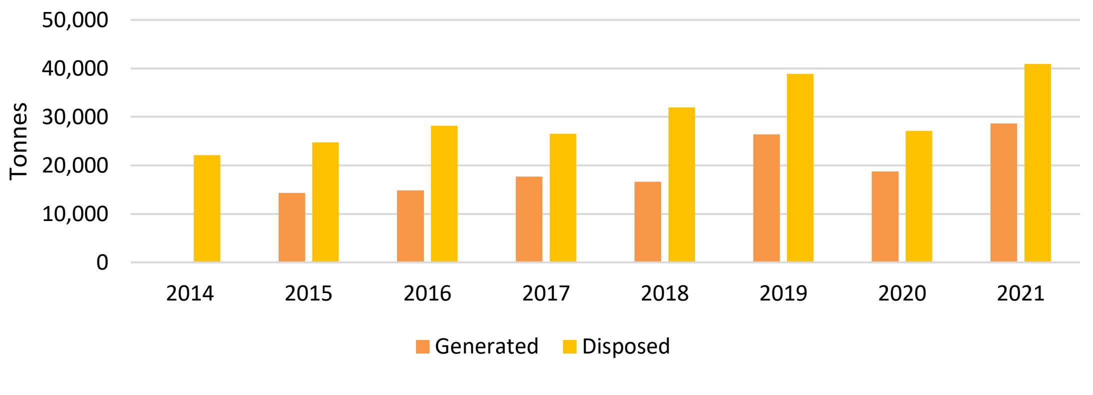

Figure 3-21: Quantities of asbestos waste generated and disposed of in Portugal between 2014 and 2021. Source: Portuguese Environment Agency

67 Baza Asbestova (n.d.). *Landfills.* https://bazaazbestowa.gov.pl/pl/usuwanie-azbestu/skladowiska.

68 Portuguese Environment Agency (n.d.). *Construction and Demolition Waste with Asbestos.* https://apambiente.pt/residuos/residuos-de-construcao-e-demolicao-com-amianto.

Quantities of ACW had been steadily growing in Portugal, although there was a considerable dip in 2020. Quantities of disposed of asbestos waste have followed the trend; however, they were much higher than quantities generated. This trend was found to be related in part with the fact that asbestos waste was stored and sent to landfill later. In addition, Portugal also imports asbestos waste from countries like Malta, Greece and Mauritania.[69] Table below shows quantities of construction waste containing asbestos generated in Portugal between 2014 and 2021.

Table 3-22: Quantities of asbestos waste generated and disposed of in Portugal between 2014-2021 by European LoW code. Source: Portuguese Environment Agency

LoW Code	Type of ACW	Quantities (tonnes)	
		Generated	Disposal operations
17 06 01/17 06 05	Construction waste containing asbestos	137,185	240,437
	Total	**137,185**	**240,437**

According to the Portuguese Environment Agency[70], two waste management operators were licensed to deposit ACW in 2022.

Romania

In Romania, statistics on ACW are published in the 'National Plan of Waste Management 2014-2020'[71], which is available on the portal of the Ministry of Environment, Waters and Forests. Data for generated asbestos waste are only available for years 2010-2014 (Figure 3-22), but the plan says that this is an estimation of the quantities generated in this period. There is a large variation in the quantities generated, which can be mainly attributed to the lack of data for this flow and to the lack of proper management of both ACW and CDW (e.g., generated and uncollected quantities, lack of procedures for the identification and management of ACW, etc.).[72]

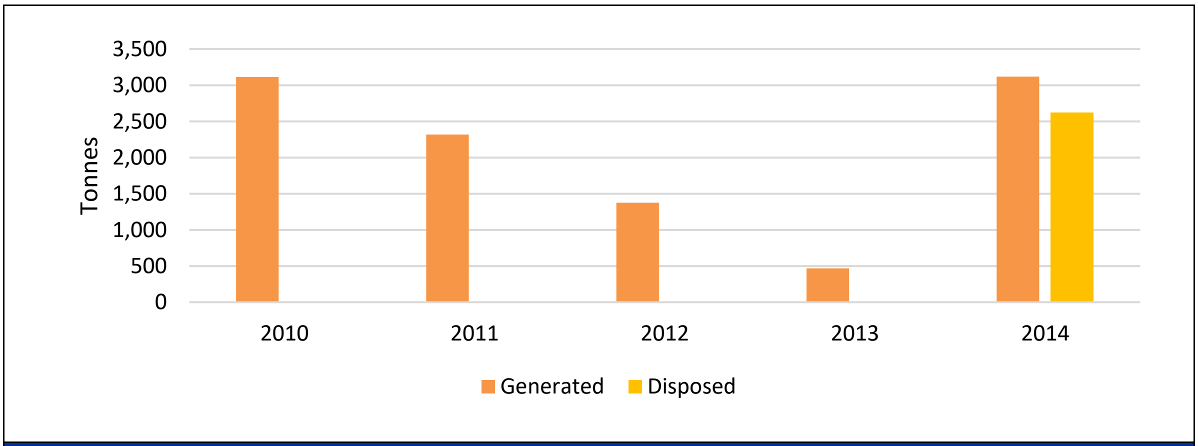

Figure 3-22: Quantities of asbestos waste generated in Romania between 2010 and 2014. Source: National plan of waste management 2014-2020

69 Ibid.

70 Portuguese Environment Agency (2022). *List of waste management operators licensed to treat construction and demolition waste containing asbestos (RCDA).* https://apambiente.pt/sites/default/files/_Residuos/FluxosEspecificosResiduos/RCD/Lista_OGR_Amianto_out2022.pdf.

71 POCA (2017). *The National Plan of Waste Management.* http://mmediu.ro/app/webroot/uploads/files/PNGD_vers5.pdf.

72 Ibid.

According to the 'National Plan of Waste Management'[73], published by the Ministry of the Environment in 2017, 99% of ACW (around 2,600 tonnes) in 2014 was landfilled (D5), while 22 tonnes of asbestos waste were incinerated (D10).

According to the Plan, in 2015 there were two non-hazardous waste landfills equipped with special cells to store ACW under the conditions imposed by specific legislation, with a total capacity of 114,158 m^3 (135,491 tonnes), of which approximately 100,000 tonnes were still available at the end of 2015.

Slovakia

For Slovakia, data on asbestos waste collected, disposed of and recovered in the country was provided by competent authorities through the stakeholders' consultation. The quantities of asbestos waste are classified by LoW codes, and the data is available for years 2016-2021. The quantities of asbestos waste generated and exported in Slovakia can be found in the graph below.

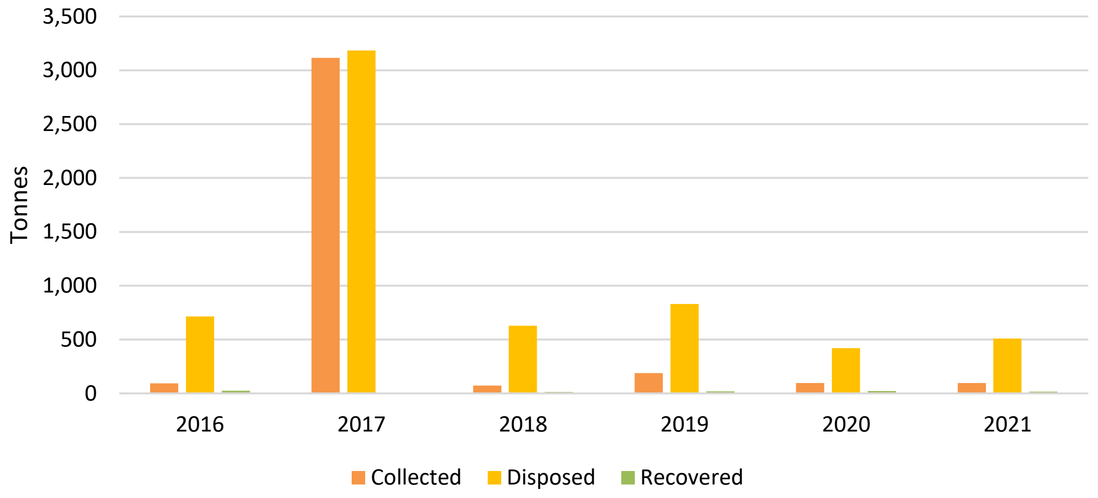

Figure 3-23: Quantities of asbestos waste collected, disposed of and recovered between 2016 and 2021. Source: Ministry of Environment

Quantities of ACW have been steady in Slovakia, although there was a considerable increase in 2017. Quantities of disposed of asbestos waste have followed the trend; however, they were generally much higher than quantities collected.

Construction materials containing asbestos (17 06 05) was the most common type of asbestos waste in Slovakia, followed by metallic packaging containing asbestos (15 01 11) (Table 3-23).

Table 3-23: Quantities of asbestos waste collected, disposed of and recovered in Slovakia between 2016 and 2021 by European LoW code. Source: Ministry of Environment

LoW Code	Type of ACW	Quantities (tonnes)		
		Collected	Disposal operations	Recovery operations
15 01 11	Metallic packaging containing a dangerous solid porous matrix (e.g. asbestos), including empty pressure containers	176	351	75
16 01 11	Brake pads containing asbestos	6	28	2

[73] Ibid.

Table 3-23: Quantities of asbestos waste collected, disposed of and recovered in Slovakia between 2016 and 2021 by European LoW code. Source: Ministry of Environment				
LoW Code	**Type of ACW**	**Quantities (tonnes)**		
		Collected	**Disposal operations**	**Recovery operations**
16 02 12	Discarded equipment containing free asbestos	0	0	1
17 06 01	Insulation materials containing asbestos	51	369	0
17 06 05	Construction materials containing asbestos	3,431	5,540	28
	Total	**3,664**	**6,288**	**105**

Slovenia

In Slovenia, statistics on ACW are published on the portal of the Slovenian Environment Agency under Ministry of the Environment and Spatial Planning.[74] ACW is classified by the European LoW, and quantities of asbestos waste generated, disposed of and recovered are available for years 2016-2021 (Figure 3-24).

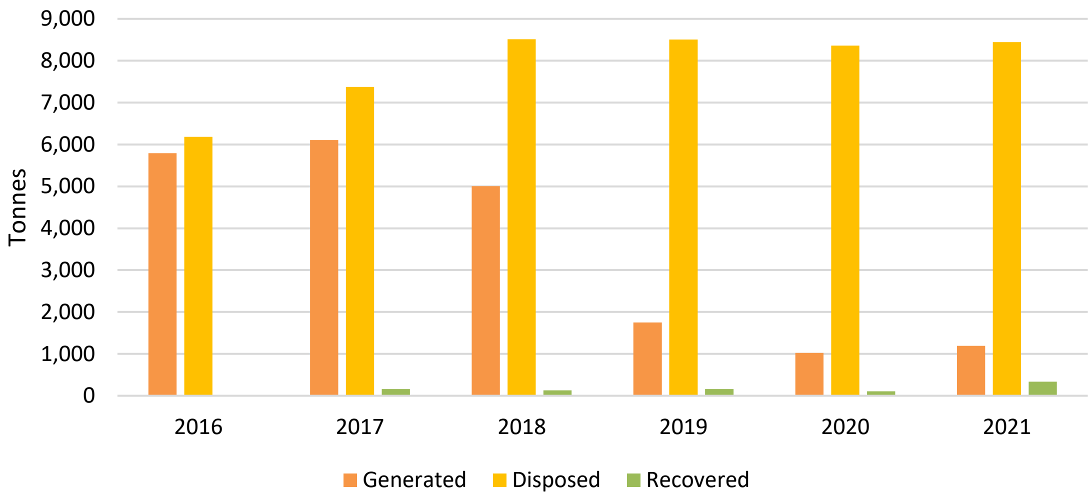

Figure 3-24: Quantities of asbestos waste generated, disposed of and recovered between 2016 and 2021. Source: Slovenian Environment Agency

According to data, quantities of ACW generated in the country have been decreasing since 2017, although there was a slight increase in 2021. On the other hand, quantities of disposed of asbestos waste has been growing between 2016 and 2018 and remained steady until 2021. The considerable gap between generated and disposed of asbestos waste could be related to the landfilling of waste that had previously been stored and waited to be disposed of or due to imports of asbestos waste from other countries.

Construction materials containing asbestos (17 06 05) was the most common type of asbestos waste in Slovenia, followed by metallic packaging containing asbestos (15 01 11) (Table 3-24).

[74] Slovenian Environment Agency (n.d.). *Waste-reports and publications.* https://www.arso.gov.si/varstvo%20okolja/odpadki/poro%c4%8dila%20in%20publikacije/.

Table 3-24: Quantities of asbestos waste generated, disposed of and recovered in Slovenia between 2016 and 2021 by European LoW code. Source: Slovenian Environment Agency				
LoW Code	**Type of ACW**	**Quantities (tonnes)**		
		Generated	**Disposal operations**	**Recovered**
06 13 04	Wastes from asbestos processing	2	0	0
10 13 09	Wastes from asbestos-cement manufacture containing asbestos	1	0	0
15 01 11	Metallic packaging containing a dangerous solid porous matrix (e.g. asbestos), including empty pressure containers	104	259	0
16 01 11	Brake pads containing asbestos	1	2	0
16 02 12	Discarded equipment containing free asbestos	0	0	0
17 06 01	Insulation materials containing asbestos	54	44	0
17 06 05	Construction materials containing asbestos	20,723	47,074	908
	Total	**20,884**	**47,379**	**908**

According to the Slovenian Ministry of the Environment, Climate and Energy[75], there were 13 landfills with an environmental permit for ACW disposal in the country as of July 2023.

Spain

No information was found on ACW generation and disposal at the national level in Spain.

The study team was able to obtain some data on ACW generation and disposal from the competent authorities' websites of some of the autonomous communities.

In the autonomous community of Catalonia, statistics on asbestos containing waste are published on the Waste Agency of Catalonia website[76]. The quantities of asbestos waste disposed of are classified by LoW codes, and the data is available for years 2008-2022. The quantities of asbestos waste disposed of in Catalonia can be found in the graph below.

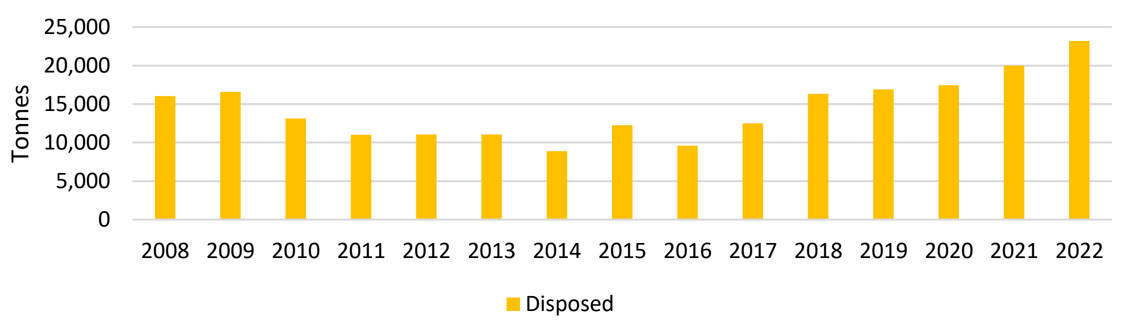

Figure 3-25: Quantities of asbestos waste disposed of in Catalonia between 2008 and 2022. Source: Waste Agency of Catalonia

[75] Ministry of Environment, Climate and Energy (2023). *Record of waste processors.* https://www.gov.si/assets/ministrstva/MOPE/Okolje/Odpadki/Podatki/Odstranjevalci-odpadkov.pdf.

[76] Generalitat de Catalunya (2022). *Els residus de la construcción gestionats a Catalunya l'any 2022.* https://residus.gencat.cat/web/.content/home/consultes_i_tramits_-_nou/estadistiques/estadistiques_de_runes/informe_runes_2022.pdf.

Quantities of ACW have been steadily increasing in Catalonia since 2016. Construction materials containing asbestos (17 06 05) was the most common type of asbestos waste in Catalonia, followed by insulation materials containing asbestos (17 06 01) (Table 3-25).

Table 3-25: Quantities of asbestos waste disposed of in Catalonia between 2008-2022 by European LoW code. Source: Waste Agency of Catalonia

LoW Code	Type of ACW	Quantities (tonnes)
16 01 11	Brake pads containing asbestos	78
17 06 01	Insulation materials containing asbestos	5,722
17 06 05	Construction materials containing asbestos	210,167
	Total	**215,967**

The study team was able to find only fragmented data on ACW generation and disposal in other Spanish autonomous communities.

In Andalusia, data from the 'Comprehensive Waste Plan of Andalusia'[77] shows that in 2018 the amount of ACW (17 06 05) generated was 5,296 tonnes, while 4,597 tonnes were disposed of in the same year.

The ACW disposed of (D5+D15) in the Balearic Islands in 2017 amounted to 1,048 tonnes[78], while in the same year 1,456 tonnes of ACW were disposed of (D5+D15) in Navarra[79].

According to the 'Integral Waste Plan of Castilla y León'[80], the ACW disposed of in the region in 2010 amounted to 3,344 tonnes.

For the remaining autonomous communities, the study team was not able to find publicly available information on ACW generation and disposal.

Sweden

For Sweden, two sets of data on asbestos waste were provided by competent authorities through the stakeholders' consultation. One set of data shows ACW generated by LoW codes for years 2020-2022 (Figure 3-26), while the other shows aggregated data for ACW generated and disposed of in 2014, 2016, 2018 and 2020 (Figure 3-27). The data overlap for one year, 2020; however, as can be seen in the figures below, the quantities shown for 2020 do not coincide, as those in the second dataset are much higher.

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77 Junta de Andalucía (2021). *Plan Integral de Residuos de Andalucía. Hacia una Economía Circular en el Horizonte 2030.* https://www.juntadeandalucia.es/medioambiente/portal/documents/20151/26992373/2021_10_19_PIRec_completo5.pdf/6c1a646a-c293-79ca-c201-a913386b86ce.

78 Govern Illes Balears (2023). *Plan Director Sectorial de Prevención y Gestión de Residuos Peligrosos de las Illes Balears.* http://www.caib.es/govern/sac/fitxa.do?codi=4337931&coduo=2390691&lang=es.

79 Gobierno de Navarra (2020). *Plan Director del proceso a desarrollar para la eliminación del amianto en Navarra.* https://oprec-navarra.com/wp-content/uploads/2021/02/PD-eliminacion-amianto.pdf.

80 Junta de Castilla y León (2014). *Plan Integral de Residuos de Castilla y León (PIRCyL).* https://medioambiente.jcyl.es/web/es/calidad-ambiental/plan-integral-residuos-castilla.html.

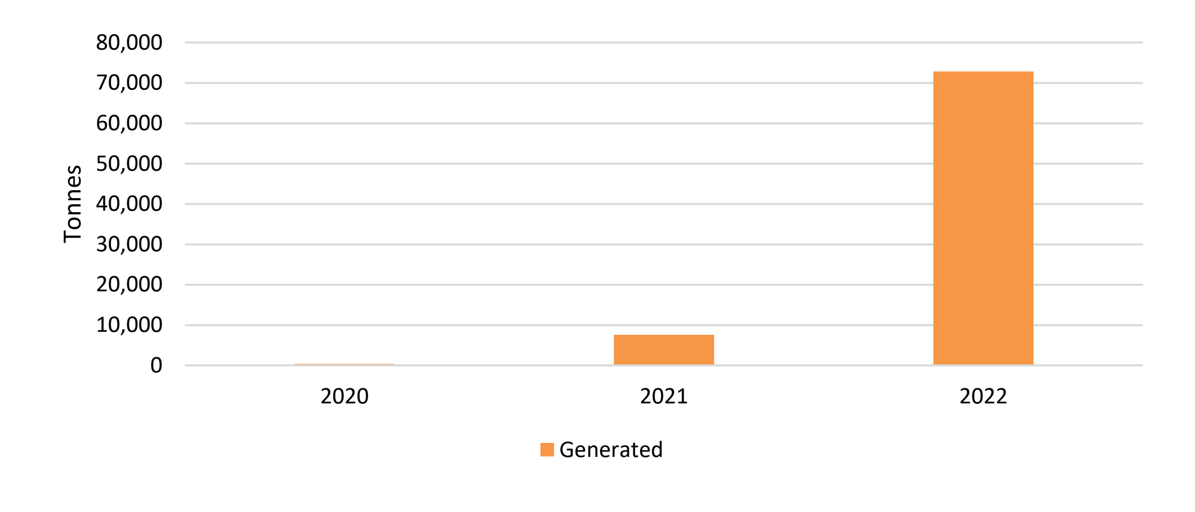

Figure 3-26: Quantities of asbestos waste generated in Sweden between 2020 and 2022. Source: Swedish Environmental Protection Agency

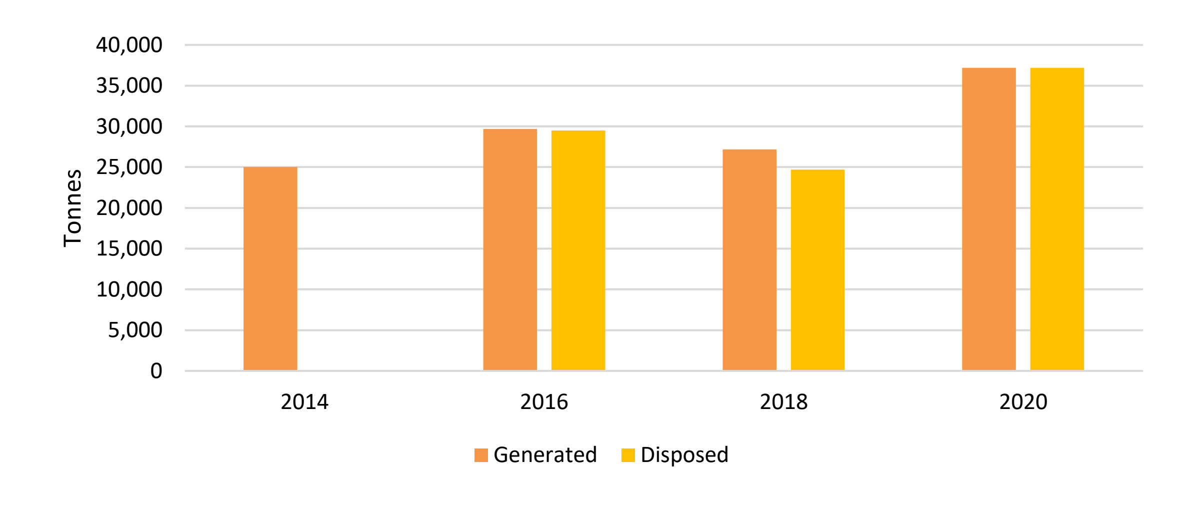

Figure 3-27: Quantities of asbestos waste generated and disposed of in Sweden in 2014, 2016, 2018 and 2020. Source: Swedish Environmental Protection Agency

Construction materials containing asbestos (17 06 05) was the most common type of asbestos waste in Sweden, followed by insulation materials containing asbestos (17 06 01) (Table 3-26).

Table 3-26: Quantities of asbestos waste generated and disposed of in Sweden between 2020-2022 by European LoW code. Source: Swedish Environmental Protection Agency

LoW Code	Type of ACW	Quantities (tonnes) Generated
15 01 11	Metallic packaging containing a dangerous solid porous matrix (e.g. asbestos), including empty pressure containers	97
16 01 11	Brake pads containing asbestos	0
17 06 01	Insulation materials containing asbestos	4,776
17 06 05	Construction materials containing asbestos	75,933
	Total	**80,806**

Overview of all Member States

Table 3-27 shows the total quantities of ACW recorded in each Member State.

Table 3-27: Total quantities of ACW recorded in Member States. Source: Data from Member States and Eurostat

Member State	Years	Quantities (tonnes)								
		Generated	Collected	Collected and managed	Produced in-house	Recovery operations	Disposal operations	Processed	Imported (2001-2020)	Exported (2001-2020)
Austria	2009-2021	909,140	-	-	-	-	870,890	-	57,928	2,589
Belgium	2012-2021	-	-	-	-	-	1,458,731	-	11,370	132,542
Bulgaria	2017-2021	9	-	-	-	-	2,539	-	-	-
Croatia	2008-2021	69,358	-	-	-	-	68,735	-	-	4,163
Cyprus	2009-2014	-	-	5,167	-	-	-	-	-	4,055
Czech Republic	2013-2021	240,202	-	-	-	-	-	-	476	-
Denmark	2011-2020	721,321	-	-	-	36,498	684,823	-	1,107	-
Estonia	2004-2022	124,783	-	-	-	798	123,187	-	-	-
Finland	2010-2022	-	-	-	-	709	569,212	-	39	169
France	2013-2014	897,213	-	-	-	-	198,000	-	17,823	18,767
Germany	2005-2021	8,287,600	-	-	63,500	-	10,860,400	-	3,515,850	4,805
Greece	-	-	-	-	-	-	-	-	7	23,578
Hungary	2010-2018	35,885	-	-	-	495	98,198	-	-	-
Ireland	2014	-	-	-	-	-	6,246	-	-	123,856
Italy	2007-2021	5,584,707	-	-	-	-	3,650,105	-	8,718	3,569,531
Latvia	2002-2022	2,876	26,938	-	-	172	30,531	-	-	-
Lithuania	2004-2021	181,828	-	-	-	18	178,493	262	10	-
Luxembourg	2016-2021	30,995	-	-	-	964	27,802	-	-	102,322
Malta	2012-2021	4,251	-	-	-	-	-	-	-	4,784
Netherlands	2009-2020	3,623,550	-	-	-	-	3,275,779	-	116,056	50,754
Poland	To date	-	-	-	-	-	1,647,960	-	-	6,031
Portugal	2014-2021	137,185	-	-	-	-	240,437	-	5,059	3,279
Romania	2010-2014	10,390	-	-	-	-	2,622	-	-	-
Slovak Republic	2016-2021	-	3,664	-	-	105	6,288	-	-	-
Slovenia	2016-2021	20,884				908	47,378		-	2,953
Spain	-	-	-	-	-	-	-	-	17,277	2,001
Sweden	2020-2022	80,806	-	-	-	-	-	-	3,396	30
Total	**2004-2022**	**20,144,757**	**30,602**	**5,167**	**63,500**	**40,667**	**23,066,753**	**262**	**3,755,116**	**4,056,209**

3.3.2 Imports and exports of asbestos waste in the EU

Statistics on shipments of waste from Eurostat[81] have been analysed to understand the exports and imports of waste-containing asbestos by Member States. Waste streams assigned category Y36 - Asbestos (dust and fibres) as per Annex I of the Basel Convention have been investigated.

Data in Eurostat is reported in accordance with the Regulation (EC) No 1013/2006 on shipment of waste[82] , and data on imports and exports is available for 2001-2020 period. The figure below shows that, except for Bulgaria, Estonia, Hungary, Latvia, Romania and Slovakia, all other countries had imported and/or exported ACW to other countries. In total, approximately 3.8 million tonnes of ACW had been imported to Member States, either from other Member States or non-EU countries, whereas around 4.1 million tonnes had been exported.

Quantities of imported/exported waste differs substantially depending on the country. The biggest importer of ACW is Germany, with over 3.5 million tonnes of asbestos waste imported between 2001 and 2020. Other countries that imported more than 10,000 tonnes of asbestos waste include Austria, Belgium, France, the Netherlands and Spain. The highest exporter of asbestos waste is Italy, which exported almost 3.6 million tonnes of such waste throughout the period. Other countries that exported more than 10,000 tonnes of asbestos waste are Belgium, France, Greece, Ireland, Luxembourg and the Netherlands.

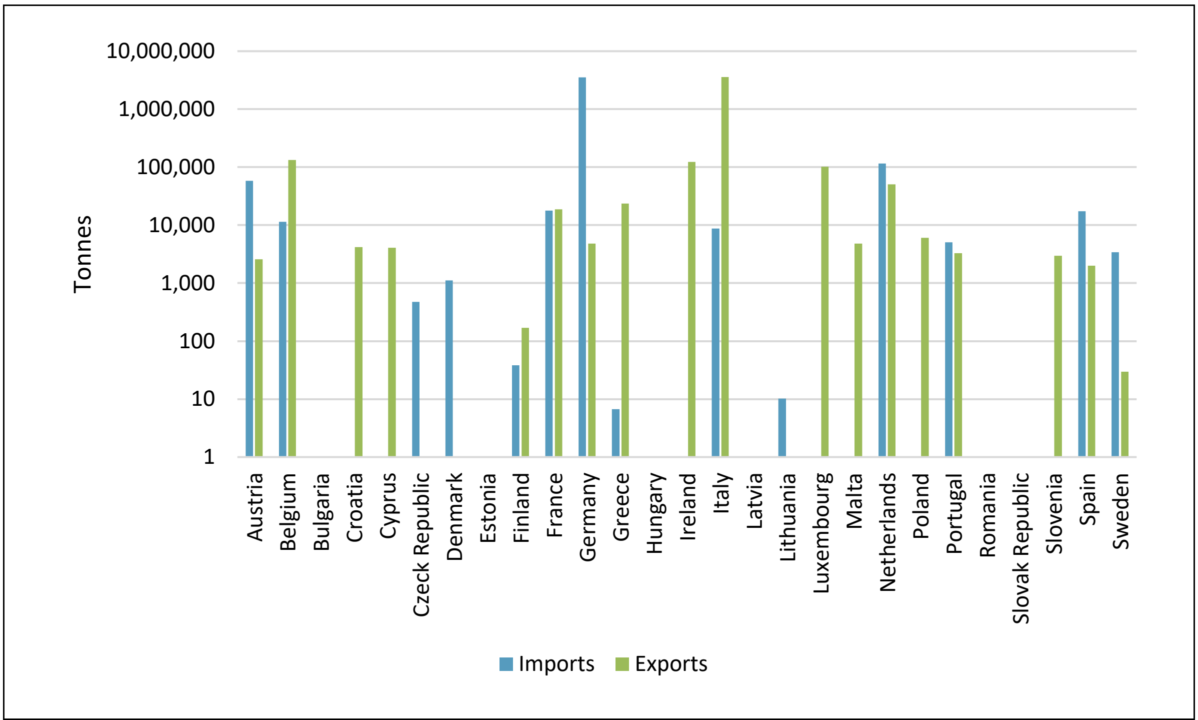

Figure 3-28: Quantities of asbestos waste imported and exported in Member States (data last updated on 28 October 2022). Source: Eurostat. NOTE: quantities presented in logarithmic scale.

81 Eurostat (2022). *Waste shipment statistics.* https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_shipment_statistics#:~:text=Between%202001%20and%202020%2C%20the,million%20tonnes%20(%2B22%20%25).

82 European Parliament (2006). Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste. *Official Journal of the European Union,* 190. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32006R1013.

The list of countries that Member States have imported from and exported to is presented in Table 3-28. Germany imported from a substantially larger number of countries compared to other Member States. The largest quantities of ACW were imported from Italy (3.26 million tonnes), followed by Ireland with 88.4 thousand tonnes. This shows that Italy is the most significant exporter of asbestos waste to Germany. France also imported from more than ten countries, with the largest quantities imported from Luxembourg (10.8 thousand tonnes).

Table 3-28: Countries that Member States imported from and exported to[83]. Source: Eurostat

Member State	Countries imported from	Countries exported to
Austria	Italy, Slovenia	Germany, Italy
Belgium	Congo, France, Luxembourg, Netherlands	Czechia, France, Germany, Netherlands
Bulgaria		
Croatia		Germany
Cyprus		Germany, United Kingdom
Czech Republic	Belgium, Germany, Poland	
Denmark	Italy	
Estonia		
Finland	Sweden	Czechia
France	Algeria, Andorra, Belgium, Gabon, Germany, Ireland, Italy, Luxembourg, Monaco, Morocco, Poland, Spain, Switzerland	Belgium, Germany, New Zealand, Spain
Germany	Afghanistan, Austria, Belgium, Bosnia and Herzegovina, Côte d'Ivoire, Croatia, Cyprus, Denmark, Former Serbia and Montenegro (before 2006), France, Greece, Hungary, Ireland, Italy, Kosovo, Kuwait, Luxembourg, Malta, Montenegro, Netherlands, North Macedonia, Norway, Pakistan, Poland, Portugal, Serbia, Slovenia, Spain, Sudan, Sweden, Switzerland, Turkey, United Kingdom, Unites States	Czechia, France, Netherlands
Greece	Albania	Germany, Norway, Spain, United Kingdom, Portugal
Hungary		
Ireland		Denmark, France, Germany, Norway, Netherlands, Sweden, United Kingdom
Italy	Croatia, San Marino, Senegal, Germany	Austria, Denmark, France, Germany, Switzerland
Latvia		
Lithuania	Georgia	
Luxembourg		Belgium, France, Germany
Malta		Germany, Portugal, Spain
Netherlands	Belgium, Germany, Norway, Former Netherlands Antilles, United Kingdom	Belgium, China (including Hong Kong), Germany, Denmark, Turkey
Poland		Germany, France, Czechia
Portugal	Greece, Malta, Nigeria, Oman	Germany, Spain
Romania		
Slovak Republic		
Slovenia		Austria, Germany

83 Some discrepancies may be present due to differences in reporting between the respective countries, e.g., the use of different waste classification or treatment codes. Hence, a country that shows imports from another country may not show as an export country for that same country.

Table 3-28: Countries that Member States imported from and exported to[83]. Source: Eurostat		
Member State	**Countries imported from**	**Countries exported to**
Spain	Andorra, Greece, Italy, Portugal, United Kingdom, Malta	Czechia, Germany
Sweden	Ireland	Finland, Denmark

3.3.3 Future trends and projections

The data on quantity of asbestos currently embedded in buildings in Member States, as quantified in Annex 2, was converted to an estimate of the quantity of ACW that would be generated if all currently embedded asbestos in buildings were to be removed completely and disposed of as per the current methods. Table 3-29 provides conversions of the tonnes of raw asbestos remaining in buildings into quantity of ACW that would be generated, using the 3%, 5% and 10% asbestos waste content assumptions. According to the estimates, considering the 10% asbestos content in waste, over 200 million tonnes of asbestos waste may be generated if all remaining asbestos is removed from buildings, rising to more than 760 million tonnes if the asbestos content is 3%. The reasoning for these assumptions is presented in Annex 2.

Table 3-29: Implied total quantity of ACW that would be generated by total removal of remaining asbestos with current methods (t)			
Assumed content of asbestos in construction waste	**3%**	**5%**	**10%**
Austria	21,833,273	12,638,606	5,742,606
Belgium and Luxembourg	59,898,998	35,024,331	16,368,331
Bulgaria			
Croatia	11,470,753	6,852,087	3,388,087
Cyprus	11,114,083	6,666,083	3,330,083
Czech Republic	11,706,414	6,885,080	3,269,080
Denmark	18,534,554	10,683,887	4,795,887
Estonia	1,128,550	627,217	251,217
Finland	10,375,238	5,959,238	2,647,238
France	119,662,696	68,825,363	30,697,363
Germany	233,870,613	136,622,613	63,686,613
Greece			
Hungary	25,720,365	15,405,698	7,669,698
Ireland	10,941,113	6,546,446	3,250,446
Italy	121,149,400	70,109,400	31,829,400
Latvia	2,905,303	1,731,970	851,970
Lithuania	4,597,313	2,677,313	1,237,313
Netherlands	14,326,169	6,624,836	848,836
Poland			
Portugal	11,726,665	6,905,332	3,289,332
Romania	9,263,261	5,540,594	2,748,594
Slovakia	34,635,513	20,779,513	10,387,513
Slovenia	15,587,536	9,326,202	4,630,202
Spain			
Sweden	13,348,892	7,834,225	3,698,225
TOTAL	**763,796,701**	**444,266,034**	**204,618,034**

The impact of renovation wave on the quantities of asbestos waste generated in the future was also estimated. Using the method in Annex A2.3, the additional quantities of ACW generated by 2050 due renovation wave have been derived.

Table 3-30 provides the resulting increases in ACW under the 2x, 3x and 4x energy renovation rate scenarios in the EU for the period 2024-2050. The increase in ACW generation per Member State can be found in Annex A2.3.2. The table below present the increases in ACW as:

- Cumulative total additional waste generated from 2024-2050 in tonnes;
- Annual average increase in tonnes over the period 2024-2050;
- Cumulative total additional waste generated from 2024-2050 in m^3; and
- Annual average increase in m^3 over the period 2024-2050.

Table 3-30: Total (EU27) increases in ACW under the 2x, 3x and 4x energy renovation rate scenarios for the renovation wave 2024-2050

	Total additional waste generated (t)	Annual average increase (t)	Total waste generated (m^3)	Annual average increase (m^3)
2x scenario	7,355,265	272,417	6,693,291	247,900
3x scenario	14,710,531	544,834	13,386,583	495,799
4x scenario	22,065,796	817,252	20,079,874	743,699

According to estimates, doubling of energy renovations in the EU would increase the ACW generation by more than 7 million tonnes by 2050. Quadrupling energy renovations may increase ACW generation by 22 million tonnes.

4 Asbestos waste management in the EU

4.1 Introduction

This section of the report summarises the relevant EU legislation and the information collected by the study team on the current asbestos waste management practices in EU Member States – this information includes legislation, guidance and common practices. This section concludes with a few examples of best practice. In this report, the term 'asbestos waste management' refers to the identification, collection, sorting as well as final disposal of ACW and includes national strategies and targets for asbestos identification (incl. inventories) and removal.

4.2 Legislation and guidance

4.2.1 EU legislation

Asbestos regulation within the European Union has undergone significant evolution over the years, marked by stringent directives and regulations aimed at addressing the health and environmental risks associated with asbestos exposure. This overview explores key milestones in EU legislation, including bans on asbestos use, occupational health guidelines, waste disposal directives, and recent developments in the pursuit of a comprehensive strategy for asbestos removal. Understanding the regulatory framework is essential to appreciate the collective efforts made by EU Member States to safeguard both public health and the environment.

Ban on the use of asbestos

In the 1970s, five of the six asbestos fibres were prohibited by Framework Directive 76/769/EEC[84] relating to restrictions on the marketing and use of certain dangerous substances and preparations. Only the use of chrysotile, also called white asbestos, remained authorised, with the exception of certain products.

At the same time, in the 1970s most European countries took the first large-scale measures to control the use of asbestos. The prohibition of asbestos was introduced in the early 1980s by a number of European countries, with more countries following suit over the subsequent two decades.

Directive 1999/77/EC[85], amending Directive 76/769/EEC, finally banned the use of any asbestos fibres throughout the European Union as of 1 January 2005. Furthermore, the Registration, Evaluation,

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[84] Council Directive of 27 July 1976 on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations, OJ L 262, 27.9.1976, p. 201, available at https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1976L0769:20081211:EN:PDF. Amended by Council Directive 91/338/EEC of 18 June 1991 amending for the 10th time Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations, OJ L 186, 12.7.1991, p. 59–63, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31991L0338.

[85] Commission Directive 1999/77/EC of 26 July 1999 adapting to technical progress for the sixth time Annex I to Council Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations (asbestos) (Text with EEA relevance), OJ L 207, 6.8.1999, p. 18–20, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31999L0077.

Authorisation and Restriction of Chemicals (REACH) Regulation[86] specified that the manufacture, selling and use of asbestos fibres and products containing these fibres added intentionally is prohibited. Additionally, the Commission Regulation 2016/1005[87] amending Annex XVII to REACH aims to ensure the complete phase out of asbestos products in Member States by 1 July 2025.

The use of articles containing asbestos fibres which were already installed and/or in service before 1 January 2005, remains permitted until they are disposed of or reach the end of their service life.

Occupational exposure and health protection

In 1989, the European Framework Directive on Safety and Health at Work (OSH Framework Directive 89/391/EEC[88], subsequently amended[89]) set minimum safety and health requirements - with the possibility for Member States to maintain or established more stringent measures - to improve safety and health at work in the EU. The OSH Framework Directive applies together with a number of specific OSH Directives, including the Chemical Agents Directive (CAD, Directive 98/24/EC), the Carcinogens, Mutagens and Reprotoxic Substances Directive (CMRD, Directive 2004/37/EC), and the Asbestos at Work Directive (AWD, Directive 2009/148/EC).

The key instrument for the protection of workers exposed to asbestos is the Asbestos at Work Directive[90] (2009/148/EC), which, amongst other requirements, lays down the limit values for occupational exposure to asbestos. The health of those working with asbestos must be monitored and employees must have the opportunity to undergo a medical examination, companies should provide evidence of their expertise in working with asbestos before commencing demolition and refurbishment work, and, if the national legislation so requires, have an official licence for working with asbestos. Appropriate training of employees in dealing with asbestos also has to be provided (DG Employment, 2012).

Furthermore, Directive 2004/37/EC[91] on the protection of workers from the risks related to exposure to carcinogens, mutagens and reprotoxic substances (including asbestos as a carcinogenic agent), continues to apply to workers exposed to asbestos, with the key requirements including a risk assessment, exposure minimisation and a range of risk management measures.

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86 Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC (OJ L 396, 30.12.2006, p. 1).

87 Commission Regulation (EU) 2016/1005 of 22 June 2016 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards asbestos fibres (chrysotile) (OJ L 165, 23.6.2016, p. 4).

88 Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A31989L0391

89 Consolidated text: Council Directive of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work (89/391/EEC) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01989L0391-20081211

90 Consolidated text: Directive 2009/148/EC of the European Parliament and of the Council of 30 November 2009 on the protection of workers from the risks related to exposure to asbestos at work https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02009L0148-20190726

91 Directive 2004/37/EC of the European Parliament and of the Council of 29 April 2004 on the protection of workers from the risks related to exposure to carcinogens or mutagens at work, OJ L 229, 29.6.2004, p. 23–34, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32004L0037R%2801%29.

Asbestos waste

Directive 87/217/EEC[92] contains provisions to prevent and reduce pollution caused by asbestos in the interests of the protection of human health and the environment.

There are synergies with the Asbestos at Work Directive, particularly in relation to activities involving the demolition of buildings and installations containing asbestos, the removal of asbestos and of products containing asbestos with the risk of releasing asbestos fibres.

In addition, the Waste Framework Directive[93] and the Landfill Directive[94] lay down measures for the management of asbestos waste.

The first step to allow correct management of asbestos waste is identification. In this sense, the EU Commission published in 2018 the Guidelines on pre-demolition audits (European Commission, 2018, currently being updated), providing information about the best practices for the assessment of CDW streams prior to demolition, deconstruction or renovation of building or infrastructure, called a 'waste audit' or 'pre-demolition audit' (PDA). The purpose of PDA is to identify and assess the materials to be removed from the building to be renovated/demolished (incl. potential hazardous substances), their potential value and their appropriate management option prior to the demolition or renovation activity. While the European Commission might recommend Member States to make PDA mandatory to increase the quality of recycling, the practical implementation of PDA is currently decided at national level (Wahlström et al, 2019).

Recent Developments

On 20 October 2021, the European Parliament called on the Commission to present a 'European Strategy for the Removal of All Asbestos'[95].

Gaps in EU legislation

EU legislation sets out the framework, objectives, and principles for ACW management, whilst the detailed strategies and approaches for screening, removal and disposal of ACW are a national competence and, consequently, the specific requirements vary from Member State to Member State. The fact that some Member States make greater use of best practices than others is thus not a direct consequence of EU legislation, but rather of the national (or regional/municipal) systems in place for ACW management.

As potential solutions for reducing the disparities between Member States and ensuring that effective national strategies and approaches to asbestos identification and removal are in place across the EU, the following approaches could be considered:

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[92] Council Directive 87/217/EEC of 19 March 1987 on the prevention and reduction of environmental pollution by asbestos, OJ L 85, 28.3.1987, p. 40–45, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31987L0217.

[93] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance), OJ L 312, 22.11.2008, p. 3–30, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0098.

[94] Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste, OJ L 182/1, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31999L0031&from=EN.

[95] European Parliament, Resolution of 20 October 2021 with recommendations to the Commission on protecting workers from asbestos, 2019/2181(INL), available at: https://www.europarl.europa.eu/doceo/document/TA-9-2021-0427_EN.html.

- Expansion of the legal requirements in EU acquis, such as specific requirements on asbestos screening, removal and disposal, potentially including specific targets for asbestos screening and removal of asbestos that can pose risk to human health.
- Greater use of co-ordination mechanisms to facilitate exchange of best practices and stimulate their greater uptake.
- Greater use of EU financial mechanisms to fund asbestos identification and removal or the introduction of elements in the modalities for environmental subsidies (e.g., energy efficiency funding) that stimulate asbestos removal (e.g., funding for roof solar panels on an asbestos roof not allowed, etc.).
- Assistance to countries that may wish to develop a national guidance document by means of providing a template. Although the national requirements differ and any guidance thus has to be developed at the national level, a provision of a generic guidance that can subsequently be tailored to the specifics of each country could help the Member States that currently provide limited guidance to improve both the awareness of the legal requirements and knowledge of best practices among stakeholders.

4.2.2 National legislation

The key national legal instruments that are relevant to asbestos waste management are summarised for each EU Member State in the relevant factsheet. The factsheets focus on the most relevant legislation identified through stakeholder consultation. The factsheets aim to provide a brief summary rather than an exhaustive and detailed overview - many Member States have in place a broad legal framework that has some relevance to asbestos waste, in particular its collection and occupational exposure. Where this is the case, only the most relevant legislation has been included the relevant factsheet.

In addition, it should be noted that the factsheets should not be interpreted as meaning that some Member States do not have in place the legislative acts that transpose the EU OSH and waste directives, it is likely that there are additional relevant legal instruments that have not been included in the factsheets. However, the legislation identified for this study still provides a useful overview for the identification of the key features of Member States' legislation and differences between the Member States.

In some Member States, some of the competences are organised at the regional (e.g., Belgium) or municipal level (e.g., Germany). In these Member States, there can be large differences between the regions (e.g., there are differences between the extent of asbestos screening in Flanders and Wallonia in Belgium) or the systems in the different regions and municipalities can share a number of key features (e.g., municipalities in Germany).

There are also differences between Member States regarding the complexity of their legislation. In some Member States, the relevant requirements for the management of ACW are scattered across many pieces of legislation, whilst in others, these are concentrated in a single piece of legislation. For example, the Estonian regulation 'Handling requirements for waste containing asbestos in Estonia' (Riigi Teataja, 2014) provides a clear and concise summary of the requirements on the handling of asbestos containing waste. In some Member States, e.g., in the Czech Republic, the complexity of the national legislation is reduced by the existence of guidance documents.

An overview of the guidance documents in EU Member States is also provided in the country factsheets. In approximately half of the EU Member States, one or several guidance documents that provide information on the handling and disposal or ACW has been identified (see the table below). In other 50% of Member States, no guidance document has been identified through desk research and/or stakeholder consultation or, in some cases, stakeholders consulted for this study confirmed that such a document does not exist.

Table 4-1: National guidance documents – number of Member States with/without guidance documents		
Aspect	**Yes**	**No**
A guidance document with relevance to ACW exists?	14 (50%)	13 (50%)
A guidance document with high relevance to ACW exists?	10 (40%)	17 (60%)

In some Member States, although guidance documents exist, they primarily focus on controlling occupational exposure to asbestos and contain limited information for the treatment or disposal of ACW. For example, the guides on the management of asbestos waste in Poland and Romania are translations of a document developed before 2010 by the Institute of Occupational Medicine (IOM) for the Senior Labour Inspectors Committee (SLIC) of DG Employment, which focuses on assessing and controlling occupational exposure. Similarly, there are extensive guidance documents in Ireland and Luxembourg, but these contain only limited information on the treatment and disposal of ACW.

4.3 Management practices

Based on the national legislation and guidance, as well as other information on the national practices collected through stakeholder consultation, this section provides an overview of the current practices in EU Member States regarding the identification, removal, treatment and disposal of ACW.

4.3.1 Identification of asbestos containing waste

An overview of ACW identification practices in each of the EU Member States is provided in the factsheets. This includes mandatory requirements, approaches set out in guidance documents and common practices. In many instances, it is difficult to determine which specific aspects of the national practice originate from a legal requirement, guidance or whether they simply reflect practical arrangements, in particular when the information was provided through stakeholder consultation. To gain a full overview of the practices in each Member State, the information presented for legal requirements, guidance and common practices should be considered together.

Most Member States require that buildings are screened for asbestos content, see the table below. However, it should be noted that different sources often provide contradictory information, including instances of different stakeholders in the same Member States disagreeing on whether screening for asbestos content is mandatory.

Table 4-2: National practices – screening of asbestos content in buildings			
Aspect	**Yes**	**No**	**No information**
Mandatory screening in place?	19 (70%)	5 (20%)	3 (10%)

Although screening is mandatory in most Member States, there are significant differences regarding what triggers the application of screening requirement. This can include, for example, demolition, construction or renovation where asbestos exposure is likely to occur, any construction or renovation, change of ownership of the building or a blanket requirement that all buildings must be screened for asbestos by a certain date. For example, the Flanders region of Belgium requires mandatory screening by private owners of buildings whenever a building is sold and all buildings must be screened by 2032, even where there is no change in ownership. The results of asbestos surveys are centrally collated by OVAM. In addition, there is a requirement for asbestos screening and removal for public buildings. This is complemented with a range of other measures within a comprehensive overarching strategy that also includes prohibitions regarding constructions on - and cleaning of - asbestos cement roofs-facades, mandatory asbestos removal when renovating, a unique design of the uniform asbestos survey report to incentivise owners into action (behavioural science), sectoral agreements to support asbestos removal and set targets towards asbestos-safe goals, support of citizens to make asbestos removal easier and affordable, related policy and instruments in order to stimulate combined asbestos removal and energy renovation, etc.

The approaches in the different Member States vary regarding whether asbestos surveys encompass both visible and non-visible asbestos and methods of identifying whether asbestos is present (invasive, non-invasive, both, etc.). Both destructive and non-destructive methods are sometimes used in combination, for example in Flanders, a non-destructive method is used when selling or by 2032, but in cases of demolition and renovation, there is always a destructive inspection.

In some Member States, useful advice is provided on how asbestos in buildings can be identified. For example, the guidance in Austria includes an annex with photos of ACPs and tables with detailed guidance on the proper demolition of asbestos-containing materials (ACMs) and the proper collection and treatment of ACW. The Czech guidance document provides a comprehensive strategy that advises building owners to combine a number of different approaches for the identification of asbestos ranging from sampling to a review of existing documentation and interviews the inhabitants/users to determine the construction history of the building.

The Czech guide also provides examples of asbestos-containing construction materials made in the Czech Republic (or Czechoslovakia), including the names of the manufacturers and the year in which production of asbestos containing materials was discontinued (the list is based on information from the relevant companies and the Research Institute for Construction Materials in Brno, Czech Republic).

4.3.2 Removal, separation and collection/storage/transport of asbestos containing waste

An overview of ACW removal, separation and collection practices in each EU Member State is provided in the factsheets, together with information on their national or regional strategies for asbestos removal from buildings in cases other than demolition.

In case of demolition, Member States typically have requirements in place to ensure removal of asbestos prior to the commencement of demolition (or requirements to ensure separation during demolition). Member States also typically have in place licencing or permit systems for asbestos removal operations and operators. A number of examples of public registers in the Member States listing operators authorised to carry out asbestos removal activities have been identified. Public registers ensure transparency and enforcement of legal requirements. They help building owners find suitable companies and facilitate enforcement of the legal requirements by the authorities. Member States also typically have in place detailed requirements on collection and transport of ACW in closable containers/packaging. Advice on removal, separation, collection activities is provided in many of the national guidance documents.

Most Member States do not appear to have any specific targets or strategies for the removal of asbestos from buildings other than in cases of demolition. There are some exceptions, however, such as the targets for the removal of asbestos that poses risk in Flanders (2034 for high-risk asbestos and 2040 for other asbestos that deteriorates to a point where it starts posing a risk) and in Spain (municipalities are required to identify and remove high-risk asbestos by 2028). Some countries provide or provided in the past financial assistance for asbestos removal, but such schemes tend to be limited in scope (e.g., funding asbestos removal from schools) and temporary.

Some Member States provide advice to private citizens that remove asbestos containing materials from their homes. Examples of Member States that define when private citizens are allowed to remove asbestos containing materials and the requirements that citizens have to follow have been identified by the study team (see the country factsheets). The requirements appear to vary from private citizens having to follow the same requirements as commercial contractors and ensure appropriate on-site supervision to the possibility to remove some types of materials (with thresholds such as size of the materials, etc.) themselves (with or without the possibility for ACW to be collected or brought to collection points). In Flanders, private individuals are also provided with guidance on safe removal together with a bag for collection and personal protective equipment (PPE) required for removal. ACW from private citizens is collected at a lower cost or can be taken to collection centres.

4.3.3 Treatment and disposal (incl. permitted treatment and disposal options)

An overview of ACW treatment and disposal practices in the EU Member States is provided the factsheets.

The main disposal option for ACW is landfilling, although the specific practices, including which types of landfills ACW can be disposed in, specific pre-treatment requirements and the specific landfilling practices differ. There are indications that ACW is exported from some Member States (e.g., Croatia, Denmark, etc.) for disposal elsewhere.

In addition to the ban on the placing on the market of asbestos under REACH, that also applies to recycled material or prepared for reuse article (all of which are a new placing on the market of a product in the scope of REACH), many Member States have a prohibition on recycling and/or preparation for reuse of ACW in their national legislation or advise against such practices in the relevant guidance documents. These Member States include, for example, Austria, Denmark, Estonia, Germany, Slovakia and Slovenia.

In the Netherlands, there is a landfill ban in national legislation, but for asbestos cement waste it has not come into force yet because its application is conditioned to the availability of sufficient recycling capacity. The trigger for when the landfill ban becomes effective is the existence of a recycling plant that is capable of treating 75% of the total amount of ACW that is produced in the Netherlands each year.

Incineration is often explicitly permitted (e.g., R1 permitted in Croatia) but not practiced given the lack of calorific value of asbestos and its incombustibility.

In this regard, it is important how ACW is defined. For example, in Germany the objective of the new Communication from the Federal/State Working Group on Waste 23 (Mitteilung der Bund/Länder-Arbeitsgemeinschaft Abfall 23 [LAGA M 23]) is to ensure that as much of the CDW as possible is recycled as reinforced concrete (RC) building material. To this end, the new LAGA M 23 introduces an assessment value (0.010 %) similar to those in the Netherlands and Belgium, which links recyclability to a concrete value with the help of a clear definition of 'asbestos-free' as a convention. It is worth highlighting that demolition waste meeting a new assessment value between > 0.010 M-% < 0.1 M-% is classified as 'non-hazardous waste' (e.g., waste code 17 01 01 according to the LoW), but it must still be disposed of if it is a man-made asbestos contamination ('on purpose'), since geogenic material containing asbestos may be placed on the market up to < 0.1 M-%.

4.3.4 Best practices

Best practices suggested by stakeholders

Examples and opinions on best practice treatment approaches for ACW suggested by respondents to the survey carried out for this study include:

- 'Mechanochemical treatment in the presence of other salts'.
- 'Vitrification, with complete destruction of asbestos and dissolution of chemical components in a glass matrix'.

- ‘Maximising separation of asbestos waste from non-asbestos-containing waste through selective collection and by using techniques that minimise the mixing of asbestos fibres with non-asbestos-containing or recyclable material’.
- ‘Compacting the remaining asbestos-containing waste as much as possible so that minimum landfill capacity is required’.
- ‘Heat asbestos waste to a maximum of 1,000 degrees. After destroying the asbestos, reduce and grind the materials. There is the need to know with certainty the sources of the asbestos waste and therefore of clear agreements with the remediation companies’.
- ‘Landfilling is the best option to isolate asbestos fibres from the biosphere and to secure human health risk linked to asbestos waste. Before landfilling and to secure the risk, all the steps of asbestos removal during a deconstruction work should be framed and supervised with a real traceability. Regarding the physical composition of asbestos, the most important thing is to make it safe rather than to try to recover or recycle it’.
- ‘Landfilling is the safest practice’.
- ‘Ensure the complete isolation of the asbestos fibres from the environment and material loops. Operating conditions must integrate occupational safety rules and protect workers from long terms diseases linked to asbestos fibres. On these kinds of waste, the main concern should be the protection of health and the environment before any circular economy thoughts’.
- ‘Proper collection, by using proper PPE and transport containers and then using a professional landfill for disposal’.
- ‘The classification of asbestos waste as hazardous waste guarantees the safe treatment, registration and traceability until final treatment (landfilling). In the case of household waste that contains asbestos, it is important to facilitate its delivery to municipal facilities that guarantee its safe management’.
- ‘The safe removal of asbestos, especially on roofs, the obligation to be registered as a company for the handling of asbestos and the management of this type of waste’.
- ‘Best practices should prevent the recirculation of asbestos in the handling of asbestos-containing waste, and should also be feasible’.
- ‘Controlled removal of the asbestos material from the building structure / Security of the workers / Compliance with safety measures when handling hazardous substances. Due to the size and the quantities of asbestos waste generated, national or regional disposal seems to be the most appropriate solution for Luxembourg’.
- ‘Recycling hazardous waste into non-hazardous waste and, if possible, into other products that have value and are not harmful to the environment’.
- ‘Once generated, asbestos-containing waste must be immediately packed in airtight packaging or stored in sealed containers and labelled and handed over to a waste management facility intended for the collection or disposal of asbestos-containing waste. When landfilled the asbestos-containing waste is landfilled only in special sectors reserved for asbestos-containing waste. Asbestos-containing waste when being landfilled is packed in sealed packaging or stored in sealed containers, and the landfill site is covered with technological material immediately after the landfilling. Surface compaction is only possible after it is covered. Workers who deal with this waste are equipped with appropriate work aids and trained in how to manage this hazardous waste’.
- ‘Proper removal of asbestos from buildings. Taking special care to prevent contamination of workers and surrounding population. Avoid breaking the asbestos materials during removal and transportation to landfill. Wrapping the asbestos with plastic film to prevent the release of fibres. Avoiding mixture of asbestos waste and biowaste in the same landfill cell’.
- ‘For households specially designed containers which are in use at municipal civic amenity sites. They are normally locked and only opened by the personal on demand to hinder the contamination of asbestos’.

- ‘The removal of asbestos-containing material by a licenced company. The waste is stored in plastic bags so that the asbestos fibres do not spread into the air. The waste is then taken to a hazardous waste landfill. Thus, the waste is stored and covered’.
- ‘Implementation of selective collection and recycling of asbestos-free fibrocement (still landfilled together with asbestos containing fibrocement) Processing asbestos cement waste into asbestos free resource, at a cost lower < 250 euro/ton and energy-neutral/ low ecological footprint, using green energy or waste chemicals’.
- ‘Organizing intermediate storage for safely packed asbestos cement roof plates and tubes till they will be processed at industrial scale’.
- ‘The best practices are, per our opinion, neutralization and recycling’.

Proposed best practices for asbestos removal

In consideration of the best practices proposed by stakeholders and the review of ACW management practices in EU Member States (see the country factsheets), the best practices set out below are proposed by the study team for further consideration by the Member States. These practices primarily relate to the approaches to identification and removal of ACW. The practices are summarised using the criteria in the Ongaro protocol (definition, smartness, effects, transferability). A quantitative score has been assigned to the criteria ‘smartness’, ‘effectiveness’ and ‘transferability’ on a scale from 0 to 3, where 0 corresponds to insufficient performance and 3 corresponds to the best performance. For instance, the element “transferability” of a practice can be rated as 0 – the practice cannot be used by authorities and stakeholders in other countries, 1 – the practice can be used only by authorities and stakeholders of a limited group of countries under specific conditions and 3 – the practice can be transferred to authorities and stakeholders of other countries.

Table 4-3: Best practices for further consideration – Ongaro summary

Definition	Smartness	Effects	Transferability
A comprehensive guide to legal requirements and best practice	3: Some stakeholders (e.g. private citizens) lack awareness and legal requirements can be difficult to navigate. User friendly and comprehensive guidance can help both professionals and citizens.	2: Increases awareness and compliance with legislation and best practice, in particular where specific problems (e.g. misclassification of waste) have arisen. However, guidance is not a substitute for enforcement	2: Many Member States have comprehensive and useful guidance documents, and it is thus likely that their development would be feasible for other Member States, too. However, guidance has to be developed for each Member State to suit the local conditions.
Proactive screening triggers not limited to demolition and renovation (e.g. when selling or renting, etc.)	3: Many buildings with asbestos materials have not been screened. Having proactive screening triggers ensures that asbestos is identified more frequently than at less frequent demolition/ renovation intervals	2: Having proactive screening increases the likelihood that unsafe asbestos is identified and disposed of correctly.	2: Some Member States (e.g. Belgium (Flanders region) and France) have such requirements for privately owned dwellings. However, this requirement entails some costs for private owners.
Screening targets (e.g. a date by which all private or public buildings must have been screened for asbestos)	3: Many buildings with asbestos materials have not been screened. A target date by which all buildings must be	2: Increases likelihood that unsafe asbestos will be identified. Should be combined with other measures to ensure that building owners do not	2: Requires political will as it entails costs for owners. Can be organised centrally (e.g. Flanders) or by mandating

Table 4-3: Best practices for further consideration – Ongaro summary			
Definition	**Smartness**	**Effects**	**Transferability**
	screened can address this problem.	postpone action until the deadline.	municipalities (e.g. Spain).
Support for screening (framework contracts, financial support)	2: Screening entails a cost which is an obstacle to public and private owners carrying out asbestos surveys in the absence of a specific trigger	2: Different mechanisms (e.g. direct provision of funding, possibility for public authorities to draw on a framework contract that ensures a reduced price) can increase the rate of screening	2: Entails a cost but similar measures have been implemented in some Member States
Inventories of buildings with asbestos	2: Without such information, it may be difficult to assess the scale of the problem, ensure effective enforcement, etc.	2: Having a central database of buildings with asbestos that is comprehensive and up-to date could help with determining the scale of the problem, assist emergency services in case of emergency, help enforcement, etc.	3: Some Member States have started building inventories and it is not expected that there are significant obstacles to other Member States pursuing a similar strategy
Design of the asbestos survey that stimulates removal	3: The survey is an opportunity to incentivise removal and the use of 'behavioural' tools can communicate the benefits of removal	2: Useful only where the survey is carried out independently of demolition. In instances where the survey is carried out due to e.g. selling or renting, such an approach can be useful in stimulating increased removal.	1: A standardised format of an asbestos survey and the use of a central electronic tool is required
Financial incentives/ funding for asbestos removal	3: Lack of funding is an obstacle to faster removal of asbestos from buildings	3: Availability of funding or financial incentives such as reduced landfill tax, subsidised collection, etc. can increase the rate at which asbestos is removed	1: Although such instruments have been implemented in some Member States, their extent and duration depend on budgetary constraints
Embedding ACW management into other requirements/ funding	3: Many construction activities are undertaken for reasons other than to remove asbestos and these offer the opportunity to remove asbestos at the same time	2: Interventions such as installing roof-top solar panels can be coupled with the requirement to remove asbestos roofing materials	2: Depends on the priorities in the relevant Member States since some Member State may not want to disincentivise energy efficiency
Including the potential for illegal dumping as an explicit policy consideration	3: Stakeholder consultation for this study suggests that some stakeholders fear that additional requirements or costs may increase the rate of illegal dumping	2: The potential effect on illegal dumping should be borne in mind when designing national asbestos screening and removal strategies	Not relevant

Table 4-3: Best practices for further consideration – Ongaro summary			
Definition	**Smartness**	**Effects**	**Transferability**
Support for private citizens	3: Some asbestos removal is carried out by private citizens – the specific rules and support provided to them differs by country	3: Private citizens are likely to be the group with the lowest level of awareness and knowledge	3: Guidance for private citizens is already available in some Member States. In Flanders, private citizens receive a pack with instructions, PPE, disposal bag and collection is organised.
Public register of asbestos removal companies	3: It is important for building owners to be able to easily identify authorised asbestos removal companies	3: A publicly accessible database of authorised asbestos removal companies is useful for building owners and improves enforcement of existing legislation	3: Identified as being in place in a number of Member States

The best practices set out above are important for ensuring that there is a comprehensive and reliable approach to the removal of asbestos from buildings. They contribute to ACW being correctly identified and disposed of in accordance with legal requirements, thus reducing risks for the environment and human health.

5 Asbestos waste treatment

5.1 Introduction

Currently, almost all ACW in the EU is being disposed of in landfills, as described in previous sections of the report. However, the European Parliament resolution 2012/2065 (INI) of 14 March 2013 on asbestos related occupational health threats and prospects for abolishing all existing asbestos states that 'delivering asbestos waste to landfills would not appear to be the safest way of definitively eliminating the release of asbestos fibres into the environment (particularly into air and groundwater) and whereas therefore it would be far preferable to opt for asbestos inertisation plants'. In addition, it calls on the EC to promote the establishment of centres for the treatment and inertisation of ACW throughout the EU, combined with phasing out all delivery of such waste to landfills.[96]

In recent decades, there has been a growing interest in the research community, waste management industry and some countries in finding solutions to treat and recycle ACW to ensure that the hazardous asbestos fibres are destroyed, and the recovered material reused where possible.

Several types of asbestos waste treatment technologies exist, and they have been comprehensively reviewed in a number of scientific papers, reports and other types of literature sources (see Table 2-1 for some examples). The aim of this report is not to carry out a general overview of the asbestos waste treatment technologies, but rather to investigate and analyse the progress made in this area since 2018, as explained in the Methodology section of the report. Therefore, this section will look at what are the existing asbestos waste treatment installations in Europe (including disposal installations, considering they are the main destination point for such waste), analyse technologies that have been researched and patented since 2018 and overview emerging asbestos waste treatment technologies, which have the highest potential to become industrialised and commercialised in the EU in the near future.

5.2 Existing asbestos waste disposal/treatment installations

5.2.1 Disposal

In the EU, most of the ACW comes from renovation, deconstruction and demolition activities. Such waste is predominantly disposed of in landfills. Article 6 of the Landfill Directive (1999/31/EC) states that only waste that has been treated can be landfilled, although several exceptions exist.[97] When it comes to asbestos waste, according to the Council Decision 2003/33/EC, construction materials containing asbestos and other types of suitable asbestos waste can be landfilled at landfills for non-hazardous waste in accordance with Article 6(c)(iii) of the Landfill Directive without testing. In addition, landfills receiving construction materials that contain asbestos and other asbestos waste can only accept waste that contains no other hazardous substances than bound asbestos, including fibres packed in suitable plastic packaging or bound by a binding agent.[98] The latter is more applicable to

[96] European Parliament (2013). European Parliament resolution of 14 March 2013 on asbestos related occupational health threats and prospects for abolishing all existing asbestos (2012/2065(INI)). *Official Journal of the European Union,* 36. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52013IP0093.

[97] Council of the European Union (1999). Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste. *Official Journal of the European Union,* 182. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01999L0031-20180704.

[98] Council of the European Union (2002). 2003/33/EC: Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to

friable asbestos, which can undergo a stabilisation process by cementation in concrete blocks, through which the risk of fibres release is reduced, but the volume and mass of the waste is substantially increased.[99] Although EU waste legislation sets strict requirements for a safe disposal of asbestos in landfills, exploring alternative ways to treat asbestos waste in an environmentally sound manner is a priority in the EU as the waste hierarchy prioritises waste recovery over disposal.[100]

The information on asbestos waste disposal installations, their remaining capacity for accepting ACW and cost of landfilling such waste are not available for all Member States. Hence, a comprehensive picture of all disposal installations accepting ACW, their capacities and costs could not be drawn. Nevertheless, for countries where such information is available and accessible, it has been provided in 'Country factsheets' listed in Annex 1. The table below presents costs of disposal of asbestos waste in some Member States.

Table 5-1: Average cost of ACW landfill disposal in some EU Member States.

Member States	Cost of disposal (average)	Reference
Belgium (Flanders)	100 €/ton	OVAM
Croatia	240 €/ton	Average among prices listed on 3 landfills operators' websites
Czech Republic	130 €/ton	Stakeholders' consultation
Denmark	148 €/ton	Average among prices listed on landfills operators' websites in 9 municipalities
Finland	237 €/ton	Average among prices listed on landfills operators' websites in 2 municipalities
Italy	199 €/ton	ISPRA
Latvia	178 €/ton	Average among prices listed on 4 landfills operators' websites
Lithuania	100 €/ton	Ministry of the Environment
Netherlands	103 €/ton	KLB
Poland	336 €/ton	Paper "Problem of asbestos-containing wastes in Poland"
Slovenia	215 €/ton	Average among prices listed on 4 landfills operators' websites

The number of the three types of landfills (non-hazardous waste, hazardous waste and inert waste) in each Member State and the remaining capacities are provided in Eurostat, although these data are not specific to ACW. Nevertheless, the analysis of remaining capacities in these landfills can give a better understanding on what proportion of these landfills would be filled by ACW in the coming decades (based on the analysis of future trends), assuming that no or limited number of new landfills with additional capacities will be built in the coming decades. This is based on the fact that landfilling in the EU has been decreasing in recent years, which is in line with the EU Landfill Directive and the

Directive 1999/31/EC. *Official Journal of the European Union,* 011. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32003D0033.

[99] Bureau KLB (2018). *Practicable sustainable options for asbestos waste treatment.* https://www.asbeter.com/documents/KLB%20assessment-of-asbestos-waste-treatment-techniques.pdf.

[100] European Commission (2022). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS on working towards an asbestos-free future: a European approach to addressing the health risks of asbestos. *Official Journal of the European Union,* 488. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A488%3AFIN.

wider EU's ambition to move towards a circular economy and gradually reduce landfilling of waste destined for landfills for non-hazardous waste to a minimum.[101]

Number of landfills in Member States

In the EU, the number of landfills vary from country to country, as seen in Table 5-2. The inert waste landfills share the highest proportion of all landfills in the EU, with the highest numbers in France, Belgium and Germany. However, ACW cannot be disposed of in such landfills, as stated in the Council Decision 2003/33/EC establishing criteria and procedures for the acceptance of waste at landfills.[102] In some Member States, such as Belgium, Croatia, Cyprus, Luxembourg and Malta, there are no landfills for hazardous waste, and some Member States, such as Luxembourg and Malta, have only one landfill each.

Table 5-2: Number of landfills in Member States in 2020. Source: Eurostat

Member State	Landfill for hazardous waste	Landfill for non-hazardous waste	Landfill for inert waste	Total number of landfills (D1, D5, D12)
Austria	12	21	5	38
Belgium	0	147	964	1 111
Bulgaria	4	66	10	80
Croatia	0	91	2	93
Cyprus	0	3	8	11
Czech Republic	20	126	18	164
Denmark	9	30	1	40
Estonia	7	5	1	13
Finland	:	:	:	:
France	13	217	1 247	1 477
Germany	27	269	719	1 015
Greece	1	89	0	90
Hungary	:	:	:	:
Ireland	:	:	:	:
Italy	11	176	131	318
Latvia	1	10	:	11
Lithuania	12	11	1	24
Luxembourg	0	1	9	10
Malta	0	1	0	1
Netherlands	1	56	0	57
Poland	38	398	13	449
Portugal	3	38	4	45
Romania	11	83	3	97
Slovak Republic	10	85	14	109
Slovenia	1	13	3	17
Spain	19	194	183	396
Sweden	39	96	53	188
Total	**239**	**2 226**	**3 389**	**5 854**

Note: where data is not available, it is indicated by ' : '.

[101] European Parliament and Council of the European Union (2018). Directive (EU) 2018/850 of the European Parliament and of the Council of 30 May 2018 amending Directive 1999/31/EC on the landfill of waste. *Official Journal of the European Union,* 150. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32018L0850.

[102] Council of the European Union (2002). 2003/33/EC: Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC. *Official Journal of the European Union,* 011. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32003D0033.

The figures below show the concentration of non-hazardous and hazardous waste landfills in the EU Member States.

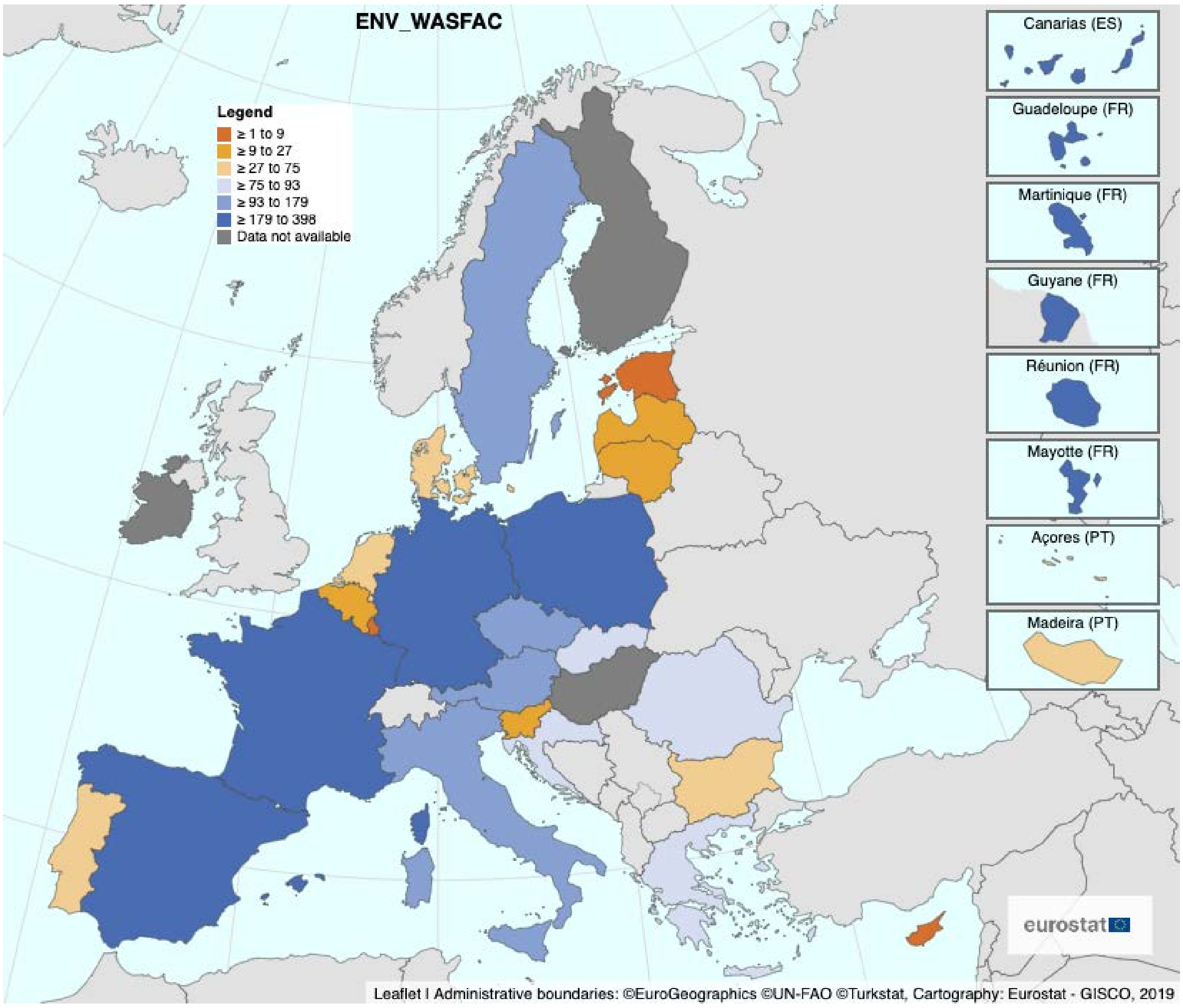

Figure 5-1: Number of non-hazardous waste landfills in Member States in 2020. Source: Eurostat

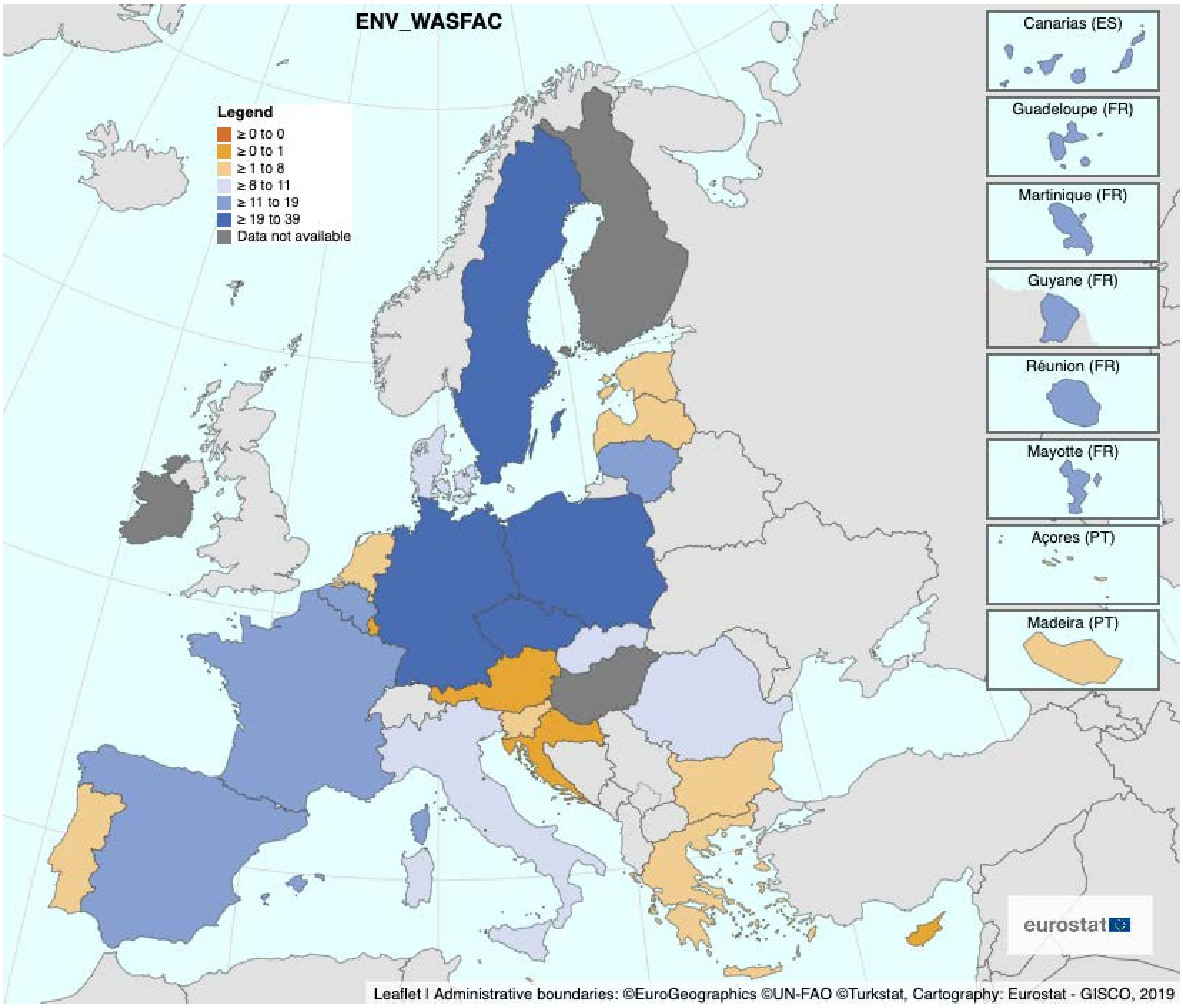

Figure 5-2: Number of hazardous waste landfills in Member States in 2020. Source: Eurostat

The number of all types of landfills in most Member States has been slightly decreasing or staying stable since 2004, as shown in Figure 5-3. The large increase in the number of landfills seen in France since 2010 is related with the increase in the number of inert waste landfills. Similarly, the sharp increase in Austria between 2018 and 2020 is also in relation to inert waste landfills. Overall, there has been a slight downward trend in the number of landfills, specifically for non-hazardous and hazardous waste, in the EU since 2004 and it is expected that this trend will continue, considering the current EU ambition on the reduction of landfilling in the context of circular economy.

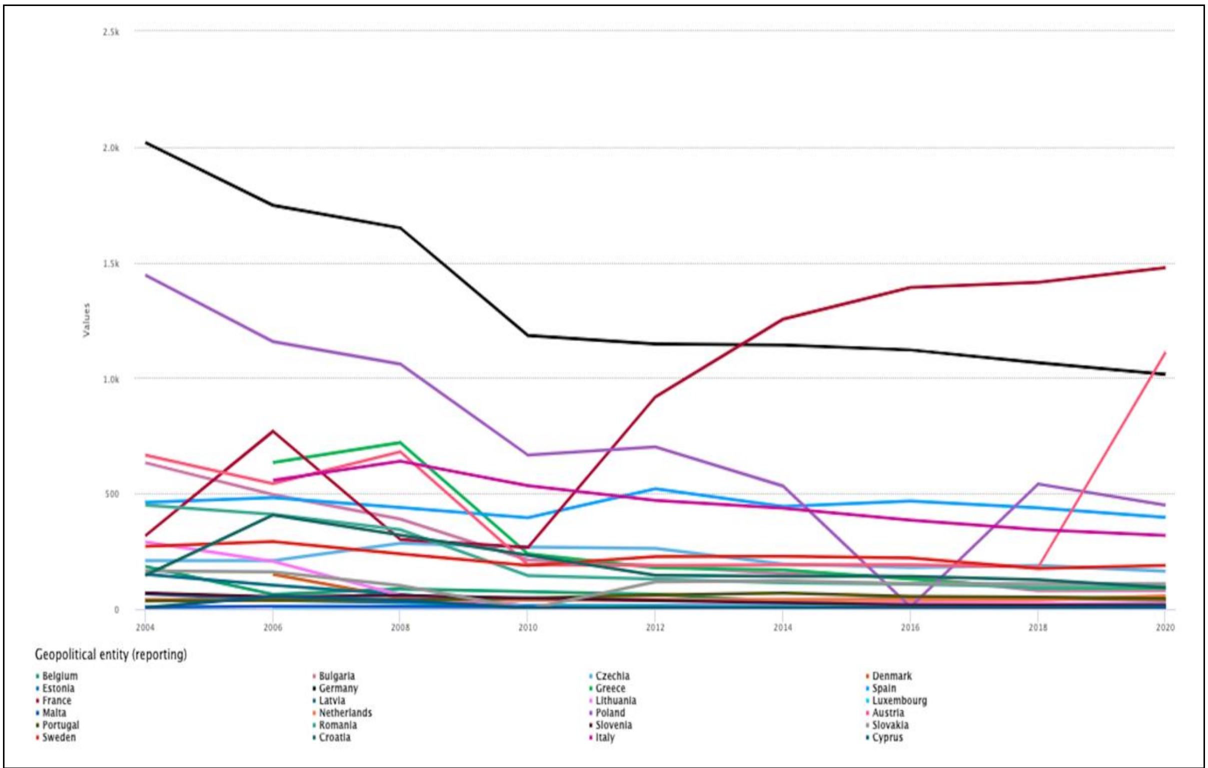

Figure 5-3: Number of all types of landfills in Member States in 2020. Source: Eurostat

Remaining capacities in landfills in Member States

To understand whether landfilling of the estimated quantities of asbestos waste that are yet to be generated (see Section 3.3.3) can be an issue for Member States, the study team looked at the remaining non-hazardous and hazardous waste landfill capacities in Member States. The most recent (2020) Eurostat data on the landfill disposal volume available in Member States and in total in the EU27 is set out in Table 5-3 below. It can be seen from the table that data is not available for some Member States. In addition, some countries report no capacity at hazardous waste landfills.

Table 5-3: Landfill disposal volume available in 2020 (rest capacity) in m^3. Source: Eurostat			
	Disposal - landfill for hazardous waste	**Disposal - landfill for non-hazardous waste**	**Total**
Austria	0	44,827,419	44,827,419
Belgium	8,690,259	25,567,429	34,257,688
Bulgaria	1,055,814	237,091,256	238,147,070
Croatia	0	65,502,629	65,502,629
Cyprus	0	793,635	793,635
Czechia	5,471,872	35,460,342	40,932,214
Denmark	5,319,828	9,295,121	14,614,949
Estonia	372,000,000	4,900,000	376,900,000
Finland	No data	No data	No data
France	24,325,508	161,000,000	185,325,508
Germany	30,428,056	284,640,743	315,068,799
Greece	16,340	9,122,474	9,138,814
Hungary	No data	No data	No data
Ireland	No data	No data	No data
Italy	4,559,165	39,579,014	44,138,179
Latvia	160,000		160,000
Lithuania	259,228	7,531,381	7,790,609
Luxembourg	0	1,186,000	1,186,000
Malta	0	429,140	429,140
Netherlands	59,000	34,200,000	34,259,000
Poland	3,226,842	1,262,344,902	1,265,571,744
Portugal	0	0	0
Romania	338,116	34,167,445	34,505,561
Slovakia	919,801	8,184,344	9,104,145
Slovenia	17	2,912	2,929
Spain	3,780 661	167,349,716	171,130,377
Sweden	6,054,555	9,402,015	15,456,570
EU27 (from 2020)	**467,330,000**	**2,502,630,000**	**2,969,960,000**

Table 5-4 provides the implied volume of ACW that would be generated by total removal of remaining asbestos with current methods (m^3 using a conversion factor of 0.91 m^3/t[103]) as a percentage of available landfill volume (m^3) in Member States. This provides data on all three scenarios for asbestos waste content (3%, 5% and 10%) and shows that a number of Member States are likely to lack the capacity in hazardous landfill, in non-hazardous landfill or both for disposal of all remaining building asbestos as asbestos containing waste using current methods. However, these figures are only indicative, and do not foresee the increase in landfill capacity. Nevertheless, they show which countries would potentially need substantial increase in their landfill capacity to allow for disposal of the remaining asbestos waste. The full methodology for estimating these figures is presented in Annex 2, Section A2.4.

[103] Based on conversion factors presented in the report by the Agency for Statistics of Bosnia and Herzegovina (2015). *Waste Weight Determination.* https://bhas.gov.ba/data/Publikacije/Metodologije/KFO_00_2015_MD_1_EN.pdf.

Table 5-4: Implied volume of ACW that would be generated by total removal of remaining asbestos with current methods (m^3 using a conversion factor of 0.91 m^3/t) as a percentage of available landfill volume (m^3)									
	Assumed content of asbestos in construction waste = 3%			Assumed content of asbestos in construction waste = 5%			Assumed content of asbestos in construction waste = 10%		
	Hazardous landfill	Non-hazardous landfill	Total	Hazardous landfill	Non-hazardous landfill	Total	Hazardous landfill	Non-hazardous landfill	Total
Austria	No listed capacity	44%	44%	No listed capacity	26%	26%	No listed capacity	12%	12%
Belgium and Luxembourg	627%	204%	154%	367%	119%	90%	171%	56%	42%
Bulgaria	-	-	-	-	-	-	-	-	-
Croatia	No listed capacity	16%	16%	No listed capacity	10%	10%	No listed capacity	5%	5%
Cyprus	No listed capacity	1274%	1274%	No listed capacity	764%	764%	No listed capacity	382%	382%
Czech Republic	195%	30%	26%	115%	18%	15%	54%	8%	7%
Denmark	317%	181%	115%	183%	105%	67%	82%	47%	30%
Estonia	0%	21%	0%	0%	12%	0%	0%	5%	0%
Finland	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity
France	448%	68%	59%	257%	39%	34%	115%	17%	15%
Germany	699%	75%	68%	409%	44%	39%	190%	20%	18%
Greece	-	-	-	-	-	-	-	-	-
Hungary	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity
Ireland	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity
Italy	2418%	279%	250%	1399%	161%	145%	635%	73%	66%
Latvia	1652%	No listed capacity	1652%	985%	No listed capacity	985%	485%	No listed capacity	485%
Lithuania	1614%	56%	54%	940%	32%	31%	434%	15%	14%
Netherlands	22096%	38%	38%	10218%	18%	18%	1309%	2%	2%

Table 5-4: Implied volume of ACW that would be generated by total removal of remaining asbestos with current methods (m^3 using a conversion factor of 0.91 m^3/t) as a percentage of available landfill volume (m^3)									
	Assumed content of asbestos in construction waste = 3%			**Assumed content of asbestos in construction waste = 5%**			**Assumed content of asbestos in construction waste = 10%**		
	Hazardous landfill	**Non-hazardous landfill**	**Total**	**Hazardous landfill**	**Non-hazardous landfill**	**Total**	**Hazardous landfill**	**Non-hazardous landfill**	**Total**
Poland	0%	0%	0%	0%	0%	0%	0%	0%	0%
Portugal	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity
Romania	2493%	25%	24%	1491%	15%	15%	740%	7%	7%
Slovakia	3427%	385%	346%	2056%	231%	208%	1028%	115%	104%
Slovenia[104]	83439161%	487110%	484283%	49922612%	291444%	289752%	24785200%	144694%	143854%
Spain	-	-	-	-	-	-	-	-	-
Sweden	201%	129%	79%	118%	76%	46%	56%	36%	22%
TOTAL	149%	28%	23%	87%	16%	14%	40%	7%	6%

[104] Slovenia reports very low volumes of remaining capacity for year 2020 (see Table 5-3), hence these high figures.

5.2.2 Treatment

The only commercially available technology to treat asbestos containing waste in the EU is vitrification by thermal plasma in France. According to the operator, this technology provides a complete destruction of asbestos fibres. A commercial facility named Inertam[105] at Morcenx-la-Nouvelle, in southwestern France, treats asbestos waste and converts it into a non-leachable product by applying an elevated temperature plasma vitrification route, which employs air as plasma gas. The plant, which was designed by Europlasma to process ACW, uses three plasma torches placed at different locations: two 2 MW torches and one 700 kW torch. The asbestos waste is continuously added to the fusion chamber, where two 2 MW torches are used to bring it up to a fusion temperature of between 1,400°C and 1,600°C. The asbestos fibres are claimed to be totally destroyed. Europlasma employs a post combustion chamber in many of their designs to meet the incinerator regulations by ensuring complete combustion of carbon containing gases (Sikarwar et al., 2020). The obtained molten vitrified product called Cofalit is reused as aggregate to form a road-building substrate. However, other uses are being examined, particularly for the storage of solar energy.[106] For instance, in their study, Keilany et al. (2020) presented the first use of Cofalit as a solid filler in pilot-scale thermocline thermal energy storage (TES). The study compares the thermal performance of the thermocline filled with Cofalit to the reference case of alumina spheres for typical charge and discharge operations.

The solutions implemented by Inertam cover the entire process, from the collection of the waste to its destruction, with the issuing of a certificate of final disposal.[107] The installation is capable of processing both friable and non-friable ACW. The processability of the material is dependent on the calorific value of the ACW (as high energy amounts are required to heat a thermally inert material) and the amount of asbestos present. At the moment, the plant is licensed to process 8,000 tonnes/year, but it actually treats around 7,000 tonnes/year at a price ranging between €1,000-2,500/tonne of waste treated. The amount of energy required depends on the composition of the ACW and ranges between 500 and 1,300 kWh/tonne, with an average consumption of 1,000 and 1,300 kWh/tonne. Cofalit, which can be used as a substitute for quartz and basalt in building materials, can be sold for €10/tonne, excluding transportation costs. The amount of produced Cofalit varies between 4,000 and 6,000 tonnes per year.[108]

Although this technique has the advantage of completely destroying asbestos fibres, as claimed by the technology provider, the high energy needs result in a processing cost that is about 35% higher compared to cementation. This energy consumption is linked to the composition of the ACW, the main factors being the water content and the calorific value.[109]

Several other technologies treating ACW at a pilot or demonstrator plant level exist, but they are yet to be realised at an industrial scale. More details about these technologies are provided in Section 5.4.2.

105 https://www.inertam.com/
106 Ibid.
107 Ibid.
108 OVAM (2016). *State of the art: asbestos – possible treatment methods in Flanders: constraints and opportunities.* https://www.dnature.nl/wp-content/uploads/2020/07/State-of-the-art-asbestos-waste-treatement.pdf.
109 Ibid.

5.3 Asbestos waste treatment technologies under research

5.3.1 Peer-reviewed publications

The screening of the results of peer-reviewed research publications returned 53 relevant articles – 44 experimental studies, two life cycle assessments and seven review articles. Experimental articles were mainly from Italy (12), Poland (9) and France (6) in the EU and Brazil (5) and South Korea (3) for non-EU countries. Life cycle assessments were from Italy and Argentina. Finally, there were three review articles from Italy, and one from each of the following countries: Germany, Serbia, Australia and Taiwan. The review articles and life cycle assessments have been analysed in the context of environmental, social, and economic impacts as well as technological readiness level, because most of these studies look at asbestos waste treatment technologies developed and/or investigated before 2018, whereas the current literature search aimed at identifying any emerging asbestos waste treatment technologies or establish any developments/improvements in already existing asbestos waste treatment technologies since 2018 (see Section 2.1 for more details on methodology).

The most common asbestos waste treatment method published in peer-reviewed publications since 2018 has been thermal treatment (25 publications), followed by biological (6), chemical (5), and mechanical (2), mechanochemical (2), biothermal (2) and thermochemical (2) (Figure 5-4). The most common asbestos waste treated by these methods was **asbestos cement**. The overview of all identified technologies can be found in Annex 4 Table (thermal technologies) and Table (all other technologies). Several technologies have been grouped together due to significant similarities in methods.

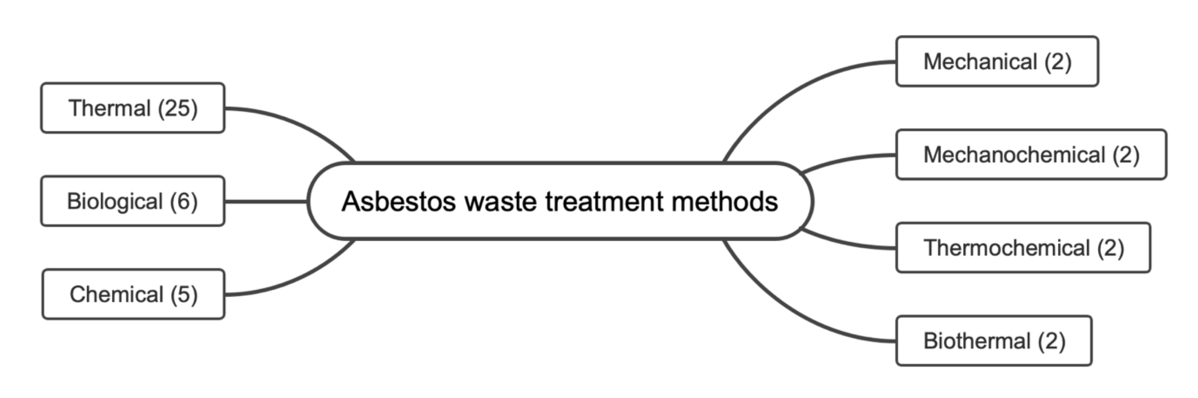

Figure 5-4: Asbestos waste treatment methods identified in peer-reviewed publications.

Most **thermal treatment methods and all other types of treatment methods have been performed in a laboratory** and are not available at a pilot or an industrial level. Only three methods discussed in these publications, all thermal, have been performed at a pilot or an industrial setting. These include:

- **Thermal plasma vitrification** of ACW at Inertam plant in France designed by Europlasma, which transforms asbestos waste into a road construction material 'cofalit' on an industrial scale. In addition, 'cofalit' has been used as a solid filler in a pilot-scale thermocline thermal energy storage (TES).
- **Microwave thermal treatment** of ACW at ATON plant in Poland, which neutralised asbestos waste on a pilot scale.
- **Short-time thermal treatment** of ACW at Scame Forni Industriali pilot plant in Italy, which produces secondary raw material for ceramic industries.

Advantages and disadvantages (where these have been identified in publications) of these technologies can be found in Annex 4. To summarise, the main advantages of thermal plasma vitrification are a complete destruction of asbestos fibres, lower emissions of gases and installations with lower footprint compared to other thermal waste processing pathways (e.g., pyrolysis, gasification). In addition, the transformed asbestos waste can be reused as a construction material. However, the installation and operational costs are high, and the process requires significant amounts of energy (Sikarwar et al., 2020). The microwave thermal treatment is claimed to be economically optimal as it requires lower temperatures compared to the conventional thermal treatment, which reduces energy costs. However, according to Obminski (2021), the process does not fully destroy asbestos and would require further research on the recyclability of the amorphous product obtained during the process. Finally, short-time thermal treatment has the advantage of a very short processing time (15 minutes), which substantially reduces costs of inertisation. In addition, the recovered material has proved to be suitable for recycling as a secondary raw material in several sectors, such as ceramics and cement industries. No disadvantages were identified in the study (Marian et al., 2021).

Regarding thermal treatment technologies that have only been carried out at a laboratory level, apart from microwave thermal treatment, the application of thermal treatment technologies resulted in the recovery of a secondary material which can be used in several different industries (see Outcome column in Table). The outcome of a microwave thermal treatment is an amorphous product, although one study reported the recovery of valuable metals, such as magnesium and calcium (Hong et al., 2021).

Several thermal treatment processes used not only ACW but other types of waste to create a new secondary raw material suitable for recycling. For instance, waste glass cullet (Iwaszko et al., 2021), other glass waste or recycled glass (Ligabue et al., 2020; Ligabue et al., 2022) was used in vitrification of asbestos waste to produce harmless vitrified product, foam glass or glass-ceramic frits for manufacturing porcelain stoneware slabs. Fly ash from fluidised-bed boilers was also used together with asbestos waste in thermal plasma process to produce a glassy slag, which could be used in the production of thermal insulation materials (Lázár et al., 2018).

Biological treatment involves biodegradation of asbestos by bacteria and fungi (David et al., 2020a; David et al., 2020b; David et al., 2021; Bhattacharya et al., 2021; Borges et al., 2022a) or dark fermentation and anaerobic digestion (Trancone et al., 2022) of asbestos waste. In the former process, biodegradation or weathering of asbestos waste occurs, whereas in the latter, biohydrogen and biomethane is produced. Both methods are considered eco-friendly, efficient, and promising in the context of circular economy.

Chemical treatment described in the analysed studies uses acids, fluorides from the glass and metal industry[110] or sodium hydroxide to decompose/dissolute asbestos and produce pure silica powder or layered double hydroxide from asbestos cement roof tile, asbestos rope, and other types of asbestos waste (Necasova & Buchta, 2019; Talbi et al., 2019; Li, 2019; Necasova et al., 2021). A hydrothermal treatment in supercritical water converts ACW and raw asbestos to several types of minerals and/or silicates (Nzogo Metoule et al., 2019).

Mechanical treatment involves milling of asbestos cement to a powder without fibrous asbestos structure (Iwaszko et al., 2018; Bloise et al., 2018). According to the study by Iwaszko et al. (2018), the high-energy milling resulted in destruction of the crystalline structure of the asbestos phase. Bloise et al. (2018) claimed that after grinding for 10 mins, tremolite and anthophyllite fibres were below the limits defining a countable fibre according to World Health Organisation.

[110] Fluorides release hydrofluoric acid in the acid medium, which acts as the main decomposition medium (Necasova et al., 2021).

Thermochemical treatment involves thermal treatment in the presence of special clays (Ruiz et al., 2018) and microwave thermal treatment using chemical additives (Hong et al., 2022). According to Ruiz et al. (2018), the process managed to achieve a high degree of transformation of the original carbonates and asbestos minerals and turn ACW into products that contain important amounts of clinker phases such as dicalcium silicate and tricalcium silicate and free magnesium oxide. According to the results obtained by Hing et al. (2022), asbestos was eliminated in the ACW at 800°C with magnesium chloride at 900°C with sodium hydroxide as the additives.

Mechanochemical treatment includes the binding of hazardous asbestos fibres in a polymer matrix formed from waste cooking oil (Staroń et al., 2020) and mechanochemical process using citric acid as a reactant (Borges et al., 2022). Finally, **biothermal treatment** uses dark fermentation process followed by a hydrothermal phase and anaerobic digestion to produce methane, hydrogen, as well as to crystallise struvite, which is an eco-friendly phosphorous-based fertiliser (Spasiano, 2018; Spasiano et al., 2018). The details of these treatment methods can be found in Annex 4.

5.3.2 Research projects

EU funded projects

The search for EU funded projects on asbestos waste treatment technologies was done on EU Cordis and EU Life platforms. The search was not restricted by time period to ensure that all EU funded projects on asbestos treatment were identified for further investigation on whether they have been successful and are currently being used to treat asbestos waste.

The initial search on EU Cordis returned 17 projects**, 7 of which were relevant for the study**, and the initial search on EC Life Public Database found 20 projects, **3 of which were on asbestos waste treatment** (see Table 2-4: Search terms, Table 2-5). The list of projects, their acronyms, start and end dates and current status can be found in Annex 5.

The majority of the projects on asbestos waste treatment that were funded by the EU have not subsequently been further followed-up, although for some, no information to confirm their status could be found. In particular, no information could be identified for projects that took place in 1990's, which can be explained by the age of the projects. It is likely that these technologies either did not mature or simply became outdated.

One of the companies that is still operating is ATON in Poland, which developed a waste utilisation technology based on **microwave thermal treatment (MTT)** (project AMIANTE, 2008-2010). The method is used to destroy several types of hazardous waste, including ACW. However, it needs to be noted that subsequent investigations on the technology, and more precisely the end product, found that the efficiency of asbestos destruction was insufficient (Obminski 2021). According to the author, the MTT technique should be used as a process for inertisation of asbestos waste or reduction of its harmfulness rather than to recycle it. The author added that although lowering the temperature of the process was economically desirable, there was a risk of incompletely destroyed asbestos with traces of hard-to-detect fibres. Hence, the technology is claimed to require further research to achieve the recyclability of the end product (Obminski, 2021).

Project IRCOW (2011-2014) looked more broadly on innovative strategies to recover high-grade materials from CDW, including ACMs. The project generated some interesting results of technical and non-technical nature for managing CDW as a resource of valuable materials which can be recovered for high-grade applications back in the construction sector. The technology owned by ATON (the project partner) was obtained within IRCOW. According to the project team, the **use of MTT is a promising technology to transform fibrous structures into inert compounds that could potentially be used in other construction applications**. Furthermore, it is quoted that cost of asbestos treatment by MTT is at the level of landfill deposition costs and even 10 times cheaper than plasma treatment. Advantages of the technology compared with other waste management options include the possibility of the onsite treatment since the reactor could be installed on a mobile platform, inert by-products and the possibility of treatment with toxic substances.[111]

The ADIOS project based in Netherlands (2010-2013) aimed to demonstrate that the **thermal treatment of asbestos waste was feasible on a large scale with the final product being safe for industrial uses**. The project had an objective to construct a pilot plant with a tunnel oven to demonstrate a prototype thermal treatment process for denaturing asbestos.[112] The technology is currently owned by D-nature, which is a young company that focuses entirely on the development of a solution for asbestos cement waste. D-nature offers a solution for asbestos cement waste by means of denaturing: heating asbestos so that the asbestos fibrous structure changes permanently and an allegedly harmless mineral remains. The harmless residual product has similar properties to cement, and it is size-reduced by breaking and grinding it, which results in a granulate, also known as Bestof. Bestof is claimed to be suitable for reuse in the cement industry or in asphalt. Currently, the plant is not running on an industrial scale yet, all attention is focused on the design and preparations for the realisation of the installation.[113]

During the project LIFE FIBERS, the University of Genoa developed a technique and an apparatus for triggering the breakdown reaction of chrysotile asbestos by means of an alumino-thermic reaction and the process of combustion synthesis (Self Propagating High Temperature Synthesis [SHS]). According to the project team, this approach allows the development of an efficient method for inertising natural asbestos fibres as well as asbestos products, transforming fibres at the scale of few grams. The preliminary results allowed the team to patent the technology (Gaggero L., Ferretti M., Belfortini C., Isola E., 2010 METODO E APPARATO PER L'INERTIZZAZIONE DI FIBRE DI AMIANTO). The SHS takes advantage of the enthalpy variation of an alumino-thermic reaction, which is strongly exothermic and even self-sustained. Once triggered by an external heat source for a few seconds, the reaction proceeds across the volume of reagents as a combustion wave, without the need for further energy input from outside. The advantage of this method is the high density of thermal energy and high temperature (1600 °C) but short time heat induction, which significantly lowers the cost of the process when compared with other thermal technologies.[114] Although the project website is still active, it is not clear if the technology has been advanced or in the process of being applied on an industrial level.

Other projects

Several countries where the research of asbestos waste treatment technologies is more active (based on scientific publications and patents) have been checked for any research projects funded by the national authorities and/or other relevant institutions. The websites and databases of research councils, technology and science agencies, science foundations were screened for projects related to asbestos waste treatment. No such projects have been identified in countries such as the United States (US), Australia, Canada, the United Kingdom (UK), Japan, South Korea, Switzerland and Brazil.

[111] EC Cordis (2015). *Innovative Strategies for High-Grade Material Recovery from Construction and Demolition Waste.* https://cordis.europa.eu/project/id/265212/reporting.

[112] EC Life Public Database (n.d.). *Asbestos denaturing with innovative ovensystems.* https://webgate.ec.europa.eu/life/publicWebsite/project/details/3100.

[113] https://www.dnature.nl/

[114] https://www.fibers-life.eu/en-home.html

5.3.3 Patents

The search of patents on asbestos waste treatment technologies was carried out on Espacenet[115] and Lens[116] portals. The initial search identified 835 patents on Espacenet and 264 patents on Lens (see Table 2-5). After the results were screened against the inclusion criteria and duplicates were removed, **the total of 44 patents have been taken further for the analysis**, 29 from Espacenet and 15 from Lens.

The most common patented asbestos waste treatment methods since 2018 have been **thermal treatment** (19) **and chemical treatment** (16), followed by thermochemical (4), mechanochemical (2), mechanical (1), and biochemical (1). One patent covered the technology for recycling of thermally or chemically detoxified asbestos waste.

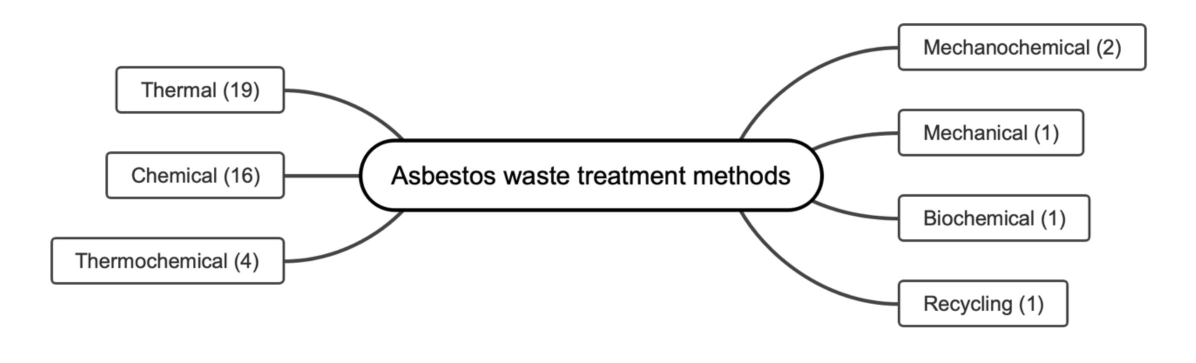

Figure 5-5: Types of patented asbestos waste treatment methods identified on Espacenet and Lens.

The highest number of patents came from inventors in South Korea (15), followed by Japan (7), Italy (6), and Netherlands (4). China and France had three, Switzerland and the UK had two, and Poland and Slovakia had one invention each.

It needs to be noted that several patents were from the same inventor or company and may have been part of the same technology but required separate patents for different units/stages/modes of the invention. However, they have been kept as separate patents because it was not possible to distinguish whether the patent was for the same technology, or it was a different technology invented by the same inventor/company. The list of patents is presented in Annex 6.

5.4 Emerging asbestos waste treatment technologies

5.4.1 Technologies investigated at country level

A few countries have investigated potential options to treat ACW to avoid landfilling. In **Belgium** and the **Netherlands**, two comprehensive reports on asbestos waste treatment technologies were published in 2016 by OVAM[117] and in 2018 by the Bureau KLB.[118] They looked at possible practicable and sustainable options to treat asbestos containing waste in Belgium and in the Netherlands. As the literature search in this study focused on technologies that are being researched or have been

[115] https://worldwide.espacenet.com
[116] https://www.lens.org
[117] OVAM (2016). *State of the art: asbestos – possible treatment methods in Flanders: constraints and opportunities.* https://www.dnature.nl/wp-content/uploads/2020/07/State-of-the-art-asbestos-waste-treatement.pdf.
[118] Bureau KLB (2018). *Practicable sustainable options for asbestos waste treatment.* https://www.asbeter.com/documents/KLB%20assessment-of-asbestos-waste-treatment-techniques.pdf.

implemented since 2018, these reports have not been analysed in greater detail. However, the following conclusions have been made in the reports:

- Based on the study by OVAM (2016), the two most promising techniques for asbestos waste treatment in Flanders were thermal plasma vitrification and denaturation.
- The study by the Bureau KLB (2018) showed that there were several techniques for asbestos waste treatment that may have presented themselves on the Dutch market in the following years. Once made available, some of these techniques would hardly or not require specifically adapted conditions, whereas some other techniques would be more dependent on market conditions, for which the government intervention would be required.
- According to the Bureau KLB (2018), several of the techniques may have their own markets or niches of asbestos waste that they can treat most effectively and profitably:

    - Recycling asbestos containing steel scrap in steel melting furnaces;
    - Thermal denaturation of asbestos cement roofing or pipes;
    - Thermo-chemical treatment of ACW and high-energy waste;
    - Mechanochemical treatment of homogeneous stream of asbestos cement; and
    - Biological treatment of asbestos in soil *in situ*.

In 2021, the General Council for the Environment in **France** published 'A Roadmap for the Treatment of Asbestos Waste'.[119] Four asbestos waste treatment processes under development in France were discussed in the report. They had two common characteristics: they were based on an acid attack on asbestos fibres, and they had been supported by public authorities. All were at the prototype development stage following the validation of the process at the laboratory stage. Hence, their operational nature could not be confirmed.

The promoters of these processes highlighted the achieved destruction of asbestos fibres, their lower energy consumption compared to thermal processes, and the possibility for some of them to recover the constituent materials of asbestos, namely silica and metals, especially magnesium. Chemical processes have greater or lesser efficiencies depending on the type of asbestos, often require prior sorting of waste, and they are not exempt from dangers in terms of the operation of the process. Ultimately, the prospect of these processes being less expensive than vitrification, or even competitive with landfilling, is largely based on the recovery of the products resulting from the treatment, and therefore on the quality of the prior sorting and/or on the regularity of the incoming flows (General Council for the Environment, 2021).

The report also looked at other processed developed outside France. The review was based on summaries published by Bureau KLB (2018)[120] and the 'International Benchmark of Research and Development on the Treatment of Asbestos', produced by the French Scientific and Technical Centre for Building (CSTB) as part of the Asbestos Research and Development Plan (PRDA), as well as searches on the internet and interviews with French stakeholders. The following conclusions have been drawn:

- Inertising asbestos waste by plasma torch was at the time the only alternative to landfilling; and
- No other technology had yet materialised in the form of an industrial processing unit. Attempts to move from the laboratory to the pilot or from the pilot to the industrial stage for technologies under development were mostly challenging and unsuccessful.

[119] General Council for the Environment (2021). *A roadmap for the treatment of asbestos waste.* https://www.economie.gouv.fr/files/files/directions_services/cge/dechets-amiante.pdf?v=1667228240.

[120] Bureau KLB (2018). *Practicable sustainable options for asbestos waste treatment.* https://www.asbeter.com/documents/KLB%20assessment-of-asbestos-waste-treatment-techniques.pdf

According to the report, VALAME technology was the most advanced among the four processes in France.[121] The other three projects meant to open demonstrator plants by the end of 2022, envisaging to build fixed units capable of treating tens of thousands of tonnes of asbestos waste per year.

The report also indicated that Japanese cement manufacturers had filed numerous patents on the treatment of asbestos waste. The temperatures of the furnaces used to produce cement can indeed be interesting for thermally destroying asbestos fibres, considering that asbestos waste has a similar mineralogical composition to clays (hydrated aluminium silicates), asbestos waste if often bound to cement or plaster, and the temperatures of the furnace (800-1,500°C) and the durations of treatment are sufficient to denature the fibrous structure of asbestos after the contact with a flux as well as to destroy any organic pollutants (RECORD, 2016). Patents to treat asbestos waste in cement kilns were also filed in South Korea. For example, one invention[122] provides a method for detoxifying asbestos products using a cement kiln, comprising a step of pre-treating waste slate containing asbestos, a step of supplying the pre-treated waste asbestos slate to a cement kiln, a step of heating the cement kiln at 600 to 2,500°C[123], a step of recovering the treated waste asbestos slate, and a step of manufacturing construction materials using the treated waste asbestos slate. The process produces fillers, base materials, and other construction materials using asbestos slate that has been detoxified. The Polish company ATON, which treated ACW in industrial pilots using a mineralising agent and implementing microwave thermal processes, was also mentioned in the report, although this pilot did not seem to have resulted in industrial installations to date (General Council for the Environment, 2021).

In **Denmark**, the Danish Environmental Protection Agency published a report on waste containing asbestos and other environmentally problematic substances, its characterisation, associated risks and management options.[124] The overview of treatment technologies had an international scope to show the existing possibilities. The literature search looked for studies that investigated or reviewed the options to treat asbestos waste with particular focus on thermal treatment technologies. Table 5-5 lists the processes discussed in the report, their advantages and disadvantages.

Table 5-5: Overview of advantages and disadvantages of asbestos waste stabilisation and inertisation technologies. Adopted from: Boldrin et al. (2022).

Process	Process type	Advantages	Disadvantages
Stabilisation	Stabilisation in cement blocks	• Incorporation of large amounts of heavy metal ions which are chemically bonding inside an inorganic amorphous network; • The final process product is inert towards most chemical or biological agents and can be disposed of in landfills.	• Increase in volume of the waste; • Not a final solution, rather a postponing of the problem; • Expensive method in the long term.
Inertisation	Thermal treatments	• Incorporation of large amounts of heavy metal ions which are chemically	• High energy demand for heating as most products are asbestos cements;

[121] https://www.valame.com/home/

[122] Espacenet (2020). *Harmless method of asbestos products using cement kiln and construction material manufacturing method using harmless asbestos products.* https://worldwide.espacenet.com/patent/search/family/071894291/publication/KR102136685B1?q=pn%3DKR102136685B1.

[123] The maximum temperature reported for cement kilns is 1,600°C. The patent may be referring to Fahrenheit rather than Celsius.

[124] Boldrin, A., Maresca, A., Fauser, P., Sanderson, H., & Astrup, T. F. (Eds.) (2022). *Waste containing asbestos and other environmentally problematic substances: Characterization, risks and management. Danish Environmental Protection Agency.* Miljøprojekter No. 2216. https://backend.orbit.dtu.dk/ws/portalfiles/portal/302213476/978_87_7038_454_4.pdf.

Table 5-5: Overview of advantages and disadvantages of asbestos waste stabilisation and inertisation technologies. Adopted from: Boldrin et al. (2022).			
Process	**Process type**	**Advantages**	**Disadvantages**
		bonding inside an inorganic amorphous network; • The final process product is inert towards most chemical or biological agents and can be disposed of in landfills; • Flexibility to treat wastes of various types; • Consolidated technology; • Reduced amount of waste. • Existing full-scale facilities.	• Need to control the feeding rate to avoid too high a ratio between asbestos and vitrifying material; • Formation of atmospheric pollutants; • Need to deal with extreme temperatures and high corrosion.
	Chemical	• Low energy consumption (process at room temperature); • Transportable installations; • Existing full-scale facilities.	• Long treatment time; • Costs of reagents; • Potentially highly corrosive conditions; • Intrinsic risk from working with strong acids/alkalis; • Need for treatment of liquid waste.
	Thermochemical	• No use of chemicals; • When using reducing agents, the reaction is spontaneous; • Products can be recycled as secondary materials.	• Prototype scale; • High operational pressure; • Costs of the reducing agents (e.g., metals).
	Mechanochemical	• Similar technologies largely used in the mining industry; • Can be done at a small scale, in transportable units. • Fast and cheap.	• Potential risk of aero dispersion.
	Biological	• Cheap; • Low energy consumption; • Can be performed in-situ. • Promising for contaminated soils.	• Long treatment time • Potentially incomplete destruction of fibres; • Only proved for fibres, not in matrix conditions.

In **Serbia**, Zoraja et al. (2021)[125] investigated the potential of applying a mechanochemical treatment technology to treat asbestos waste in the context of a circular economy. According to the authors, it is necessary for the state of Serbia to invest in infrastructure and to strengthen the implementation of existing regulations in order to implement this model of asbestos waste management. Similarly, Nabango and Majale (2022)[126] reviewed and explored the potential of applying vitrification and dissolution in acids for managing asbestos waste in **Kenya**, especially with the emphasis on reuse and recycling processes. The review stated that although landfilling is considered safe by the regulations, it implies a relatively high risk due to compromised standards of disposal as well as unforeseen risks arising from geologic activity that may create channels for leaching and other exposure pathways. The study proposes that the policy guidelines rethink the way asbestos waste should be handled and adopt the treatment of the substance through processes such as dissolution in acids and/or thermal

[125] Zoraja, B., Živančev, M., Ubavin, D., & Nakomčić-Smaragdakis, B. (2021). Circular economy as possible solution for asbestos burden. In IOP Conference Series: Materials Science and Engineering (Vol. 1163, No. 1, p. 012033). IOP Publishing.

[126] Nabango, H., & Majale, C. (2022). Towards a Circular Economy: A Review on Asbestos Waste Management Regulations in Kenya. *East African Journal of Environment and Natural Resources, 5*(1), 34-47.

conversion processes. According to the review, the processes guarantee the elimination of asbestos fibres and yield by-products that can be further processed, such as glass and fertilisers.

In the **US**, the 'Guide to Handling, Disposing, and Recycling Asbestos'[127] describes several existing asbestos waste recycling technologies, such as thermochemical, microwave thermal and high-speed milling treatment technologies. The most established method heats ACMs in a sodium hydroxide solution above 1,250°C to break down asbestos. The process results in thermal decomposition of asbestos fibres and produces a type of non-hazardous glass, which can be used to create ceramic and stoneware products, or it can be used as aggregate for roadways and concrete. Another method uses a microwave thermal treatment to turn asbestos into ceramic bricks or porcelain tiles. A third method uses a high-speed milling process to break asbestos fibres into non-hazardous inert minerals. The non-hazardous end products of these recycling methods are either delivered to a regular landfill or they can be used in construction materials, as packing material or as concrete aggregate. According to the guidelines, some of these methods reduce the asbestos waste volume by 50% to 99.7%, depending on the type of product being recycled. The reduction in volume can be beneficial for disposing asbestos waste because disposal pricing is based on volume. The guidelines explain that currently, the cost of recycling asbestos is about three times higher than the traditional disposal in special landfills designated to receive asbestos waste. Some of the costs, however, may be recovered by selling the non-hazardous end products. It needs to be noted though, that in the United States, asbestos recycling is currently not available to the general public, only to public authorities, such as the Department of Defence.[128]

5.4.2 Most advanced asbestos waste treatment technologies

Based on the literature review and stakeholder consultation activities, several types of asbestos waste treatment technologies have been identified as having the highest potential to be industrialised in the EU, considering the status in the development process and commercialisation plans of the technology providers for the near future. The list of these technologies is provided in the table below.

Table 5-6: Asbestos waste treatment technologies identified through the literature review and consultation activities as most promising.

Process group	Principle	Outcome	Companies/projects
Thermal	Melting of ACW at temperatures ranging between 650 and 1,600°C	Secondary material	D-Nature, Thermal Recycling, Purified Metal Company
Chemical	Dissolution of ACW in acid (hydrofluoric, hydrochloric, sulphuric acids) or base (sodium, potassium hydroxides) at temperatures ranging from room to 200°C	Secondary material	VALAME, De Dietrich/BlackAsbestos, Somez, Colas
Thermochemical	Shredding and mixing ACW with fluxing agent and then heating for demineralisation at temperatures ranging from 1,200 to 1,250°C for ~20min	Secondary material	ARI/EnviroMaster
Mechanochemical	Chemical and physical-chemical transformations produced by the effect of mechanical energy with or without addition of acids/bases	Secondary material	Asbeter, ABCOV®, MID-MIX® Technology

127 Asbestos (2023). *Guide to Handling, Disposing and Recycling Asbestos.* https://www.asbestos.com/exposure/handling-disposing-asbestos/.

128 Ibid.

Thermal

Thermal treatments consist of the modification of the crystal-chemical structure of the amyloidous silicates, which occurs spontaneously at high temperatures. Materials thus obtained are devoid of initial toxicity and danger. This category is very articulated, and it is also the one where the most important industrial experiences are concentrated. The main thermal techniques are:

- **Vitrification**: ACW is melted with plasma torch or standard furnace. During this treatment, the material is heated to extreme temperatures (1,100-1,600°C) and is transformed into an inert, asbestos-free, vitrified end-product.
- **Ceramitisation**: ACW is melted with standard furnace with or without additives. The application of the ceramitisation method makes it possible to obtain inert and asbestos-free materials at temperatures ranging between 800-950°C.
- **Denaturation**: ACW is heated to 1,000°C for the destruction of fibre structure.
- **Pyrolysis**: ACW is melted in furnaces with or without additives to produce expanded clay. Process temperature ranges from 600 to 1,300°C. The addition of additives normally reduces the operational temperature.[129]

Two parameters of importance with thermal treatment methods for ACW are time and temperature. The temperature depends on the different technique applied according to the range of decomposition temperature for each asbestos-type fibre (Paolini et al, 2019). The table below shows decomposition temperatures for different types of asbestos.

Table 5-7: Decomposition temperature for each type of asbestos (Paolini et al, 2019)

Asbestos type	Decomposition temperature (°C)
Chrysotile	450-700
Crocidolite	400-600
Amosite	600-800
Anthophyllite	800-850
Tremolite	950-1,040
Actinolite	620-960

Asbestos waste thermal decomposition consists of three stages: the first is associated with the loss of adsorbed water, the second is the removal of structural OH groups from the structure of asbestos minerals and the third is responsible for the crystallisation of amorphous materials where the growth of new phases occurs after dehydroxylation. The common critical issues for all thermal treatments are the high energy required to heat a thermally inert material such as asbestos. In this regard, it should be recalled that the most common type of ACW is asbestos-cement, where asbestos fibres are dispersed in a thermally inert material. Other issues are related to the formation of atmospheric pollutants during the heating phases. The second important parameter is the residence time of the ACW. This is the time during which the ACW has to be treated in order to ensure complete destruction of the asbestos fibres, ranging from minutes to several hours or even days. Consequently, the cost to process ACW increases with longer residence times. Furthermore, the infrastructure necessary for these techniques, e.g., furnaces, plasma torches, among others, is very expensive and often not readily available (OVAM, 2016).

[129] Fujishige, M., Kuribara, A., Karasawa, I., Kojima, A. (2007). Low-Temperature Pyrolysis of Crocidolite and Amosite using Calcium Salts as a Flux. *Journal of the Ceramic Society of Japan, 115*(1343), 434–439.

D-Nature

D-Nature[130] is a company owned by Twee "R" Recycling Groep B.V that focuses entirely on the development of a solution for the treatment of asbestos waste, specifically asbestos cement products. Currently, all the attention by the company is focused on the design and preparations for the realisation of an industrial installation.

The technology relies on decomposition of asbestos fibres at a temperature of up to 1,000°C. The process does not entail any kind of pre-treatment. However, a specific check is performed visually and by sampling ACW before the transformation at the site to avoid the presence of hazardous material or contaminants that could hinder the process. Unopened bags of ACW are put into a tunnel oven and submitted to a maximum temperature of 1,000°C to destroy all type of asbestos, with a residence time of about 3 days. This time is required to build-up the temperature because the material must not heat up too quickly to avoid the explosion of asbestos cement plates in the oven and to prevent fibre-formation and other air currents. The cooling down of denatured asbestos waste also takes time. This heat can be reused in the process. After the process, denatured material comes out of the oven and only then it is reduced in size. The process control is performed by controlling temperature, residence time, gas emissions and asbestos fibres presence in the end-product.

D-Nature claims 100% destruction of asbestos fibres, with 25% reduction of the initial volume of ACW. The end-product, named Bestof, is characterised by cement-like properties and can be used as a filler, in co-formulation with cement or as an aggregate for road construction.

According to the company, the main advantages of the process are the fact that no pre-treatment is needed, the process runs in a closed system with no release of fibres, the end-product is asbestos-free, no additives are used, and energy consumption is fairly low. The process could also run on electricity instead of gas.

Currently, D-Nature has no operational plants but is planning to build a facility with a potential capacity of 100,000 to 120,000 tonnes/ACW treated per year. This is only possible if the Dutch government issues a landfill ban.

Purified Metal Company

According to the information available on the website[131] and retrieved from experts' consultation, Purified Metal Company (PMC) is a former Dutch company, which developed a process to transform asbestos contaminated steel scrap into a safe raw material.

During the process, the contaminated steel scrap is loaded into standard disposal containers, which are then placed on a transport trolley and brought in via a lock. The container is transported to the storage bunker in the factory via two locks that are pressurised. An overhead crane feeds the scrap into a shear, where it is cut and pressed.

The material is then loaded into a loading vehicle and slowly fed into a melting bath at more than 1,500°C. During the melting process, contaminants are separated from the steel and the asbestos fibre structure is claimed to be completely destroyed and converted into harmless components, H_2O, SiO_2 and MgO. Other hazardous substances are collected or neutralised by a flue gas cleaning system. Once the steel has completely melted, it is transported to the casting machine via special channels. In order to determine the chemical composition of the melt, chemical analyses are performed on the liquid

[130] www.dnature.nl

[131] www.purifiedmetal.com

melting bath. In the casting machine, a batch of 20 tonnes of liquid steel is transformed into Purified Metal Blocks (PMBs). The PMBs are stored outside for sale to steel mills or foundries.

During the melting process, the flue gases are continuously extracted via the flue gas duct and transported to a purification system.

The company went bankrupt in 2022 due to the shortage of material to be processed.

Thermal Recycling

Thermal Recycling[132] is a company based in the UK, which has developed a thermal denaturation process for ACW. Thermal Recycling claims that this technology can treat all types of asbestos, although currently UK Environment Agency permit only allows to treat cement-bound chrysotile. The company wants to work with the Environment Agency to extend the range of asbestos types they can treat.[133]

During the process, ACW is delivered in specially designed bags into a kiln and submitted to high temperatures (1,250-1,300 °C) for the denaturation of asbestos fibres. The process does not include any pre-treatment or addition of chemical additives. Process control is performed after each firing by sampling and testing by-product to check the complete destruction of asbestos fibres. The by-product is then crushed to obtain an inert material, named CALMAG, which is a mixture of calcium, aluminium and magnesium, silicate, sulphates, oxides and other compounds. It can be re-used as a cement replacement or in the production of concrete in the construction sector.

Currently, the technology operates at a pilot scale with a surface occupation of 700 m^2 to treat 10-12 tonnes of cement-bound asbestos per day. The company has an Environment Agency permit to develop a full-scale treatment facility with a capacity of 29,500 tonnes/year to accept cement-bound chrysotile. The full-scale plant would need an area of around 4,000 m^2 and would treat around 50 tonnes of asbestos waste per day. The company has received a Smart Innovation grant from the UK Government to investigate the highest value use for the recyclable material produced by the process. It has expressed its intention to establish a network of treatment plants across the UK and internationally so that they could treat as much asbestos as possible and divert it away from landfill.[134]

According to the company, no need for pre-treatment and no secondary waste are some of the main advantages of their process. In addition, the process can treat all six types of asbestos and the obtained material can be reused in the construction sector, reducing the use of cement. The company claims their process should also work for other forms of asbestos, such as friable asbestos.

Chemical

Asbestos fibres could be denaturated through a chemical treatment consisting in a water dissolution of the metals present in their crystal structures (Spasiano & Pirozzi, 2017)

Several processes have been patented and studied concerning ACW chemical treatment. It consists of treatment of the compounds included in asbestos structure with chemical additives, which are added to lower the melting temperature or enhance mineralogical decomposition. The main advantage of this technique is the reduced energy cost as the decomposition happen also at room temperature, however the main drawbacks are the long treatment time and the need of wastewater treatment. As

[132] www.thermalrecycling.co.uk

[133] https://www.thermalrecycling.co.uk/storage/media/content/files/ARCA%20NEWS%20Recycling%20article.pdf

[134] Ibid.

it is necessary to hydrolyse the oxygen–silicon bond, the two main strategies include the use of highly basic or acidic pH that degrades the structure of asbestos by producing free silanols. In general, in order to obtain satisfactory results, it is necessary to operate at temperatures close to 100°C (Paolini et al, 2019).

At high pH, silicate compounds can be degraded by means of the hydrolysis of the Si–O bond, driven by the OH− anion. Under alkaline conditions, asbestos is converted into magnesium hydroxide and sodium silicate. Similar reactions can be derived for the other forms of asbestos, and from the use of other basic reactants such as potassium hydroxide KOH and calcium hydroxide $Ca(OH)_2$. Similarly to basic solutions, strong acidic solutions can hydrolyse the Si–O bond, creating free silanol moieties (R3Si–OH) (Paolini et al, 2019). In both processes there is the need to perform a solid-liquid separation by means of a filtration/centrifugation step, in order to recover the solid by-product and to neutralise and/or recycle the liquid phase.

VALAME

This project is based on the work carried out by the company Neo-Eco based on the patented work of two researchers from the French National Centre for Scientific Research (CNRS), carried out in the chemical engineering laboratory of the National Polytechnic Institute of Toulouse. The VALAME start-up, created in 2019, counts Neo-Eco among its shareholders, and holds the exclusive license for the process developed in Toulouse (General Council for the Environment, 2021) has been granted 2 additional patents on process improvement. According to VALAME, the company is offering an alternative for asbestos waste management that is both eco-friendly and innovative. Their process is based on a chemical process using hydrochloric acid, which is a commodity product widely spread in the industrial sector.

The process is claimed to be capable to treat asbestos cement, plaster, asbestos primer, slates, floor tiles, glue and bituminous glue, thermal insulation, glass wool and asbestos flocking. ACW is sorted, milled to a 2-3 mm granulometry and submitted to a 2-stage acid digestion with hydrochloric acid at low temperature (<100°C) and ambient pressure for a residence time of approximately 30 to 60 minutes. According to the company, the process is capable to treat only chrysotile asbestos fibres. In order to optimise the process, anti-foaming agents are added to avoid foam formation and lime to correct acidity at the end of the digestion phase.

The end-products are calcium and magnesium chloride (with a yield of 60-70 kg/100 kg ACW), amorphous silica (with a yield of 40 kg/100 kg ACW), hydroxides (iron and aluminium). According to the company, these products can be used as additives and fillings for road construction, concrete formulation and as de-icing agents, products for the chemical industry, water treatment product. Process control is performed by a gas scrubbing tower to prevent release of hydrogen and acid vapours. Currently, the control process is conducted by laboratories labelled by the French Accreditation Committee (COFRAC).

The company states that process limitations are related mainly to the type of asbestos that can be treated, i.e., only chrysotile fibres.

Currently, the process is at a pilot scale. The potential future capacity is 15,000 tonnes/year of ACW treated per site with a land footprint of 30,000 m^2.

BlackAsbestos / De Dietrich / Neutraval

The chemical process for asbestos destruction, known as NEVADA (NEutralization and VAlorization of Asbestos Waste), is the culmination of 12 years of research and development by BlackAsbestos, a company based in Malta. BlackAsbestos specialised in finding effective solutions for neutralising ACW.

After laboratory validations of its globally patented process, in 2019, BlackAsbestos has partnered with De Dietrich Process Systems and Neutraval, a joint venture between Group Beck and APPI. De Dietrich Process Systems is a provider of advanced equipment to the pharmaceutical and fine chemical industries, as well as an expert in plants design and maintenance. Group Beck is a construction and waste recycling company with multiple operations in the eastern part of France. APPI is a company specialised in engineering chemical processes and industrial plants.

The process is claimed to ensure complete destruction of asbestos, particularly in building materials, where the resulting by-products—such as magnesium sulphate, anhydrite, zeolites, and silica—are all reusable. According to the company, the method is energy-efficient due to its exothermic reaction. Moreover, it requires minimal human intervention, as it is automated and operates in an isolated environment.

Before treatment, the ACW is sorted and ground to sub 1 mm granulometry with a negative pressure containment to avoid asbestos fibres dispersion. The digestion process is based on an acid attack using sulfuric acid and moderate heat (100°C) for 6 hours. Temperature is constant as the reaction is exothermic and self-sustained. It is claimed to be capable of treating all kinds of asbestos, with the only variation being the duration of the attack. Amphiboles, which are less common, require a longer attack but no more than a few hours. After a solid/liquid separation step, silicates, anhydrites, gypsum and magnesium sulphate are recovered and, according to the company, can be used in construction and chemical industry, agriculture, electronics, automotive, metallurgy. The liquid phase containing hydrochloric acid is recycled. Wastes containing metallic parts cannot be treated currently due to their chemistry and risks to equipment, but a specific process is being developed, while the treatment of hydrocarbon-asbestos mixed waste, such as road tar, is excluded for the time being.

The technology is being implemented at a pilot scale, with an installation capable to treat 60 tonnes/year of ACW with a potential future capacity of 15,000 tonnes/year of ACW treated per site.

According to the company, the pilot plant has started operation early December 2023 and has destroyed a first batches of ACW on an industrial scale. The full destruction of asbestos has been confirmed by an independent laboratory using a full-blown range of analysis on multiple samplings and in line with the French legislation. The laboratory report provided by the company states that no asbestos has been detected.

After a series of tests and industrial process optimisation using the pilot plant that are due to take place in the coming months, the company will move forward with the construction of the first plant in France.

According to the company, some of the advantages of the process are the utilisation of sulfuric acid, which is readily available and cost-effective due to being a by-product of the chemical industry, the single-step procedure, the scalability and the exothermic nature of the reaction. The company claims that the use of sulfuric acid for asbestos destruction is emitting no-toxic gas and produces inert and chlorine-free by products.

Somez

The MEGAMIANTE project for the destruction of asbestos by acid bath, carried out by the company Société Méditerranéenne des Zéolithes (SOMEZ), is at a Detailed Preliminary Design (DPD) stage. The process which takes a strictly chemical route, proceeds to waste sorting in order to separate the flocked-type waste (flocked asbestos is a particular type of friable asbestos with low cohesion and high friability) from that of the fibrocement type. They are then submitted to a first acid attack at 80°C, which eliminates the chrysotiles. This attack lasts about 10 hours. A filtration step separates the liquid phase from the solid phase. If the latter contains amphiboles, it then undergoes a second alkaline attack at higher temperature. The process makes it possible to treat all types of fibres (chrysotile and amphiboles) free or bound in an inorganic matrix. The company hopes to eventually be able to process those found in organic matrices. The company envisages the recovery of silica, potentially important for flocking, metal oxides and tobermorite (hydrated calcium silicate of interest for the cement industry) (General Council for the Environment, 2021).

Work is currently being carried out to set up a semi-industrial pilot site (capacity of around 100 kg/day or around 30 tonnes/year) in Bergerac, France, in conjunction with various local authorities. The company Somez is now looking for partners to set up a new company, whose vocation will be to carry MEGAMIANTE project, to continue operating the pilot, to create the first operating unit and then to ensure the deployment of the solution at national, European and international level. The project promoter is then targeting fixed units with a treatment capacity of 10 to 20,000 tonnes of waste/year, located in the waste-producing regions (General Council for the Environment, 2021).

The company Somez did not reply to the request for consultation.

Colas

The company is leading a project[135] based on the destruction by hydrothermal means of bound asbestos and recovery of neo-products (D.HY.VA) process. Namely, asbestos cement waste is attacked by an acid cocktail. The reaction takes place under vapor pressure at a temperature between 100 and 200°C. The treatment cycle is currently 24 hours with the objective of reducing it significantly. At this stage, the process does not require prior grinding of the waste (General Council for the Environment, 2021).

The project favours the treatment of asbestos-cement, which constitutes the bulk of the mass of asbestos waste. In the long term, the project managers envisage treatment units of several tens of thousands of tonnes per year. The economy of the process largely depends on the ability to recover the products: amorphous silica, hydroxyapatites (heavy metal sponges that can replace activated carbon), metals (e.g., magnesium) (General Council for the Environment, 2021).

The company Colas did not reply to the request for consultation.

Thermochemical

Thermochemical conversion is a thermal process in which the ACW is converted into harmless mineral substances through pyrolysis. This process takes place at a temperature of approximately 1,200°C and has a duration of about 20 minutes. The chemical component of the process consists in the addition of fluxing agents (e.g., sodium borate) which causes the expulsion of hydroxides and results in the destruction of the fibre structure of asbestos and as such, rendering it harmless (OVAM, 2016).

The demineralisation process accomplishes several goals, including:

- Conversion of asbestos minerals into non-asbestos minerals without melting;
- Destruction of organic compounds through pyrolysis and/or oxidation; and
- Immobilisation of metals and radionuclides.

ARI / EnviroMaster

ARI Global Technologies Ltd's is a company in the UK treating asbestos waste by thermochemical processes. The company applies a patented process using the combination of chemical treatment and heat to cause demineralisation of asbestos and other silicate materials. The process is called the

135 www.premys-deconstruction.fr

Thermochemical Conversion Technology (TCCT). The technology utilises size reduction of waste, application of fluxing solution and heat to treat asbestos waste that would otherwise be landfilled.

During the process, ACW is shredded to small particles and sodium borate is added as fluxing agent. According to the technology provider, asbestos is efficiently destroyed within 20 minutes of processing at a temperature of 1,200°C resulting in an inert, non-hazardous product, volcanic type aggregate (olivine, wollastonite, diopsides) that can be potentially used in a variety of non-structural construction applications, such as earth and embankment fills, granular drains and filters, aggregate for road base, and aggregate for weaker concrete and flowable fills. Transmission electron microscopy (TEM) is used at the end of the process to check complete destruction of fibres. Off-gases are routed through a secondary thermal oxidising unit for the destruction of residual organic compounds.

In 2017, EnviroMaster became the exclusive Australasian territory licensee for the ARI Global Technologies patented TCCT technology. The company EnviroMaster states they have developed engineering designs and concept planning for a state-of-the-art, purpose built, commercial scale TCCT asbestos waste processing facility designed to process a minimum of 100 tonnes of asbestos waste per day.

Mechanochemical

Mechanochemical technology covers a wide range of important reactions in industrial processes:

- Intensification of dissolution and of leaching processes;
- Faster decomposition and synthesis;
- Preparation of substances with new properties;
- Control of mineral properties during preparation of raw materials; and
- Improvement in sintering properties of different compounds.

The mechanochemical treatment of ACW can be carried out in small, transportable plants, although not in all cases. This technology operates in a close and limited environment, and it does not use thermal equipment, which results in extremely limited gas and dust pollutions from mechanochemical reactors.

The process relies on the mechanical energy transmitted to ACW by crushing machines, with the task of destroying the crystal lattices and molecular bonds present in asbestos. High-energy milling or ultramilling processes have been successfully proposed and used at both the real and laboratory scale to handle ACW. It has been demonstrated that milling of phyllosilicates, taking place in mills operating with various methodologies, leads to progressive amorphization through the release of hydroxyl ions necessary to maintain the crystalline structure. This process is referred to as 'cold vitrification.'

During a mechanochemical process, different types of reactions can occur. Part of the mechanical energy transferred to solid systems is converted into heat, while part is used to cause fractures, compression, and slips at macro-meso and microscopic levels, affecting the crystalline structure of solids.

The mechanochemical process, when applied to ACW, can transform asbestos into an amorphous material, resulting in a complete modification of its fibrous morphology (Plescia et al, 2003; Paolini et al, 2019).

Asbeter

Asbeter's patented AC Minerals process[136] is a mechanical-chemical process that generates high alkalinity and thus dissolves the asbestos fibres. With this technology, asbestos cement roofing sheets, pipes and insulation materials can be processed, resulting in a flow of end products such as calcium silicate and calcium carbonate that can be used as building materials.

The Asbeter process is capable to treat chrysotile, crocidolite and amosite fibres contained in cement bonded or unbonded asbestos. The process is a combination of mechanical impact, temperature, and chemical conversion in an alkaline environment. The pH of approximately 12.5 is achieved and maintained without adding any chemicals by the water dissolution of the calcium hydroxide present in the cement. The input material is pre-treated by waste removal and grinding to 12 mm granulometry to enter the patented process. In the patented process the material is grinded several times down to microns in the end product to create more reaction surface. Water is then added creating an alkaline environment in which the solution reaction starts. The slurry is heated to accelerate reaction, in which asbestos fibres are being dissolved. Dispersing agents are used for a high total solids content in the end slurry. The control of the process consists of sampling and analysing asbestos destruction at relevant process steps by Scanning Electron Microscope (SEM). The company claims 100% rate fibre destruction, this has been verified and confirmed by Det Norske Veritas.

The end products are a calcium silicate hydrate (CSH) or a calcium silicate carbonate (CSC) slurry depending on the optional carbonation of input material. These products can be used as raw materials for cement and hybrid cement, as precursors in geopolymer concrete, or as paint additives (as a partial replacement to titanium oxide). The end product CSH has received the End-of-Waste status by the Environmental Protection Agency in the Netherlands in June 2023.

Currently the technology has been deployed at a demonstration scale with one site treating 15-50 tonnes/year of ACW. A full swing factory for a location in the Netherlands is under development and will process 75,000 tonnes ACW per year. Potential future capacity will be of 15-20 sites (by licensing the technology). Each site to process the amount required in that area. The patented process is simply up- and down scalable.

According to the company, the presence of rubber, plastics, adhesives, and metals may represent a limitation for the process. The selected solution is the sorting out of these materials as a pre-treatment prior the chemical steps.

ABCOV®

ABCOV®[137] is a US company, which developed a non-thermal treatment process for asbestos waste destruction. According to the company, the process has been approved by the United States Federal Environmental Protection Agency. This process uses size-reduction equipment that feeds into the reactors that are injected with proprietary ABCOV® chemicals.

A pre-treatment step entails the wetting of ACW with water and a sorting step can be mandatory depending on the input waste. During the process, ACW is shredded by a shredder equipped with water spray nozzles and then submitted to the reactor at room temperature. While the ACW is being converted in the reactor, the reaction of asbestos treatment may reach 65°C. All conversion equipment is operated by accredited asbestos workers in a negative air pressure containment similar to an asbestos abatement negative air containment. The duration of the process to destroy the ACW is dependent on the types of asbestos, i.e., chrysotile or amosite or a combination of both, and the binder matrix that asbestos is embedded in. Solids are settled and the ABCOV® chemicals are siphoned

[136] www.asbeter.com
[137] www.abcov.com

off and regenerated for further treatments. A proprietary chemical is added to the solids to neutralise acidity. According to the company, they are able to treat all type of asbestos fibres. Polarised Light Microscopy (PLM) or TEM, and if necessary, Toxic Characteristic Leaching Procedure (TCLP) are used to validate the destruction of asbestos fibres. Because the ABCOV® process is non-thermal, the destruction of ACW is tested through the process until no asbestos is detected.

The end-products of the process are cement-like materials that can be used in the construction sector as additives and filling agents in the production of asphalt or concrete. Asbestos-contaminated steel or copper can be cleaned asbestos-free and can be sold in the metallurgic sector.

According to the company, some of the advantages of the technology are the capability to destroy all forms of asbestos and asbestos-containing materials as well as address nuclear and other types of hazardous waste, the reduction of asbestos waste up to 20% of its original volume to a non-asbestos product that can be recycled, modularity of equipment that can be installed in a required location that meets the user's needs and in any size, and off the shelf equipment and parts that allow minimum downtime and easy maintenance.

All ABCOV® equipment and parts are off the shelf, allowing minimum downtime and easy maintenance. The ABCOV® process can be built to any size. All equipment specifications and designs are provided by process engineers with 30 years of ABCOV® field experience.

MID-MIX® Technology

Yunirisk International[138] is a Serbian company which has been managing industrial waste for over a decade. By using its MID-MIX® patented technology, the company claims to be able to treat various types of hazardous industrial wastes, including asbestos, by converting them into a new harmless material which has reuse value, that is named Neutral. In this process, the goal of solidification is the stabilisation and inertisation of waste, i.e., its transformation in such a form in which its constituents are immobilised so as not to leach out in the environment. A solid end-product and condensed water from evaporation are the final products of the process and are claimed to not have a harmful effect on people and their environment (Zoraja et al, 2021).[139]

The installation consists of various components. From the supply buffer, dewatered sludge is pre-treated and then processed in two reactors. The process of inertising asbestos waste is carried out by the MID-MIX® technological process, which involves complex physical-chemical-thermal processes of dissociation, vacuum encapsulation and primary solidification of waste.

Briefly the overall process consists of two main phases (Zoraja et al, 2021):

- Preparation of asbestos mash: after the delivery of the ACW to the plant, this is milled, grinded and wetted to obtain an asbestos slurry. The wetting prevents the asbestos particles from air-spreading; and
- Processing of asbestos mash: the ACW slurry is fed into a mixer which homogenizes the waste with the additives (sand, calcium hydroxide and calcium oxyde), after which enters in the main reactor where the process of primary solidification takes place. The end material is drained from the reactor, with a bucket elevator, into a silo, in which secondary solidification occurs, i.e., the completion of the chemical reaction.

138 www.yunirisk.com

139 Zoraja, B., Živančev, M., Ubavin, D., Nakomčić-Smaragdakis, B., 2021. Circular economy as possible solution for asbestos burden. IOP Conf. Ser.: Mater. Sci. Eng. 1163 012033

The end result is a solid, inert material in the form of a thick white to grey-brown colour powder with exceedingly hydrophobic attributes. This solidifier is an inert, non-hazardous material that can be further processed. It consists of 80%-90% $Ca(OH)_2$ and 20%-10% $CaCO_3$. The material is claimed to be potentially used as an aggregate in construction, as a soil improver and as a substitute for primary building materials (Zoraja et al, 2021).

The basic single line MID-MIX® installation processes between 4 and 8 tonnes of sludge per hour.

The company applying this technology did not reply to the request for consultation.

5.5 Comparison of existing and emerging asbestos waste treatment technologies

5.5.1 Asbestos waste streams and potential use of end-products

Asbestos waste streams that can be treated by the existing and emerging processes discussed in the previous section can be found in the table below. Some technology providers claim they can treat all types of asbestos in all types of ACW, e.g., thermochemical treatment by ARI Technologies or mechanochemical treatment by ABCOV®. Whereas others can only treat chrysotile, e.g., Thermal Recycling or VALAME. It needs to be noted, however, that Thermal Recycling is only treating this type of asbestos, because their Environment Agency permit currently only allows to treat cement-bound asbestos-containing chrysotile. According to the company, the process can work for other types of asbestos, and they want to work with the Environment Agency to extend the range of asbestos types they can treat.[140]

The possibility to recover a reusable product at the end of the asbestos waste treatment process can be seen as one of the most important aspects for the plant to reach the economic feasibility. All processes discussed in Section 5.4.2 produce a secondary material, which can be used in a number of industries. The potential use of end-products obtained by the processes are presented in the table below. The prevalent use of the end-products is in the construction sector, such as the production of cement or concrete or the use as an aggregate in road construction. Other uses include metallurgy, chemical industry, agriculture, electronics and automotive, although these are more common for products derived through chemical or mechanochemical processes, e.g., De Dietrich or Asbeter.

[140] Thermal Recycling (n.d.). *Worlds first commercially viable asbestos recycling plant established in the UK.* https://www.thermalrecycling.co.uk/storage/media/content/files/ARCA%20NEWS%20Recycling%20article.pdf.

Table 5-8: Asbestos waste streams and potential applications of end-products obtained from asbestos inertisation					
Process group	**Process**	**Waste stream**	**End-product**	**Use of end-product**	**Reference**
Thermal	Inertam	ACW – friable and non-friable	Cofalit	As aggregate to form a road-building substrate	OVAM (2016)
	D-Nature	Asbestos cement	Bestof®	Filler, in co-formulation with cement, aggregate for road construction	Interview with D-Nature
	Thermal Recycling	Cement bound chrysotile	CALMAG	Cement replacement, in the production of concrete	Interview with Thermal Recycling
	Purified Metal Company	Scrap contaminated with asbestos fibres	Purified Metal Blocks (PMBs)	In mills or foundries	Company's website
Chemical	VALAME	Asbestos waste containing chrysotile	Calcium and magnesium chloride and amorphous silica	Road construction, concrete / chemical industry for chlorides + gas desulphurisation and industrial water treatment formulation, de-icing agents	Interview with VALAME
	BlackAsbestos / De Dietrich / Neutraval	All types of asbestos waste except asbestos waste mixed with metals or tar	Silicates, anhydrites, gypsum and magnesium sulphate	In construction, cement and chemical industries, agriculture, electronics, automotive, metallurgy	Interview with BlackAsbestos and De Dietrich
	Somez	All types of asbestos waste	Silica, metal oxides and tobermorite	In cement industry	General Council for the Environment (2021)
	Colas	Favours treatment of asbestos-cement	Amorphous silica, hydroxyapatites, metals (e.g., magnesium)		General Council for the Environment (2021)
Thermochemical	ARI/EnviroMaster	All types of asbestos in all types of ACW	Volcanic type aggregate	Non-structural construction applications	Interview with ARI Technologies
Mechanochemical	Asbeter	Bonded and unbonded serpentine and amphibole asbestos and cement bonded asbestos	Calcium silicate hydrate (CSH) or a calcium silicate carbonate (CSC) slurry	In cement and hybrid cement, precursors in geopolymer concrete, paint additives	Interview with Asbeter
	ABCOV®	All types of asbestos	Cement-like material, metals (steel or copper)	In asphalt or concrete production, in construction sector, in metallurgic sector	Interview with ABCOV®
Physicochemical	MID-MIX® TECHNOLOGY	Sludge containing asbestos	Neutral	Aggregate in construction, soil improver, substitute for primary building materials	Zoraja et al., 2021

Overall, all processes are similar in the end-products they produce, although their technical parameters and quality may differ.

5.5.2 Environmental, social and economic impact analysis

This sub-section will look at environmental, social and economic impacts of the most advanced asbestos waste treatment technologies. Landfilling of ACW will also be reviewed, but only as a benchmark disposal option.

Through the consultation activities, the study team aimed at collecting the necessary technical, environmental, and economic data in order to compare the technologies and also analyse their impact. Some information has been obtained from several technology providers. However, in many cases, the technology providers were reluctant to share economic information, mainly due to confidentiality. Environmental data was shared by a handful of technology providers, the others claiming that such data would be collected when a pilot or a full-scale plant is built and running. Data on key parameters that were collected from the technology providers are presented in Annex 7.

Hence, the analysis of environmental, economic and social impact of these technologies was based on the literature review, which was supplemented with the data provided by technology providers.

Landfill

Environmental impact

Depositing ACW in landfills has positive and negative environmental impacts. Landfilling of asbestos waste does not require intensive use of energy, which result in low CO_2 emissions during the disposal stage of the process. Transportation of asbestos waste from source to landfill creates the largest environmental impact due to fuel consumption and resulting greenhouse gas (GHG) emissions and air pollution, as well as noise pollution. As reported by Mercante et al. (2021) in the life cycle assessment (LCA) study on asbestos waste management in Argentina, the transportation stage made a large net contribution to the environmental impact across all indicators (99%) selected for study[141] compared with a smaller contribution made at the stage of final disposal in a hazardous waste landfill. The system boundaries and the scope of the LCA for the scenarios under the study included materials, fuel, water and energy as inputs, and emissions to air and water, solid waste and impacts on soil as outputs.

Landfilling of asbestos waste also requires space, which could otherwise be used for other non-recyclable waste streams. Growing quantities of asbestos waste due to national and/or EU strategies (e.g., Renovation Wave) may create the need of expanding landfills if the capacity is not there. This can result in unsustainable land use, especially in some countries or regions, where the lack of space is a concern, such as in Flanders.[142] In addition, the development of new landfills can potentially result in the destruction of natural habitats and the wildlife.

Furthermore, disposing of asbestos waste does not guarantee a zero risk of fibre dispersion to the environment. There is always a risk of fibre dispersion during disposal operations because, although sealed packages of cement asbestos should be handled with considerable care, there is always a possibility of breakage of the packaging and dispersion of fibres. Furthermore, there is a risk that leachate can contain acid-corrosive agents, which, in the medium to long term, can partially dissolve

[141] Selected midpoint indicators: abiotic depletion potential of elements (ADPe), abiotic depletion potential of fossil fuels (ADPf), global warming potential (GWP), ozone layer depletion potential (ODP), photochemical oxidants creation potential (POCP), acidification potential (AP), and eutrophication potential (EP) (Mercante et al., 2021).

[142] Stakeholder consultation.

the fibres and redistribute them into the environment (Paolini et al., 2019). Another issue is the loss of resources, as construction waste, which could otherwise be recycled, is disposed of due to the contamination with asbestos. Nevertheless, landfilling of asbestos waste is an established practice with well-tried and tested control of risks to human health and the environment (Bureau KLB, 2018).

Social impacts

Landfilling of ACW also has several social impacts. As depositing asbestos waste in landfills is the only solution for the final stage of asbestos waste management in almost all Member States, it is a familiar and socially accepted way of getting rid of asbestos. It is an established practice with tested control of risks to human health. However, landfilling of ACW does not remove the intrinsic risks of asbestos, because there is a risk of compromised standards of disposal. It is also not a permanent solution; it only postpones the issue (in the sense asbestos is not destroyed) and extends socio-environmental risks to future generations (Nabango and Majale, 2022). Such landfills will need further maintenance and control of risks.

Economic impacts

From the economic point of view, creating the necessary capacity for depositing asbestos waste does not require huge amount of investment as far as the infrastructure is concerned. Also, disposal of ACW in landfills is a relatively cheap way to dispose of asbestos waste in the short term. However, due to required ongoing maintenance of the landfill, the method can become expensive in the long term. In addition, the cost of land also needs to be taken into consideration.

Positive	Negative
Environmental: - Low energy use (at disposal stage) - Low CO_2 emissions (at disposal stage) - Well-tried and tested control of risks for environment Social: - Familiar and socially accepted way of getting rid of asbestos waste - Well-tried and tested control of risks for people Economic: - Relatively inexpensive infrastructure - Relatively cheap way to get rid of asbestos waste - Does not require large investment	Environmental: - Unsustainable land use - Transportation (GHG emissions, air pollution, noise pollution) - Risk of fibre dispersion (through air or in a leachate) - Loss of resources - Destruction of natural habitats and wildlife Social: - Remaining intrinsic risks of landfilled asbestos - Not a permanent solution - Postponing the issue for future generations - Risk of compromised standards Economic: - Cots of land - Cost of maintenance - Expensive method in the long run

Figure 5-6: The summary of positive and negative environmental, social and economic impacts of landfilling of ACW.

Thermal and thermochemical treatment

Environmental impact

Thermal processes can achieve a complete fibre destruction with the proper temperatures and processing time, following the elementary laws of physics and chemistry. The effectiveness and quality of the process can be robustly controlled, monitored and inspected on the basis of several parameters (Bureau KLB, 2018). The capability of thermal processes to destroy asbestos fibres has been reviewed in peer-reviewed publications, such as Spasiano and Pirozzi (2017) and Paolini et al. (2019). The process can also reduce mass and volume. For example, D-Nature claims that their process can reduce the volume of ACW by 25%, the Inertam technology can achieve 40% mass reduction and 60% volume reduction, and the ARI Technologies claim they can reduce volume by 50-90% depending on the type of ACW.

Thermal treatment installations have a relatively small land footprint. For instance, the Thermal Recycling company claims that a plant capable to treat approximately 30,000 tonnes/year of asbestos waste would need around 4,000 m^2 of land. This can be beneficial, especially in countries where lack of space is a concern.

Another important aspect of thermal treatment of ACW is the recovery of secondary materials that can be reused in a number of sectors (see Table 5-8). This would reduce the need of some raw materials, especially in the construction sector, partially compensating the energy use and related CO_2 emissions. Also, there would be less waste sent to landfills, which would leave more space for other types of non-recyclable waste and reduce the need to expand the landfill capacity. Construction waste that would otherwise have to be landfilled due to contamination with asbestos could potentially be recycled.

However, thermal processes are energy intensive due to high temperatures required to destroy asbestos fibres (ranging from 1,000°C for denaturation to 1,600°C for vitrification with plasma torch). For example, the energy use of Inertam process is 1,000 – 1,300 kWh/tonne on average. D-Nature reports that their process would consume around 6.6 million cubic metres of gas and 2.6 million kWh of electricity a year to treat 120,000 tonnes of asbestos waste. Their environmental impact report states the consumption of energy at around 500 kWh/tonne. This results in a relatively large CO_2 footprint. The equivalent CO_2-emission for the energy consumption of 500 to 1500 kWh/tonne range between 105 – 325 kg CO_2 eq/tonne for natural gas and 325 – 975 kg CO_2 eq/tonne for electricity (Bureau KLB, 2018). For instance, the estimated CO_2 emissions of denaturation of asbestos waste with D-Nature process can reach 101 kg CO_2 eq/tonne when natural gas is used as the energy source. The CO_2 footprint can partially be compensated by the reduced need for raw materials. In addition, there is a potential to reduce CO_2 emissions with the use of renewable energy sources, although further investigations are required to establish if this is achievable.

In their LCA study, Mercante et al. (2021) compared three asbestos waste management scenarios: thermal vitrification on site, recycling in clinker furnace, and final disposal of asbestos in a hazardous waste landfill. The recycling in clinker furnace, when not assigning energy consumption to ACW treatment due to the fact that ACW is used as a partial replacement of a raw material needed to produce cement, had the most positive environmental impact. However, such process is not performed by any of the existing or emerging technology providers discussed in this report. In thermal vitrification scenario, the obtained material was not recycled but disposed of in an inert waste landfill. Hence, this scenario had three stages: treatment on site, transportation, and disposal at the inert waste landfill. The LCA results showed that the vitrification stage in this scenario had the highest environmental impact, contributing between 83% and 99% to the indicators' overall environmental impact. This was followed by the transportation, with the final stage having a minor contribution.

Thermal process of existing and emerging technologies discussed in this report have or would have fixed installations and also recover secondary materials. Hence, transportation phase (to the facility from the source of asbestos waste and from the facility to the customer) would contribute more to the environmental impact, and the impact of vitrification stage could potentially be reduced by using renewable energy sources.

Also, the processes emit atmospheric pollutants. In their study, Tomassetti et al. (2020) investigated the emission of asbestos fibres and other atmospheric pollutants such as CO, NO_x, SO_2, volatile organic compounds (VOCs), heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) dioxins and furans (PCDD/Fs) from a prototype for thermal treatment of asbestos. The study tested both cement-asbestos and asbestos waste containing polyurethane. The study data demonstrated the absence of asbestos fibres in the gaseous emission. The concentration of NO_x, SO_2 and heavy metals were comparable with municipal solid waste incinerators and cement plants. The concentration of PAHs, benzene, toluene, ethylbenzene, xylenes and styrene were higher in the presence of polyurethane. The presence of polyvinyl chloride (PVC) in the coating of asbestos cement increased the emission of halogenated VOCs, PCBs and PCDD/Fs. Overall, emissions of pollutants into the atmosphere were generally low compared to similar industrial processes, which could be reduced by means of abatement systems. In addition, the emission profile largely depended on the presence of other components in asbestos waste, such as polyurethane and chlorinated coating used during the removal of asbestos waste.

Thermal treatment processes can require long processing time, sometimes more than 24 hours (e.g., D-Nature), although thermochemical process can treat asbestos waste in as little as ~20 minutes due to the addition of fluxing agents (e.g., ARI Technologies). However, the latter process requires a pre-treatment step as ACW needs to be shredded, which creates additional risk to occupational health and the environment. Denaturing techniques, such as D-Nature or Thermal Recycling processes, do not require pre-treatment. As these types of facilities would be able to treat tens or even a hundred thousand tonnes of asbestos waste per year and also due to large investment costs to build such facility, presumably there would not be a dense network of such facilities in a country. This could cause longer transportation distances compared to landfills, resulting in higher GHG emissions and air pollution.

Social impacts

The treatment of asbestos waste and the destruction of asbestos fibres through thermal treatment processes would have less risks to human health compared to landfill, as the inherent risk of asbestos would be removed. However, the complete destruction of fibres would need to be continuously monitored to ensure that the end-product is safe and does not contain fibres (see Section 6.2 for potential measures to ensure the safety of the end-products). The treatment of ACW and recycling of the end-product would solve the problem of the accumulation of asbestos waste and not postpone it to future generations. The creation of jobs at the treatment facility could also be seen as a positive social impact. The inherent risks related with asbestos fibres can create some risks for occupational health due to dispersion of fibres, for example, in the pre-treatment steps of some of these technologies but also during maintenance or other activities where the contact with asbestos waste or fibres can occur. Hence, rigorous precautionary and health and safety measures need to be ensured at such a facility.

Economic impact

The treatment and transformation of asbestos waste into a non-harmful secondary material would mean that the asbestos waste is not sent to landfill, which would result in avoided additional costs for the future development and maintenance of landfills (there are already many landfills with asbestos waste deposits that would continue needing maintenance and control). Also, the recovered secondary materials could potentially be sold cheaper on the market compared to virgin materials, benefitting the construction and other sectors. The creation of jobs at the treatment facility could also be considered as a positive economic impact.

The cost of treatment can be seen as a drawback of the thermal processes. For example, vitrification at Inertam plant can cost between 1,000-2,500 €/tonne, which is around 10-20 times higher than landfilling in most Member States. Other technologies, such as denaturation, however, assume the costs could be as low as 175 €/tonne, which is closer to landfill costs and could potentially be economically feasible solution. Thermal treatment facilities would also require potentially large investment cost, from several million to tens of millions of euros. For instance, the D-Nature facility capable to treat 100,000 to 120,000 tonnes of asbestos waste per year would cost approximately 38 million euros to build[143].

High and/or fluctuating energy costs could also be an issue for these technologies as they are heavily dependent on the energy supply. The increase in energy costs could impact the cost of treatment, making it less attractive as a treatment solution. The lack of availability of a continuous flow of asbestos waste to the facility can increase the risk of bankruptcy as the gate fee is one of the most important sources of income for such plants. The example of a technology company going bankrupt due to the lack of waste to be treated is the Purified Metal Company. Although the company had a good business case and the process proved to be effective in treating scrap steel contaminated with asbestos, this waste stream did not reach the facility even with the national ban on landfilling of such waste in Netherlands.

Positive	Negative
Environmental: - Complete fibre destruction - Mass and volume reduction - Small land footprint - Use of secondary materials - Reduced need for raw materials Social: - Less risk to human health due to complete destruction of asbestos fibres - Asbestos waste problem solved and not postponed for future generations - Creation of jobs at treatment facilities Economic: - Avoided costs for future maintenance of landfills - Cost of secondary materials can be cheaper than raw materials - Creation of jobs at treatment facilities	Environmental: - High energy use - Large CO_2 footprint - Emissions of atmospheric pollutants that need to be controlled - Potentially long distances from source to plant - Pre-treatment steps require additional energy and create additional risk to the environment (not relevant for denaturation) Social: - Inherent occupational risks from working with asbestos waste Economic: - Cost of treatment higher than that of landfilling - Large investment costs - High and/or fluctuating energy costs can impact the cost of treatment - Risk of bankruptcy if lack of waste to treat

Figure 5-7: The summary of positive and negative environmental, social and economic impacts of thermal and thermochemical treatment of ACW.

143 Stakeholder consultation.

Chemical and mechanochemical treatment

Environmental impact

Compared to thermal treatment technologies, chemical and mechanochemical treatment processes are performed at much lower temperatures, ranging from 25°C to 90°C in mechanochemical processes to ~100-200°C in chemical processes. As claimed by a few technology providers, the energy is required to start the process, and then the reaction is exothermic (e.g., BlackAsbestos/De Dietrich/Neutraval, Asbeter). Hence, the consumption of energy to achieve required temperatures is much lower than that required during the thermal treatment. In addition, there is a possibility to use renewable energy sources. This is the case for Asbeter mechanochemical process, as the company claims no emissions of GHG based on electricity from renewable energy.

Some of the chemical and mechanochemical treatment technologies can use waste chemicals or they do not need any chemicals to achieve the required pH. For example, BlackAsbestos/De Dietrich/Neutraval utilises utilises sulfuric acid, which, according to the company, is readily available and cost-effective due to being a by-product of the chemical industry. Similarly, VALAME claims that hydrochloric acid which they use in their processes is very much a commodity in the chemical industry and is a by-product of many industrial processes. The mechanochemical process by Asbeter is using wet process where no chemicals to create alkaline environment are added. The mechanical part creates the environment for the chemical step in which fibres are dissolved.

The providers of chemical and mechanochemical technologies claim a complete fibre destruction. However, some of these technologies can only treat chrysotile fibres (e.g., VALAME, Colas), whereas others claim they can treat all types of asbestos (e.g., BlackAsbestos/De Dietrich/Neutraval, Somez, ABCOV®). The mechanochemical process by Asbeter can treat chrysotile, crocidolite and amosite, and the complete destruction of these fibres have been verified by Det Norske Veritas (DNV). The Asbeter product Calcium Silicate Hydrate (CSH) has already obtained an end-of-waste (EoW) status by the Environmental Protection Agency in the Netherlands. As some technologies can only treat one or a few types of asbestos fibres, the quality of ACW has to be ensured to avoid the presence of other types of asbestos.

Chemical and mechanochemical treatment installations have a relatively small land footprint, although larger than thermal treatment installations. For instance, the VALAME company claims that a plant capable to treat 15,000 tonnes/year of asbestos waste would need around 30,000 m^2 of land. The Asbeter facility (including logistics area) would require the same amount of space, although they would be treating 75,000 tonnes of asbestos per year. The footprint of the BlackAsbestos/De Dietrich/Neutraval treatment facility treating 15,000 tonnes/year would be 10,000 m^2. Although larger than thermal treatment, chemical treatment facilities would still have much lower land requirements compared to landfills.

For some of chemical and mechanochemical treatment processes, the installations can also be mobile (e.g., BlackAsbestos/De Dietrich/Neutraval, ABCOV® and MID-MIX®). This can especially be useful for projects that anticipate large quantities of asbestos waste to be generated during the renovation or demolition of buildings. This could lower emissions of GHG due to a less need of transportation. The positioning of the treatment facility close to the industrial plant that produces the required chemicals would also reduce the transportation of industrial acids, which would result in lower emissions of GHG and other atmospheric pollutants, but also lower risks related with the transportations of such chemicals.

Another important aspect of chemical and mechanochemical treatment of ACW is the recovery of secondary materials that can be reused in a number of sectors (see Table 5-8). This would reduce the need of some raw materials, contributing to the lower CO_2 emissions. For instance, Asbeter claims that their produced calcium silicate slurry would have an environmental cost few times to 1,000 times lower than some raw materials that it aims to replace (e.g., talc from clay or titanium dioxide). Also, there would be less waste send to landfills, which would leave more space for other types of non-recyclable waste and reduce the need to expand landfill capacity. In addition, construction waste that would otherwise have to be landfilled due to contamination with asbestos could potentially be recycled.

Almost all chemical and mechanochemical process require a pre-treatment of ACW, such as shredding and milling (e.g., VALAME, BlackAsbestos/De Dietrich/Neutraval, Asbeter, MID-MIX®, ABCOV®) or sorting (e.g., Somez), which creates additional risk to the environment. However, some of the technology providers claim that their processes are performed in controlled, negative pressure environment or in high performance vacuum, which prevents any fibre dispersion. Pre-treatment steps also require energy, which contributes to GHG emissions. For instance, the energy requirement of VALAME process is less than 1,000 kWh/tonne; Asbeter would need a 10 MW installed power for asbestos waste destruction, carbonisation and partial drying of end-product, although they would also be able to recover heat and use energy from renewable energy sources.

Social impacts

As with thermal treatment technologies, the treatment of asbestos waste through chemical and mechanochemical treatment processes would have less risks to human health compared to landfill, as the inherent risk of asbestos would be removed. However, the complete destruction of fibres would need to be continuously monitored to ensure that the end-product is safe and does not contain fibres. The treatment of ACW and recycling of the end-product would solve the problem of the accumulation of asbestos waste and not postpone it to future generations. The creation of jobs at the treatment facility could also be seen as a positive social impact.

Some chemical treatment processes use strong, aggressive and corrosive chemicals, such as hydrochloric acid or sulphuric acid, which create occupational health and safety risks. In addition, the inherent risks related with asbestos fibres also contributes to the risk for occupational health due to dispersion of fibres, for example, in the pre-treatment steps but also during maintenance or other activities where the contact with asbestos waste or fibres can occur. Hence, rigorous precautionary and health and safety measures need to be ensured at such facility.

Economic impact

As with thermal treatment technologies, the treatment and transformation of asbestos waste into a non-harmful secondary material through chemical and mechanochemical processes would mean that the asbestos waste is not sent to landfill, which would result in avoided additional costs for the future development and maintenance of landfills. Also, the recovered secondary materials could potentially be sold cheaper on the market compared to virgin materials, benefitting the construction and other sectors. For example, there have been large fluctuations in the cost of magnesium in recent years and there is a huge dependency on other countries to supply Europe with this metal.[144] BlackAsbestos/De Dietrich/Neutraval recover magnesium through their processes, which they evaluated at around 2,200 $/tonne. This is much lower than the current price of magnesium ($3,095-3,400 in March 2023).[145] The creation of jobs at the treatment facility could also be considered as a positive economic impact.

[144] Fastmarkets (2023, March). *Europe magnesium supply uncertain despite inclusion in 'ambitious but doable' CRMA: sources.* https://www.fastmarkets.com/insights/europe-magnesium-supply-uncertain-despite-inclusion-in-ambitious-but-doable-crma-sources.

[145] Ibid.

The chemical and mechanochemical processes also have higher treatment costs compared to landfilling and some thermal treatment processes. For example, the cost of chemical treatment ranges between 600 and 1,500 €/tonne (e.g., VLAME – 900 €/tonne, BlackAsbestos/De Dietrich/Neutraval – 1,000-1,500 €/tonne). The mechanochemical process by Asbeter would offer lower cost, ranging between 300 and 400 €/tonne, and ABCOV® is claiming their process would cost 250-350 €/tonne. Nevertheless, this is at least twice the cost of sending asbestos to landfill.

Chemical and mechanochemical treatment facilities would also require large investment, from several million to tens of millions of euros. For instance, the VALAME facility capable to treat 15,000 tonnes of asbestos waste per year would cost between 20 and 25 million euros to build, whereas Asbeter facility would require an investment of 70 million euros for the treatment of 75,000 tonnes of ACW per year.

Chemical processes depend on the availability of required quantity and quality of chemicals. Any fluctuations in these parameters can affect the process effectiveness and efficiency and lead to interruption of the treatment operations, resulting in economic loss. According to BlackAsbestos/De Dietrich/Neutraval, the availability of chemicals would not be an issue for their process. They explained that a single unit capable of treating 15,000 tonnes of ACW per year (equivalent to 5% of France's total ACW) would require a maximum of 3% of the sulphuric acid produced by a single supplier, considering they have multiple plants, which demonstrates a reliable supply of sulphuric acid on the market. However, according to one technology provider, the waste acid market is uncertain, and buying acids on the common markets can make the process more expensive. This may lead to increased gate fees that can results in reduced flows of asbestos waste streams.

Positive	Negative
Environmental: - Low temperatures - Low energy consumption - Possibility to reuse industrial waste acids - Complete fibre destruction - Can be mobile (not all) - Use of secondary materials Social: - Less risk to human health due to complete destruction of asbestos fibres - Asbestos waste problem solved and not postponed for future generations - Creation of jobs at treatment facilities Economic: - Avoided costs for future maintenance of landfills - Cost of secondary materials can be cheaper than raw materials - Creation of jobs at treatment facilities	Environmental: - Some GHG emissions - Pre-treatment steps require additional energy and create additional risk to the environment Social: - Intrinsic risks from working with strong acids - Pre-treatment steps create risks for occupational health Economic: - Cost of treatment higher than that of landfilling - Large investment costs - Depends on availability of chemicals - Risk of bankruptcy if lack of waste to treat

Figure 5-8: The summary of positive and negative environmental, social and economic impacts of chemical and mechanochemical treatment of ACW.

6 Improvement of asbestos waste recycling

6.1 Barriers and opportunities for implementing asbestos waste recycling

Although there has been progress made in the development of asbestos waste treatment technologies, there are still some major barriers hindering the commercialisation and industrialisation of these technologies across Member States. However, these barriers could be overcome by actions at industry, national and EU-level. There are also opportunities to improve asbestos waste treatment and recycling that could lead to a possibility of managing this hazardous waste stream in line with the EU's ambition on circular economy.

6.1.1 Barriers

Multiple barriers hindering the implementation of asbestos waste treatment technologies on the industrial scale have been identified by stakeholders through consultation activities. Stakeholders included technology providers, representatives of competent authorities, industry associations and academia and more. The investigation of these barriers was further supported by the literature search. The main barriers raised by stakeholders in the surveys, interviews and the workshop fall into six main categories: financial, regulatory, commercial, sustainability, safety, availability, and acceptability (see Figure 6-1).

Figure 6-1: Barriers to commercialisation of asbestos waste treatment technologies identified by stakeholders. Source: Consultation activities

Regulatory barriers relate to the lack of regulatory harmonisation across Member States and the relevant EU-level legislation. Specifically, there are uncertainties and lack of clarity associated with the definition of the **EoW** status in Article 6 of Directive 2008/98/EC.[146] There are no EU EoW criteria developed for materials obtained from asbestos waste treatment or known EoW criteria at a Member State level. However, the EoW status has been granted by the Environmental Protection Agency in the Netherlands to a product obtained by Asbeter mechanochemical treatment of ACW, most likely on case-by-case basis. In general, practices of assigning EoW status vary in different Member States, as EoW status granted for the end product in one Member State may not be recognised in another country, which can create obstacles for selling the end product on the international market. The **lack of regulatory harmonisation** and **different standards** in the EU may create barriers for asbestos waste treatment companies to commercialise their technologies and products resulting from them at the EU-level.

In addition, Member States have **different landfill tax for asbestos waste disposal**. In some countries, the tax is very low or there is no tax at all, which result in landfill costs that can be difficult for asbestos waste treatment technology providers to compete with. For example, in Estonia, the landfill tax for CDW, including asbestos-containing CDW, is 0.63 EUR/tonne.[147] The low tax on ACW in Estonia is due to the fact that there is no alternative to landfill, and having a low landfill tax was considered an acceptable measure to discourage illegal dumping of such waste to the environment and prevent risk to human health.[148] In Netherlands, ACW is exempt from landfill or waste disposal tax.[149]

Obtaining necessary **permits to operate** an asbestos waste treatment facility is another regulatory barrier identified by several stakeholders. Permitting procedures differ in Member States and sometimes they can differ across different regions within the same Member State. Due to the novelty of these technologies and the lack of guidance for the relevant competent authorities, there may be challenges in obtaining the necessary permits. In addition, as volumes of asbestos waste generated and requiring treatment may not match the capabilities and capacities of the asbestos waste treatment facility, **a temporary storage** may also be required, ideally close to the plant. It can be challenging for the developer to get the necessary environmental permits due to the nature of asbestos waste and inherent risks of such activity.

Financial barriers include the **cost of treatment compared with landfilling**, which creates the risk for technology developers as well as investors. For treatment technologies to reach the industrial scale, there is a **need for substantial funding**, and **attracting investments** to fund the scalability of the project is crucial. Without the right regulatory and economic environment, investors may be reluctant to take the **financial risk** and invest in these technologies.

Barriers related to safety are based on the inherent risk asbestos has to human health and the environment. Ensuring the **complete destruction of asbestos fibres** is therefore crucially important. In addition, attention needs to be paid to **other hazardous substances** that can be found in ACW.

Acceptability barriers relate to several potential issues, such as the composition of ACW that can be accepted by asbestos waste treatment technology providers, public perception and 'not in my back yard' (NIMBY) factor. The continuous flow of ACW of a **consistent composition** is a key factor for some technology providers, who can only accept and treat a certain type of asbestos waste and specific form of asbestos. For example, some thermal or chemical treatment technologies can only treat

[146] European Parliament (2008). DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on waste and repealing certain Directives. *Official Journal of the European Union*, 312. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN.

[147] Deloitte (2015). *Construction and Demolition Waste management in Estonia.* https://ec.europa.eu/environment/pdf/waste/studies/deliverables/CDW_Estonia_Factsheet_Final.pdf.

[148] Fischer, C., Lehner, M., & Mckinnon, D. L. (2012). *Overview of the use of landfill taxes in Europe.* http://www.embopar.pt/folder/documento/99_Landfill%20taxes%20in%20Europe.pdf.

[149] Business.gov.nl (n.d.). *Landfill tax (waste disposal tax).* https://business.gov.nl/regulation/landfill-tax/.

asbestos cement or asbestos waste containing only chrysotile. Another issue can be contamination of ACW with organic or non-organic materials that can cause issues for the process. Asbestos waste can be contaminated with vegetation, moss, wood fragments or plastics that can have an impact on the quality of the treatment. For example, large quantities of wood or plastic mixed with asbestos can have an effect on temperatures of denaturation process, because if temperature in the oven goes up too quickly, it may cause an explosion.

In addition, asbestos waste has a negative connotation and is often a source of **public concern and negative perception**. Materials or products obtained through asbestos waste treatment may be considered with caution and raise safety concerns in the society, and the introduction of recycled asbestos-free materials or products to the market may become a challenge. In addition, there is also a **NIMBY factor**, where the developers of the technology may face difficulties in building facilities closer to cities or other areas, where the problem of asbestos waste exist. Having a facility close to the source of asbestos waste is of a significant importance to the technology provider as it influences the cost of transportation as well as GHG emissions.

There are also **sustainability aspects** to consider, such as the energy consumption, the cost of energy and GHG emissions. Some of these technologies, especially those that require high temperatures to operate, are **energy intensive**, which can result in **higher treatment costs** and **emissions**. In addition, energy costs can fluctuate, and the treatment may become uneconomical, which can lead to the increase of the treatment cost or even a closure of the facility. Although this is not a problem for some types of treatment, such as chemical processes, the technology providers could consider renewable energy sources to make their processes more sustainable, although the possibility of using 'green' energy to run such facilities has not yet been investigated.

Availability barriers include the **lack of good quality data on asbestos waste** generation in some Member States, which can discourage technology providers to set up asbestos waste treatment plants in those countries. In order to prepare a successful business model and carry out a techno-economic viability assessment, parameters such as the size of the plant, treatment capacity, lifespan and other relevant aspects are extremely important. Without the knowledge of the quantities of asbestos waste already generated in the country and any future projections, it can be difficult for the technology providers to see the potential for commercialising their technology. Furthermore, the **continuous availability of ACW** into the facility is crucial for economic viability of the plant.

Commercial barriers, besides the competition with landfilling, relate to **the market and the demand for the end product**. For the recycled product to have a market, it needs to have a competitive cost, continuous availability, consistent quantity and quality, and required technical characteristics to compete with virgin materials.

A number of stakeholders emphasised that the moment to invest in asbestos waste treatment technologies is now, because quantities of asbestos waste in buildings is finite. It will become unfeasible to invest in asbestos waste treatment facilities as more and more asbestos is removed from buildings and there is not enough asbestos waste to develop a strong and economically viable business case. Therefore, measures to overcome the barriers identified by stakeholders are required to support the development and industrialisation of these technologies.

6.1.2 Opportunities

Opportunities to improve asbestos waste recycling come from the intrinsic EU mission on the green transition, which is embedded in a number of EU strategies that consider environmental protection, resource efficiency, circularity, and economic resilience (Figure 6-2). The opportunities for the improvement of asbestos waste recycling therefore lie not in isolation but in a context of a larger goal to improve the management of CDW and reduce landfilling of this waste stream, which is the largest waste stream in the EU by mass.

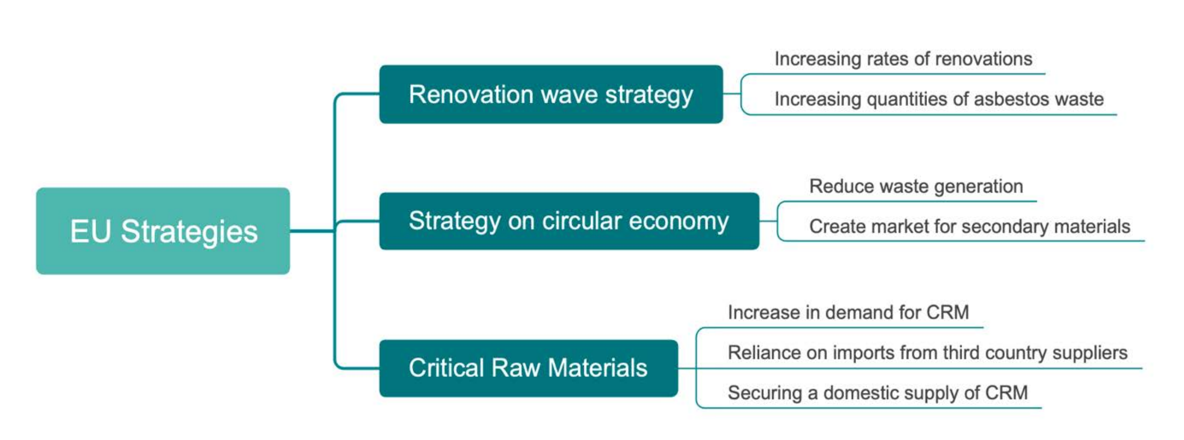

Figure 6-2: EU strategies for more resource efficient, resilient, circular Europe relevant for the improvement of recycling of ACW.

The energy performance of buildings plays an important role in assisting the progress of the energy transition and the fight against the climate change. The renovation of both public and private buildings is the key initiative singled out in the European Green Deal to drive the energy efficiency in the construction sector. To pursue this goal, in 2020, the European Commission published the **Renovation Wave Strategy**[150] to boost renovations in the EU. The strategy aims to at least double the annual energy renovation rate of residential and non-residential buildings by 2030 and to promote deep energy renovations, which can result in 35 million building units renovated by 2030 if forces at all levels are mobilised. The increased rate of renovation will have to be maintained after 2030 in order to reach EU-wide climate neutrality by 2050.

The Energy Performance of Buildings Directive 2010/31/EU (EPBD) lays down the requirements for building renovation going beyond energy efficiency and requires Member States to enhance the quality of the indoor environment through the removal of harmful materials, such as asbestos. The European Parliament has proposed to combine energy performance in buildings with asbestos removal in its resolution on "Asbestos-related occupational health threats and prospects for abolishing all existing asbestos" (2012/2065(INI)).[151] In 2014, the European Economic and Social Committee also published its opinion on "Freeing the EU from asbestos" (CCMI 130),[152] which recommends similar measures.[153] In addition, the 2021 recast of the Energy performance of buildings

[150] European Commission (2020). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives. *Official Journal of the European Union,* 622. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1603122220757&uri=CELEX:52020DC0662.

[151] European Parliament (2013). European Parliament resolution of 14 March 2013 on asbestos related occupational health threats and prospects for abolishing all existing asbestos (2012/2065(INI)). *Official Journal of the European Union,* 36. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52013IP0093.

[152] European Economic and Social Committee (2015). *Freeing the EU from Asbestos.* https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/freeing-eu-asbestos.

[153] Schindler, S. (2016). *Asbestos – Not a problem of the past.* European Trade Union Institute. https://www.etui.org/topics/health-safety-working-conditions/hesamag/construction-workers-at-the-mercy-of-social-dumping/asbestos-not-a-problem-of-the-past.

directive (EPBD)[154] strengthens the requirement of the safe removal of asbestos from the building stock by merging it under the concept of deep renovation.[155]

Due to the growing necessity to improve energy performance of buildings in Europe and the goal to double annual energy renovation rates, **asbestos waste will be handled in greater quantities** in the coming decades, especially considering that the renovation work for increasing energy efficiency in buildings is generally made on walls, roofing, or an electric installation of the building, where asbestos was used extensively in the past. This is particularly the case for buildings dating back to the high use of asbestos in Europe, which are increasingly requiring such renovation. It is estimated that around 35% of the buildings in the EU are over 50 years old and almost 75% of the building stock is energy inefficient, meaning that the large proportion of buildings in Europe will be eligible for renovation before 2050.[156]

On the other hand, the **landfill capacity to accept all the asbestos that is still in the built environment may not be sufficient**, especially in some Member States (see Section 5.2.1). Alternatives to landfilling could play an important role in dealing with the growing quantities of ACW, as not having the necessary disposal capacity or alternative treatment for ACW can hinder the renovation wave as well as national asbestos removal efforts. Looking for alternatives to treat asbestos waste is also set out in September 2022 communication by the European Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, which highlights that exploring alternative ways of treating ACW in an environmentally sound manner should be a priority.[157] Tackling the problem of growing quantities of ACW in tandem with the renovation wave can create conditions to improve asbestos waste management at the EU level as well as support the phasing out of asbestos from public and private buildings.

Another opportunity lies with the EU's strategy on circular economy. The aim of the **Circular Economy Action Plan** (CEAP) is to help bring about Europe's transition to a circular economy, one of the European Green Deal strategies. CEAP is establishing a regulatory framework to make products, businesses, and consumption more sustainable, reduce waste generation and ensure a market for secondary materials and sustainable products. Goals include revising and strengthening waste laws, increasing confidence in using secondary materials through finding solutions for waste contamination removal and high-quality sorting, creating a market for secondary materials through further development of EU-wide EoW criteria, and enhancing work on standardisation.[158]

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154 European Commission (2021). Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the energy performance of buildings (recast). *Official Journal of the European Union,* 802. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52021PC0802.

155 Maduta, C., Kakoulaki, G., Zangheri, P. and Bavetta, M., (2022). *Towards energy efficient and asbestos-free dwellings through deep energy renovation.* European Commission Joint Research Centre. https://publications.jrc.ec.europa.eu/repository/handle/JRC129218.

156 European Economic and Social Committee (2015). *Working with Asbestos in Energy Renovation (Own-initiative opinion).* https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/working-asbestos-energy-renovation-own-initiative-opinion.

157 European Commission (2022). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS on working towards an asbestos-free future: a European approach to addressing the health risks of asbestos. *Official Journal of the European Union,* 488. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A488%3AFIN.

158 European Commission (2020). Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions: A new Circular Economy Action Plan for a cleaner and more competitive Europe. *Official Journal of the European Union,* 98. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0098.

Another important strategy of the EU is to **become less dependent on other countries for raw materials**, especially critical raw materials (CRM). While the demand for CRM is forecasted to increase significantly, Europe heavily relies on imports from third country suppliers. The EU needs to mitigate the risks for supply chains related to such dependencies to enhance its economic resilience.[159] The recovery of CRM from waste can support these efforts. For instance, magnesium and silicon, which are included in the list of the CRM, are by-products of some asbestos waste treatment technologies, mainly chemical.

The treatment and recycling of ACW and the use of end-products can play an important role in achieving goals of these strategies by providing an alternative to landfilling, reducing waste generation, increasing material recovery targets for CDW, and enhancing circularity. The opportunity lies in the provision of the appropriate **regulatory and economic environment** for asbestos waste treatment technologies to evolve and the development of **policy incentives, guidance and best practices** to improve asbestos waste management in line with the waste hierarchy and principles of the green transition.

From the stakeholder point of view, the main opportunities for commercialising asbestos waste treatment technologies lie:

- in technology accessibility, as some of these technologies are not very complex, making them accessible for implementation;
- the possibility for creating a licensing model, which avoids the need for the company to build and scale treatment plants independently, promoting quicker adoption of the technology in other countries;
- market demand, as there is still a significant amount of asbestos waste present in buildings;
- environmental responsibility;
- potential reuse of treated material;
- the political and policy context, especially the European Union's guidelines and directives for the phasing out of asbestos; or the Renovation Wave.

The global challenge of asbestos waste management creates an opportunity for companies to contribute to a sustainable solution. According to stakeholders, these factors collectively contribute to the attractiveness and feasibility of adopting asbestos waste treatment solutions.

Potential legislative and non-legislative measures to improve asbestos waste management and recycling are provided in the next section.

6.2 Measures to improve asbestos waste management

There is a number of policy instruments that could be implemented in Member States and at the EU level to improve the management of ACW. These include guidelines and best practices for the C&D industry as well as for competent authorities, a uniform certification framework, fiscal measures (including taxation), and regulatory changes. Policy instruments have been categorised according to the four broad categories defined in the Better Regulation toolbox #Tool 17[160]:

1. Hard, legally binding rules;

[159] European Commission (n.d.). *Critical Raw Materials.* https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en.

[160] European Commission (2021). 'Better regulation' toolbox 2021. November 2021 edition.

2. 'Soft' regulation;
3. Education and information;
4. Economic instruments.

6.2.1 Education and information

Guidelines and best practices

The **EU-level guidelines and best practices** could facilitate the improvements in asbestos waste management in Member States and ensure that the way asbestos is detected, removed, collected, transported and treated is consistent and guarantees the safety of workers as well as the protection of the human health and the environment.

The guidance and best practices for asbestos waste management could be incorporated in the 'EU Construction and Demolition Waste Protocol and Guidance'[161] which, at the time of writing[162], is being updated. The aim of the protocol is to increase confidence in the CDW management process and the trust in the quality of recycled materials, which can boost the demand for such materials. Selective demolition combined with accurate pre-demolition audits is the key process in order to improve the quality and quantity of recovered materials (Luciano et al., 2022). This would not only ensure that ACW does not contain other materials, such as organics or plastics, but would also increase the recycling rates of other asbestos-free materials. Hence, the guidance and best practices for pre-demolition audits and selective demolition of buildings containing asbestos should play an important part of such guidance document.

Although currently asbestos waste is predominantly disposed of in landfills, the guidance and best practices should incorporate the treatment and recycling as a potential option for the final stage of the asbestos waste management, if an environmentally sound, economic, safe, and approved treatment technology exists in a Member State. It would encourage the management of asbestos waste in line with the 'waste hierarchy' but also give some assurance for asbestos waste treatment technology providers that the treatment of asbestos waste is preferred over landfilling and is considered a best practice.

Following from the above, the asbestos waste treatment technology or technologies proved to be able to treat ACW in a safe, environmentally friendly and economical manner could be included in the conclusions of the Best Available Techniques (BAT) Reference Document for Waste Treatment, upon their review. Although thermochemical conversion technology for asbestos waste is discussed in the document, there is no asbestos waste-specific section in the conclusions of the BAT.[163]

As discussed in Section 6.1.1, there is also a lack of guidance for relevant competent authorities that may be required to issue permits for asbestos waste treatment technology providers to be able to build facilities. Hence, guidelines or procedural rules that would facilitate the work of competent authorities could be a solution that would reduce the burden for the authorities and make the process more efficient.

All of the above should be complemented with raising awareness campaigns about asbestos waste management and implementation of training programs for workers, contractors, and other

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[161] European Commission (2018). *EU Construction and Demolition Waste Protocol and Guidelines.* https://single-market-economy.ec.europa.eu/news/eu-construction-and-demolition-waste-protocol-2018-09-18_en.

[162] January 2024.

[163] Joint Research Centre (2018). *Best available techniques (BAT) reference document for waste treatment.* https://op.europa.eu/en/publication-detail/-/publication/782f0042-d66f-11e8-9424-01aa75ed71a1/language-en.

stakeholders. This can contribute to safer handling practices and better management of CDW, including ACW.

6.2.2 'Soft' regulation

Standards

Another important step to improve asbestos waste treatment could be the introduction of standards for operations treating asbestos waste and converting it into asbestos-free material. That would increase confidence in the safety of the process. Such a standard, called 'Standard for operations that convert asbestos-containing waste material into non-asbestos (asbestos-free) material'[164], has been introduced in the US by the Environmental Protection Agency as part of the National Emission Standards for Asbestos under the National Emission Standards for Hazardous Air Pollutants.[165] The standard covers aspects such as testing, monitoring, record keeping, reporting, etc.

6.2.3 Economic instruments

One of the recommendations of the EU's CEAP is a broader use of well-designed economic instruments, such as environmental taxes and the use of the value added tax (VAT) rate to promote circular economy activities.[166] The Article 4(3) of Waste Framework Directive also states that Member States should make use of economic instruments and other measures to provide incentives for the application of the waste hierarchy.[167] For instance, some of the proposed measures in Annex IVa are 'charges and restrictions for the landfilling and incineration of waste which incentivise waste prevention and recycling, while keeping landfilling the least preferred waste management option' or 'use of fiscal measures or other means to promote the uptake of products and materials that are prepared for re-use or recycled'.

Subsidies and funding

There is a need for cooperation and collaboration between the authorities and technology developers to create the confidence in the market. **Government funding** could create the initial capital to build the installations and stimulate the market for these technologies. Government support is also important to give confidence to private investors that the technology is viable and scalable and that it can generate a return on investment.

The European Union is providing several funding programmes to support the transition to a circular economy. The European Regional Development Fund (ERDF) [168] is one of the tools that could be

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[164] Environmental Protection Agency (2011). 61.155 Standard for operations that convert asbestos-containing waste material into non-asbestos (asbestos-free) material. https://www.govinfo.gov/content/pkg/CFR-2011-title40-vol8/pdf/CFR-2011-title40-vol8-sec61-155.pdf.

[165] Legal Information Institute (n.d.). *40 CFR Subpart M - National Emission Standard for Asbestos.* https://www.law.cornell.edu/cfr/text/40/part-61/subpart-M.

[166] European Commission (2020). Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions: A new Circular Economy Action Plan for a cleaner and more competitive Europe. *Official Journal of the European Union,* 98. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0098.

[167] European Parliament (2008). DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on waste and repealing certain Directives. *Official Journal of the European Union*, 312. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN.

[168] European Parliament (2021). Regulation (EU) 2021/1058 of the European Parliament and of the Council of 24 June 2021 on the European Regional Development Fund and on the Cohesion Fund. *Official Journal of the European Union*, 23. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021R1058.

utilised by the governments in order to support the development of asbestos waste recycling technologies in Member States. The ERDF aims to support investments in infrastructure and activities for applied research and innovation, including industrial research, experimental development, and feasibility studies, amongst other areas. Promoting the transition to a circular and resource efficient economy is one of the specific objectives of the ERDF, with the expected output of additional capacity for waste recycling. As one of the main goals of the ERDF is to contribute to reducing disparities between the levels of development of various regions, this funding could be especially beneficial for Member States that lack the investment in research and development for waste recycling technologies.

Economic instruments, such as **recycling subsidies** that would cover the difference of the cost between the landfilling of asbestos waste and the treatment, would give companies strong incentive to shift from waste disposal to recycling. In turn, this would incentivise the developers to build facilities on an industrial scale as it would provide security and reduce risk of not having sufficient flows of asbestos waste to be economically viable and make the business more competitive. As discussed by Milios (2021), subsidies can increase efficiency and pollution reduction in the sector that benefits from the subsidy. Therefore, a subsidy could be an effective method to shift ACW towards recycling.

These economic incentives would need to go hand in hand with other initiatives to be effective, such as the increase in landfill tax, appropriate regulatory environment and improved guidance on the management of ACW.

Tax reductions

Tax reduction in the form of the **value added tax (VAT) rate relief** to promote the use of recycled waste products could be a suitable economic tool to strengthen the market for the end-products by increasing the demand and to stimulate the development of asbestos waste treatment technologies.

However, currently a reduced VAT rate can only be applied to goods and services listed in Annex III of Directive 2006/112/EC,[169] which does not include any recycled products or products with recycled content.[170] In a circular economy context, several Member States, such as Belgium, Sweden and the Netherlands, have reduced VAT for repair services and/or implemented tax deductions for repair activities. However, tax relief on recycled products or products with recycled content would require amendments to Annex III of the Directive 2006/112/EC on the common system of value added tax.

Environmental tax

To make asbestos waste treatment technologies competitive, higher environmental taxes, in the form of a **landfill tax**, would make the treatment and recycling of ACW a more viable and more favourable option than disposal. The aim of a landfill tax could also be to provide funding for the development of recycling infrastructure, to reduce the amount of waste sent to landfills and mitigate the related environmental impacts.

According to Milios (2021), a review of the waste management performance of all Member States over the period 2001-2010 has shown that landfill taxes played a major role in improving the waste management practices and enabled Member States to divert considerable quantities of waste away

[169] European Commission (2006). Council Directive 2006/112/EC of 28 November 2006 on the common system of value added tax. *Official Journal of the European Union*, 347. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32006L0112.

[170] European Union Council (2023). *Lower VAT rate for recyclates / recycled products - a possible economic tool to promote the circular economy - Information from the Czech delegation.* https://data.consilium.europa.eu/doc/document/ST-10397-2023-INIT/en/pdf.

from landfills to other more environmentally sound waste management options, such as recycling, in line with the principles of the 'waste hierarchy'. The landfill tax has encouraged the **recycling and recovery of CDW** in Member States, such as Ireland, Denmark, Sweden, or Finland, to name a few. For example, in Denmark, the taxation has promoted the development of recycling technologies and decreased the amounts of CDW deposited in landfills. Disposing of hazardous waste in landfills was initially excluded from the taxation but has been integrated in the taxing system since 2010. Since 2015, taxes for hazardous waste are the same as the regular landfill tax of EUR 64/tonne.[171]

The landfill tax therefore could be an effective instrument to drive the development of the asbestos waste recycling technologies and to divert asbestos away from landfills in a Member State. However, the introduction of such taxes would need to be progressive to allow the industry to adjust and for the required infrastructure to be developed.

The taxation on landfilling asbestos waste could be harmonised across the EU to prevent the exports to other countries, especially neighbouring regions. However, several barriers currently exist for the higher landfill tax to be effective at the EU level:

- No existing commercialised asbestos waste treatment technology in the EU that is environmentally sound and economically viable. Even if some technologies become commercially available in the coming years, it may take decades to establish these technologies in all Member States and build the required number of facilities.
- Different level of recycling of CDW in Member States. Countries with already high levels of recycling and more advanced research and development of recycling technologies may have an advantage compared to other Member States in establishing treatment facilities.
- No or insufficient number of treatment installations can create a problem of accessibility. This can lead to the increase in the GHG emissions as well as the costs of recycling due to longer transportation distances. The higher cost of landfilling together with increased distances to treatment installations from demolition or renovation sites can encourage illegal dumping of ACW.
- Quantities of generated asbestos waste in Member States might exceed the capacities of the treatment installations that could result in accumulation of asbestos waste and would create the necessity for temporary storage.

Hence, the introduction of an EU-level landfill tax on asbestos waste would need to go in tandem with other policy incentives and legislative instruments that would encourage and promote the development and commercialisation of asbestos waste treatment technologies in all Member States.

6.2.4 Hard, legally binding rules

End of Waste criteria

The certification of the recycled end-product based on a uniform EU-level framework to demonstrate the non-waste end-product is asbestos free and safe would increase confidence in the product. The lack of specific EoW criteria was perceived as a major barrier in recycling and reusing of CDW in the study conducted by Luciano et al. (2022) on the critical issues hindering a widespread CDW recycling practice in the EU. The drawing up of end-of-waste criteria consists of thorough techno-economic-environmental assessments verifying the safety of the material and the existence of a market for

[171] Deloitte (2015). *Construction and Demolition Waste management in Denmark.* https://ec.europa.eu/environment/pdf/waste/studies/deliverables/CDW_Denmark_Factsheet_Final.pdf.

candidate waste materials.[172] Hence, **EU-wide EoW criteria** for the end-products resulting from the recycling of asbestos waste could facilitate the process and guarantee the quality of the end-product and allow it to move freely across Member States, simplifying the trade on international markets.

According to Article 6 of the Waste Framework Directive, certain specified waste shall cease to be waste when it has undergone a recovery operation, including recycling, and complies with specific criteria to be developed in accordance with the following conditions:

- The end-product is commonly used for specific purposes;
- There is a market or demand for such product;
- The end-product meets the technical requirements for the specific purposes, the existing legislation and standards applicable to products; and
- The use of the end-product will not lead to overall adverse environmental or human health impacts.

The EoW criteria should include limit values for pollutants where necessary and should take any possible adverse environmental effects into account.[173]

To promote a harmonised implementation of EoW, the EU has adopted EU-wide EoW criteria for a group of specific waste streams, such as iron, steel, aluminium and copper scrap and glass cullet, which are enacted via Commission Implementing Regulations. The Joint Research Centre defined a methodology for developing specific criteria for individual waste streams based on a series of studies investigating relevant standards and legislation, typical waste generation processes, quality standards, quantities, uses/applications and recovery processes of materials as well as markets for the secondary materials. For waste streams that are not covered by EU-wide EoW criteria, Member States have the freedom to determine whether certain waste will reach the EoW at the national level following binding national criteria, which have to be notified to the European Commission to be published under the EU's Technical Regulation Information System (TRIS), or according to case-by-case decisions, which do not need to be notified to the Commission (Luciano et al., 2022).

Currently, approaches to recognise EoW status differ within Member States, especially in single-case decision-making. In some Member States, a designated institution, such as the Environment Ministry or the Environment Agency, is responsible for deciding whether EoW status is applicable or not, whereas in other countries, like in Italy or Sweden, local or regional authorities take these types of decisions. Alternatively, in some cases the producer of the waste is responsible to self-declare EoW, with random ex-post inspections carried out by the enforcement authorities.[174]

Establishing a harmonised EU-wide framework could assist in setting standards for end-products made of recycled asbestos. One of the instruments could be a European EoW criteria protocol for products made of recycled asbestos waste. A good example is the 'End of Waste criteria protocol for waste used as aggregates',[175] that has been developed through CINDERELA project, funded by the EU Horizon

[172] Joint Research Centre (n.d.). *End-of-waste.* https://joint-research-centre.ec.europa.eu/scientific-activities-z/less-waste-more-value/end-waste_en.

[173] European Parliament (2008). DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on waste and repealing certain Directives. *Official Journal of the European Union*, 312. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN.

[174] European Commission (2020). *Study to assess member states (MS) practices on by-product (BP) and end-of waste (EoW).* https://op.europa.eu/en/publication-detail/-/publication/beb56eaa-9fc0-11ea-9d2d-01aa75ed71a1/language-en/format-PDF/source-130854906.

[175] CINDERELA (2021). *End of waste criteria protocol for waste used as aggregates*. https://www.cinderela.eu/The-project/Reports/D5.5-End-of-waste-criteria-protocol-for-waste-used-as-aggregates.

2020 research and innovation program. The main objective of the project was to define a proposal of harmonised approach of EoW criteria protocol for the use of secondary raw materials from CDW and industrial waste or by-products. The protocol covers terms and definitions, input materials, types and composition of the end-product, potential permitted uses, restrictions and prohibitions of use, technical and environmental requirements, limit values, main characteristics of the secondary raw materials, processing considerations, recommendations for use and quality control procedures and frequencies. As stated in the protocol, the definition of the European EoW criteria protocol should result in a simplification of the use of secondary raw materials obtained from some specific waste streams and would bring a greater certainty and predictability for the users of recycled products or materials, which should result in increased recycling rates and reduced landfilling and the use of raw materials. [176]

The development and implementation of EU-level EoW criteria protocol for end-products made of recycled asbestos waste would ensure the safety and quality of the product by demonstrating its conformity with the product standard.

Adaptation of national legislation

Currently, there is no legislation that regulates the treatment and recycling of ACW at the EU level. As a result, recycling of asbestos waste is treated differently depending on a Member State. For example, recycling of waste containing asbestos is not allowed in some Member States, such as Austria, Denmark[177] or Croatia, to name a few. In the latter, Article 20(1) on asbestos waste management procedures of the ordinance on construction waste and waste containing asbestos (Official Gazette 69/16) states that it is forbidden to use the following asbestos waste management procedures prescribed by a special regulation governing waste management: D2, D3, D4, D7, D8, and all recovery procedures, except procedures R1 (use as fuel) and R13 for the purpose of recovery using procedure R1.[178]

In countries like France or the Netherlands, however, the recycling of asbestos waste is permitted, and the development of asbestos waste recycling technologies is promoted, either via legislation (e.g. the landfill ban in the Netherlands) or via financial support. For example, in France, multiple studies have been completed to investigate the feasibility of applying asbestos waste treatment technologies to manage ACW, as discussed in Section 5.4.1. In addition, lack of a regulatory context in which recycling of asbestos waste is permitted may inhibit the implementation of the technologies in some Member States. The removal of any impediments that prohibit the treatment of asbestos waste, adaptation of the laws to allow the recycling of asbestos waste and also setting the required conditions or minimum standards for these technologies to be able to treat asbestos waste could boost the research and development of treatment technologies that could improve the recycling of this hazardous waste stream at Member State level.

Restriction on landfilling

Some stakeholders see the **landfill ban** as the best solution, which would guarantee the movement of ACW to asbestos waste treatment facilities and reduce the risk for operators and investors. For example, in the Netherlands, the landfill ban is already set in the legislation. However, landfilling this

176 Ibid.

177 Boldrin, A., Maresca, A., Fauser, P., Sanderson, H., & Astrup, T. F. (Eds.) (2022). Waste containing asbestos and other environmentally problematic substances: Characterization, risks and management. Danish Environmental Protection Agency. Miljøprojekter No. 2216. https://www2.mst.dk/Udgiv/publications/2022/11/978-87-7038-454-4.pdf.

178 Ministry of Environment and Nature Protection of Croatia (2016). *Rules on Construction Waste and Waste Containing Asbestos.* https://faolex.fao.org/docs/pdf/cro166787.pdf.

waste is still possible as long as there are no other treatment or management options, which is currently the case for asbestos waste.[179] As soon as sufficient processing capacity is demonstrably available and other conditions for changing the minimum standard for processing asbestos waste are met, the minimum standard for these waste materials will be changed to recycling, and a landfill ban will be introduced.[180] These conditions include:

- Smaller environmental footprint or reduced risks/improved public health;
- There is a market for the end-product;
- The new technique must cost no more than 150% of the equivalent landfilling tariff;
- The technique is functioning properly, it can deal with 75% of the total waste supply and there is a plan to deal with 100% of the waste within two years.[181]

Restrictions on landfilling waste streams for which a suitable recycling solution exists is also set in Landfill Directive. In order to support the EU's transition to the circular economy, Article 5(3a) of the Landfill Directive (Council Directive 1999/31/EC)[182] states that '*Member States shall endeavour to ensure that as of 2030, all waste suitable for recycling or other recovery, in particular in municipal waste, shall not be accepted in a landfill with the exception of waste for which landfilling delivers the best environmental outcome in accordance with Article 4 of Directive 2008/98/EC*'.

According to the Waste Framework Directive, when applying the waste hierarchy, Member States need to take measures to encourage the **options that deliver the best overall environmental outcome**. In deciding on the management of specific waste streams, Member States need to consider the general environmental protection principles of precaution and sustainability, technical feasibility and economic viability, protection of resources and the overall environmental, human health, economic and social impacts.[183] In order to ensure that there is a unified understanding across the EU on what is considered a safe, sustainable and environmentally sound asbestos waste recycling option, the European Commission could determine the assessment criteria for the technology via the most suitable legal or non-legal instrument, which would need to be established by the Commission. Criteria could be used to assess the asbestos waste treatment technology based on their LCA and Life Cycle Costing (LCC) when such are available for the technology in order to establish if it achieves better environmental, social, economic and technological outcome than the disposal of asbestos waste in landfills.

In order to consider a restriction on landfilling of asbestos waste, the necessary conditions to stimulate the research, development and industrialisation of the asbestos waste treatment technologies need to be created, because introducing the landfill restriction without the infrastructure to replace landfilling is not a feasible solution. A law on banning the landfilling of waste for which a sufficient treatment capacity exists, as is done in the Netherlands, could be a potential approach. Furthermore, if the landfilling of asbestos waste is to be restricted, governments have to create the environment in which sending asbestos waste to treatment does not create a financial burden for citizens, C&D

[179] Waste Circular (n.d.). *Landfill Decree and Waste Dumping Bans.* https://www.afvalcirculair.nl/onderwerpen/afvalregelgeving/afval-storten/bssa/.

[180] Ministry of Infrastructure and Water Management of the Netherlands (n.d.). *Sector plan 37: Asbestos and asbestos-containing waste*. https://lap3.nl/sectorplannen/sectorplannen/asbest/.

[181] Bureau KLB (2018). *Practicable sustainable options for asbestos waste treatment.* https://www.asbeter.com/documents/KLB%20assessment-of-asbestos-waste-treatment-techniques.pdf.

[182] Council of the European Union (1999). Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste. *Official Journal of the European Union,* 182. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01999L0031-20180704.

[183] European Parliament (2008). DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on waste and repealing certain Directives. *Official Journal of the European Union*, 312. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN.

companies or waste managers in order to prevent illegal dumping and to avoid inhibiting renovations due to increased cost for builders and developers.

7 Foresight analysis

The foresight analysis on the potential for future development and implementation of asbestos waste treatment technologies is based on relevant megatrends, European strategies and policies, technological readiness level of the most advanced asbestos waste treatment technologies, existing barriers for commercialisation and the implementation of the proposed measures to improve asbestos waste management. The foresight analysis looks at three different scenarios.

7.1 Megatrends

Megatrends are defined as long-term driving forces that are observable now and will most likely have a global impact in the future. They can help identifying probable and preferable futures.[184] The future development of asbestos waste treatment technologies may be influenced by several megatrends:

- **Aggravated resource scarcity.** Demand for water, food, energy, land and minerals is rising substantially, making natural resources increasingly scarce and more expensive with visible environmental costs of resource production. This is driving the search for new sources and for alternatives, with technological developments and recycling processes influencing the demand, supply and availability of resources, such as raw materials for appliances, building materials and chemicals. The shift towards a more circular economy is expected to further enhance awareness and the development and exploitation of new approaches to sourcing and using resources.
- **Growing pressure on ecosystems**. Driven by global population growth and associated demands for food and energy, as well as evolving consumption patterns, the pressure on the Earth's ecosystems is continuously increasing. Despite some positive developments, such as a recent reduction in the rates of tropical deforestation, global biodiversity loss and ecosystem degradation are projected to increase. Climate change is expected to exacerbate this trend by altering the environmental conditions to which species are adapted. In addition, the need to shift to alternative energy sources may create challenges for global land and freshwater resources, most notably related to increased bioenergy production or in general for anthropogenic activity. In particular, growing global request for land resources and related concerns about food and energy security are apparent in the number of large-scale land acquisitions during recent years.[185] Sustainable management of ecosystems and socio-economic development are thus intertwined challenges.
- **Increasing environmental degradation.** Ecosystems are today exposed to critical levels of pollution in increasingly complex mixtures. Human activities (such as energy generation and agriculture, but also waste collection, treatment and disposal activities), global population growth and changing consumption patterns are the key drivers behind this growing environmental burden. Historic trends and business-as-usual projections suggest that in the coming decades pollution may reduce in some regions but could increase markedly in others. There is clear evidence of the detrimental effects of pollution on the natural environment, ecosystem services and biodiversity, for example through processes such as eutrophication and

[184] European Commission (n.d.). *The Megatrends Hub.* https://knowledge4policy.ec.europa.eu/foresight/tool/megatrends-hub_en#:~:text=Megatrends%20are%20defined%20as%20long,identify%20probable%20and%20preferable%20futures.

[185] European Environment Agency (2014). *Assessment of global megatrends — an update. Global megatrend 8: Growing pressures on ecosystems.* https://www.eea.europa.eu/publications/global-megatrend-update-8.

acidification. The increasing scale of environmental pollution has thus created new governance challenges in Europe and worldwide.[186]

These trends may influence the rise of the support for the development and implementation of asbestos waste treatment technologies. In the context of the resources challenge, the recovery of secondary materials can be seen as an advantage of asbestos waste treatment. These materials can replace raw materials in several sectors, especially in the construction sector, supporting circularity and resource efficiency. It can also reduce the dependency on raw materials from other non-EU countries. In the context of growing pressure on ecosystems, asbestos waste treatment technologies can reduce the need for the expansion of landfill capacity. The development of landfills results in an unsustainable land use and in the destruction of natural habitats and wildlife. Depositing asbestos waste in landfills risks causing environmental pollution with asbestos fibres, either via air dispersion or through leachate. On the other hand, the treatment of asbestos waste can also have some negative environmental impacts, such as large CO_2 footprint due to high energy intensity (relevant to thermal treatment) and emissions of atmospheric pollutants (see Section 5.5.2).

These megatrends will be considered as a constant in all three future scenarios.

7.2 EU policies and strategies

The EU strategies that could shape the development of the asbestos waste treatment technologies have been presented in Section 6.1.2. They include the Renovation Wave Strategy and the Circular Economy Action Plan. The increasing demand for less dependency on raw materials, especially critical raw materials, may also play the role.

As a result of the renovation wave, which aims to at least double the annual energy renovation rate of residential and non-residential buildings, the EU will most likely see the increasing quantities of asbestos waste, as the European Parliament proposed to combine energy performance in buildings with asbestos removal.[187] On the other hand, the circular economy strategy calls for the reduction in waste generation and for the creation of markets for secondary materials.[188]

The Landfill Directive may also play a role. To support the EU's transition to the circular economy, the Directive:

- Introduces **restrictions on landfilling of all waste that is suitable for recycling or other material or energy recovery** from 2030 (Article 5(3a) of Council Directive 1999/31/EC[189]);

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[186] European Environment Agency (2014). *Assessment of global megatrends — an update. Global megatrend 10: Increasing environmental pollution.* https://www.eea.europa.eu/publications/global-megatrend-update-10-increasing.

[187] European Parliament (2013). European Parliament resolution of 14 March 2013 on asbestos related occupational health threats and prospects for abolishing all existing asbestos (2012/2065(INI)). *Official Journal of the European Union,* 36. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52013IP0093.

[188] European Commission (2020). Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions: A new Circular Economy Action Plan for a cleaner and more competitive Europe. *Official Journal of the European Union,* 98. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0098.

[189] Council of the European Union (1999). Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste. *Official Journal of the European Union,* 182. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01999L0031-20180704.

- Allows EU countries to use economic instruments and other measures to encourage applying the waste hierarchy (Article 15a of Council Directive 1999/31/EC).[190]

According to the Waste Framework Directive, when applying the waste hierarchy, Member States need to take measures to encourage the options that deliver the best overall environmental outcome. This may require some specific waste streams to depart from the hierarchy where this is justified by a life cycle thinking on the overall impacts of the generation and management of such waste. In deciding on the management of specific waste streams, Member States need to consider the general environmental protection principles of precaution and sustainability, technical feasibility and economic viability, protection of resources and the overall environmental, human health, economic and social impacts.[191] In this context, if a reliable, safe, and economically viable solution for asbestos waste treatment is developed and implemented in a Member State by 2030, a restriction on asbestos waste disposal may be put in place.

These strategies and policies will be considered as a constant across all three future scenarios.

7.3 Technological readiness level

The technological readiness level (TRL) that has been assigned to each asbestos waste treatment technology is presented in the table below. The TRL was decided based on the development status of each type of the process as presented in the TRL matrix in Table 2-6.

The thermal treatment of asbestos waste by vitrification has been assigned TRL 9, because the Inertam process that is treating ACW with plasma torch has already been commercialised (see Section 5.2.2). Thermal treatment of asbestos-containing steel scrap in steel melting furnaces has also been given TRL 9 as the technology has been implemented on a commercial scale. However, the only company applying this technology in the EU went bankrupt due to insufficient flows of waste. Denaturation of asbestos waste was assigned a TRL of 6-7. This is related to the fact that the providers of this technology have not yet built a commercial-size facility, although a demonstration plant has been built in the UK by one of the technology providers. Chemical treatment via dissolution in acids was given a TRL 6-7. Although demonstration facilities have been built by a few technology providers, the technology is yet to be realised on an industrial scale. Thermochemical treatment was assigned a TRL of 9, based on the information presented by the technology provider in the interview. The technology had been tested at pilot scale and a commercial plant applying this technology on an industrial scale had been running for several years in the United States over a decade ago, but currently, there is no operating facility using this technology. According to the technology provider, their plans are to build a facility in the UK and licence the technology to other countries. Mechanochemical treatment in alkaline environment was given a TRL of 6-7. Although demonstration facilities have been built, the technology is yet to be realised on an industrial scale. The provider of mechanochemical treatment with acids claims the technology is market-ready, although currently there are no installations treating ACW, which can be explained by the fact that the process can be carried out in mobile units. The company website lists a number of projects that have been successfully completed by the company. However, as there is no full-scale running installation, the technology was assigned a TRL of 7, potentially 8. The mechanochemical treatment by MID-MIX® was given a TRL of 5. This technology treats hazardous waste, specifically sludge, and is claimed to be able to treat asbestos-containing

[190] European Commission (n.d.). *Landfill waste.* https://environment.ec.europa.eu/topics/waste-and-recycling/landfill-waste_en#:~:text=The%20Landfill%20Directive%20aims%20to,soil%2C%20air%20and%20human%20health

[191] European Parliament (2008). DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on waste and repealing certain Directives. *Official Journal of the European Union*, 312. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN.

sludge. The company has facilities across Europe; however, it is unclear if these actually treat asbestos containing sludge (technology providers did not respond to the request for an interview). Although the technology is well-established, the study team could not confirm if the facilities in Europe actually treat asbestos waste or whether a demonstration plant has been built.

Table 7-1: TRL of asbestos waste treatment technologies

Process group	Process	TRL
Thermal	Vitrification	9
	Denaturation	6-7
	Recycling asbestos containing steel scrap in steel melting furnaces	9
Chemical	Dissolution in acids	6-7
Thermochemical	Thermochemical Conversion Technology	9
Mechanochemical	In alkaline environment	6-7
	With acid	7-8
	MID-MIX®	5

7.4 The scenarios

The three possible future scenarios are largely based on what measures, if any, will be introduced to improve asbestos waste management in line with the waste hierarchy. The 'status quo' scenario serves as a benchmark to show the potential future if no action is taken, and the development of the technologies carries on at the same pace. The overview of the scenarios is presented in Figure 7-1.

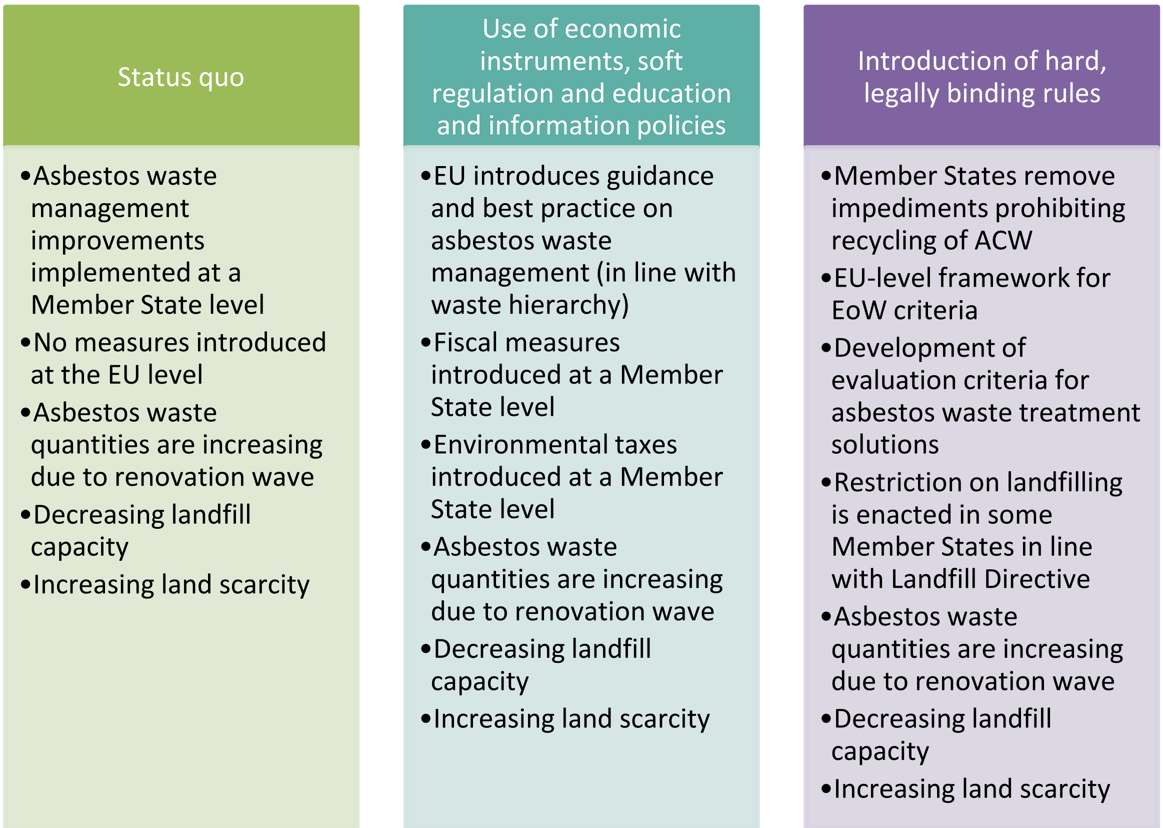

Figure 7-1: Three scenarios for the future development and implementation of asbestos waste treatment technologies.

7.4.1 Scenario 1: Status quo

In this scenario, no legislative or non-legislative measures are introduced to improve asbestos waste management in line with waste hierarchy at the EU level. The barriers that are currently hindering the implementation of asbestos waste treatment technologies remain, although some may be addressed at a Member State level, especially in countries, where the treatment of asbestos waste is seen as a potential solution in the management of growing quantities of asbestos waste. For example, in France, Article 114 of the anti-waste law for a circular economy (AGEC)[192] required that, no later than the 1 of January 2022, a roadmap on the treatment of asbestos waste was established to identify possible alternatives to landfilling of asbestos waste which are viable and, if possible, to schedule their deployment. The roadmap also had a goal to identify research and development needs for other alternative solutions to landfilling. The roadmap was delivered on time and provided the overview of several asbestos waste treatment technologies and their potential for implementation in France in the next few years.[193] Other countries, such as the Netherlands or Flanders region in Belgium also looked at the potential solutions to treat asbestos containing waste, as presented in Section 5.4.1.

Not surprisingly, some of the technologies investigated in this report are coming from France and the Netherlands. It shows that the support of the government and the overall policy on moving away from landfilling of asbestos waste can give some confidence to developers, especially considering large investment needs for building these types of facilities. If asbestos waste treatment technologies are successfully implemented in these Member States, other countries may follow suit, although it is difficult to predict how many and which countries will decide to change their policy encouraging the recycling of asbestos waste.

As discussed in Section 6.2.4, the landfill ban is already set in the Dutch legislation. As soon as sufficient processing capacity is demonstrably available and other conditions for changing the minimum standard for processing asbestos waste are met, the minimum standard for these waste materials will be changed to recycling, and a landfill ban will be introduced.[194] Considering that commercial-size facilities to treat asbestos waste are planned to be built in the Netherlands in the next few years (for example, Asbeter, at TRL 7, is planning to open the facility in 2025) and if they meet the necessary minimum standards, the landfill ban will be enforced. The cost of treatment at these facilities will be higher than landfill cost (~200-400 €/tonne compared to an average landfilling cost of around 100 €/tonne) and may thereby potentially result in illegal dumping or exports of asbestos waste to where disposal would be cheaper. The government may introduce the necessary measures for a seamless and effective transition from landfilling to treatment. In France, however, some of the technology providers claim that the construction industry is prepared to pay more for the final phase of asbestos waste management to improve their environmental performance, and the cost of treatment of 900 to 1,500 €/tonne is not seen as a deterrent.

However, in other Member States, the situation may remain as it is in the current regulatory environment, and the development of asbestos waste treatment technologies may not happen at all, especially in Member States where recycling of asbestos waste is forbidden by the legislation (e.g., Austria, Denmark). However, the development and implementation of a safe, certified, reliable and

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192 Legifrance (2020). LAW no. 2020-105 of February 10, 2020 relating to the fight against waste and the circular economy (1). https://www.legifrance.gouv.fr/jorf/article_jo/JORFARTI000041553879#:~:text=1%C2%B0%20L'identification%20des,solutions%20alternatives%20%C3%A0%20l'enfouissement.

193 General Council for the Environment (2021). *A roadmap for the treatment of asbestos waste.* https://www.economie.gouv.fr/files/files/directions_services/cge/dechets-amiante.pdf?v=1667228240.

194 Ministry of Infrastructure and Water Management of the Netherlands (n.d.). *Sector plan 37: Asbestos and asbestos-containing waste.* https://lap3.nl/sectorplannen/sectorplannen/asbest/.

economically viable solution to treat asbestos waste in one Member State can shift the attitude towards asbestos waste recycling in those countries.

The quantities of ACW will most likely grow due to increasing numbers of renovations boosted by the renovation wave, and ACW will continue to be disposed of in landfills. The landfill capacity may become an issue in some Member States (see Section 5.2.1). Hence, more land will need to be used to build the required capacity, or increasing quantities of asbestos waste will need to be exported to other countries. The potential need for building more capacity may result in unsustainable land use and the destruction of habitats and the wildlife.

In this scenario, the EU strategies that foster the move towards circular economy and encourage the recovery and reuse of materials, without incentives to support the development of asbestos waste treatment technologies, may struggle to influence the improvement of the management of this waste stream at the EU level. Furthermore, the restriction introduced by the Landfill Directive (Article 5(3a) of Council Directive 1999/31/EC[195]) that restricts landfilling of all waste that is suitable for recycling or recovery from 2030, will most likely not be applied for asbestos-containing demolition waste or enforced from 2030 in any of the Member States due to slow commercialisation of the technologies across Europe and potential lack of consensus on what can be considered the solution that brings the best overall environmental outcome in the management of asbestos waste.

7.4.2 Scenario 2: Use of economic instruments, soft regulation and education and information policies

In this scenario, no hard, legally binding rules at EU or Member State level are introduced to improve asbestos waste management in line with the waste hierarchy. However, economic instruments, soft regulation and education and information policies — such as EU guidance and best practices on asbestos waste management, standardisation of the treatment processes, and also fiscal incentives and changes in taxation — are introduced at a Member State level, which may have some influence on the development and implementation of asbestos waste treatment technologies in the EU.

The development of an EU-level guidance document that lays out the best practice for asbestos waste management in line with the waste hierarchy may increase the quality of CDW due to improved pre-demolition audits, selective demolition and safe removal of asbestos from buildings, resulting in lower rates of contamination of CDW with asbestos. This will potentially increase recycling rates of CDW and reduce the volume of ACW that will need to be sent to landfills. The best practice will consider the treatment of asbestos waste as a potential solution, where an environmentally sound, safe and economically viable solution exists, in line with the principles of the Waste Framework Directive. Ideally, the safety, sustainability and economic viability of the technology will have to be supported by a thorough environmental impact assessment, LCA and techno-economic feasibility assessment to demonstrate that the treatment of ACW with this technology delivers the best overall environmental outcome. It needs to be noted though, that guidance documents and protocols, such as, for example, EU Construction and Demolition Waste Protocol and Guidelines,[196] are voluntary in nature, so their uptake at a Member State level cannot be guaranteed.

If a Member State determines that a proven technology that can treat ACW in a safe and sustainable way is available, it can introduce some fiscal measures to support the implementation of the

[195] Council of the European Union (1999). Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste. *Official Journal of the European Union,* 182. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01999L0031-20180704.

[196] European Commission (2018). *EU Construction and Demolition Waste Protocol and Guidelines.* https://single-market-economy.ec.europa.eu/news/eu-construction-and-demolition-waste-protocol-2018-09-18_en.

technology in the country. The introduction of fiscal incentives may drive the change by supporting the developers of the technologies through funding and also providing confidence in the marker through recycling subsidies. In this scenario, developers of treatment technologies can obtain funding through several EU funding mechanisms, such as the European Regional Development Fund,[197] to initiate the building phase of the project and attract investors by demonstrating the support and confidence in the technology by the Government. This can be especially beneficial for technology providers that are currently at TRL 7 or 8 and are in the stage of reaching out to investors. In addition, recycling subsidies that cover the difference of the cost between the landfilling of asbestos waste and the treatment may give construction and waste management companies a strong incentive to shift from asbestos waste disposal to recycling when such technology is introduced in the country. The subsidy may also give confidence in the market and create some financial security for the developers to build treatment plants in the country. In addition, as some technologies are available through licencing, waste managers may also start considering the potential of building treatment facilities.

Some Member States may also introduce environmental tax if they consider that a suitable technology to treat ACW exists, making the disposal of asbestos waste less favourable. However, the governments are risking opposition from the construction industry and waste managers if the technology to treat asbestos waste is not there or the treatment of ACW is much more costly than the landfilling option. The risk for illegal dumping and exporting of asbestos waste to neighbouring countries could potentially increase. Hence, Member States may decide to introduce a progressive environmental tax, allowing for the industry to adjust but also for the treatment technology providers to set up plants.

However, although the Article 4(3) of Waste Framework Directive states that Member States should make use of economic instruments and other measures to provide incentives for the application of the waste hierarchy,[198] these are only recommendations, and it is up to a Member State to introduce such incentives. It needs to be noted that only a handful of Member States support the development of asbestos waste treatment through the legislation or other initiatives. Hence, only countries with a regulatory environment that supports the movement towards the treatment of asbestos waste or Member States that are starting to see the potential of asbestos waste treatment may decide to initiate such measures. If a Member State does not see a potential solution that is in line with the principles of the Waste Framework Directive, it may be reluctant to do so.

The quantities of ACW will most likely grow due to increasing numbers of renovations boosted by the renovation wave, and large quantities of ACW will continue to be disposed of in landfills, especially in Member States where no legislative changes to allow the recycling of asbestos waste are made. Some countries, where fiscal measures and taxation may be introduced to encourage the behavioural change towards recycling of ACW and to provide the environment in which technology providers are more likely to invest and build facilities, may see the reduction in the asbestos waste deposited in landfills. For others, the landfill capacity may become an issue, leading to the need of more space to build more landfill capacity or increasing quantities of asbestos waste exported to other countries. The potential need for building more capacity may result in unsustainable land use and the destruction of habitats and the wildlife.

In this scenario, the introduction of the EU-level guidance and best practice for asbestos waste management and fiscal measures to incentivise technology developers together with standardisation

[197] European Commission (n.d.). *European Regional Development Fund (ERDF) – About the Fund.* https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/european-regional-development-fund-erdf_en.

[198] European Parliament (2008). DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on waste and repealing certain Directives. *Official Journal of the European Union,* 312. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN.

of the treatment processes may contribute to some of the goals of the EU strategies that foster the move towards circular economy, encourages the reduction of waste generation and promotes the recovery and reuse of materials. However, the development and commercialisation of the technologies in the Member States may still be too slow for a restriction on landfilling asbestos waste to be enacted from 2030. In addition, there may be potential lack of consensus on what can be considered the solution that brings the best overall environmental outcome in the management of asbestos waste.

7.4.3 Scenario 3: Introduction of hard, legally binding rules

In this scenario, Member States remove all impediments that prohibit the recycling and treatment of asbestos waste, and the certification of products obtained from ACW via EU-level framework for EoW criteria is introduced. In this regulatory environment, waste managers and technology developers start investigating opportunities for asbestos waste treatment. With the possibility to establish asbestos waste treatment facilities in a country, waste managers may start looking at other countries, where such facilities are starting to be built (e.g., France, the Netherlands), analysing the potential business opportunities via licencing. Nevertheless, the development and implementation of asbestos waste treatment technologies in a country stays in the hands of a private sector, although some countries may implement economic instruments, to boost the development of the technologies.

In this scenario, the EU introduces an EU-level framework for the EoW criteria for products obtained through the treatment of asbestos waste. Asbestos waste treatment technology providers use the opportunity to receive the EoW status for their products, generating more confidence in the safety and quality of the end-product. This also helps the end-product to find the place in the market, ensuring the buyer that the product meets the necessary requirements. This measure grows overall confidence by the public and the governments that the products recovered through asbestos waste treatment are safe and do not pose risk to human health and the environment. In addition, such products can be sold on an international market, allowing them to freely move within the EU.

In parallel, the European Commission develops an instrument, as discussed in Section 6.2.4, that establishes criteria for assessing and evaluating whether an asbestos waste recycling solution is safe, sustainable, technically feasible, environmentally sound, and economically viable. The instrument ensures that only if the set criteria is achieved, the solution can be considered suitable and the restrictions on landfilling of asbestos waste, as stated in Article 5(3a) of Council Directive 1999/31/EC,[199] can be introduced from 2030. The introduction of such instrument may boost the development of asbestos waste treatment technologies, encouraging the developers to seek solutions that meet the criteria. If the technology that meets the criteria becomes available in a Member State, the country should endeavour to ensure that as of 2030, ACW is not accepted in landfills. However, this may create significant challenges for some Member States. Without the infrastructure to replace landfilling, some countries may not be able to enforce the restriction.

The implementation of asbestos waste treatment in all Member States may take years if not decades due to large investments necessary to build a commercial size facility, considering that some countries may need a few of such facilities to allow for the treatment of all asbestos waste generated in the country. Developers, waste managers and investors may be reluctant to invest in the facility that only treats ACW as this waste stream is finite and the economic viability of the plant depends on the availability of continues flow of waste.

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[199] Council of the European Union (1999). Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste. *Official Journal of the European Union,* 182. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01999L0031-20180704.

In order to create confidence in the market, Member States may decide to introduce national inventories for asbestos in buildings to better understand the extent of the issue and identify where and in what quantities asbestos still exists in buildings, giving some indication to the developers of treatment technologies and waste managers on what volumes of ACW can be expected in the future. Following this, some Member States may decide not to implement the treatment of asbestos waste due to low quantities of asbestos waste being generated in a country, as the treatment facility may need certain volumes of asbestos waste to be economically viable and attracting the developers and investors may be a challenge. Exports of asbestos waste to another Member State with existing treatment facilities may become the only solution in those countries.

Acknowledging all the above, a Member State may consider introducing a transition period or a set of conditions for the restriction to come into force, as was done in the Netherlands, to allow for the industry to build the necessary infrastructure. Other measures, such as fiscal incentives and taxation, may also need to be introduced to foster the movement towards recycling of asbestos waste.

As in previous scenarios, the quantities of ACW are expected to grow due to increasing numbers of renovations boosted by the renovation wave. However, not all asbestos waste will be sent to landfills due to the availability of treatment of asbestos waste in some Member States, treatment gradually replacing landfilling in most of the Member States over time. In countries where the technology is not available, asbestos waste will continue to be disposed of in landfills (considering that the set conditions for the restriction cannot be achieved) or ACW will be exported to other countries. Due to increase in recycling of asbestos waste, less landfill capacity may be required, reducing the need for land, which can be especially beneficial in countries experiencing land scarcity.

In this scenario, improved asbestos waste management in line with waste hierarchy will contribute towards the goals of relevant EU strategies by reducing the quantity of waste deposited to landfills and by recovering secondary materials, albeit not in all Member States and not at the same pace.

8 Conclusions and recommendations

8.1 Conclusions

Comprehensive and reliable data on asbestos waste generation, disposal and treatment does not exist for all Member States. EU-level statistics on asbestos waste are not collected; asbestos waste is reported to Eurostat together with other mineral waste every two years. Hence, understanding what quantities of asbestos-containing waste have already been generated in the EU is not possible, although some estimations can be made. Member States apply different methods for collecting and reporting data on asbestos waste, which makes it difficult to compare data.

The EU extensively consumed asbestos until the EU-wide ban, and most asbestos was incorporated in construction products used in buildings. Currently, those buildings represent a significant portion of in-use building stock. As a result, **asbestos waste is mostly generated by demolition and renovation works** of these buildings. Almost 97% of asbestos-containing waste is reported as ‘construction materials containing asbestos’, followed by ‘insulation materials containing asbestos’, making up 99% of all asbestos-containing waste generated in Member States over the last decade or more.

Based on estimates by the study team, only a fraction of asbestos has been removed from buildings in the EU. Large quantities of asbestos remain in public and residential buildings, which will eventually become waste. The ‘Renovation Wave for Europe’ strategy aims to at least double the rate of building renovation by 2030, extending to 2050, with a focus on deep renovations. Therefore, quantities of asbestos waste generated in Member States is expected to grow, considering that the renovation work for increasing energy efficiency in buildings is generally made on walls, roofing, floors, obsolete technical systems and electric installations of the building, where asbestos is most commonly found.

There are significant differences between Member States with regard to what triggers the requirement to screen for asbestos presence in buildings. The triggers include, for example, demolition, construction or renovation where asbestos exposure is likely to occur, any construction or renovation, change of ownership of the building, a rental agreement or a blanket requirement that all buildings must be screened for asbestos by a certain date. As a result, in some Member States, stakeholders (including building owners) have better knowledge about the presence of asbestos in buildings. This is in turn the first step to devise an adequate management plan.

Most Member States do not appear to have any specific targets or strategies for the removal of asbestos from buildings other than in cases of demolition (and renovation). Some countries provide or provided in the past financial assistance for asbestos removal, but such schemes tend to be limited in scope (e.g., funding asbestos removal from schools) and time. There are therefore limited incentives in some countries to remove asbestos containing materials from buildings other than in cases of demolition and renovation.

Currently, the main disposal option for asbestos waste is landfilling. Asbestos waste is typically accepted in hazardous waste landfills and/or in some non-hazardous waste landfills (depending on availability in the relevant Member State). The specific landfilling practices for non-hazardous waste landfills may differ across Member States and can include requirements on packaging of landfilled asbestos waste, sectors or cells in which it can be deposited, covering of these cells, etc.

Around half of the EU Member States have in place guidance documents for the management of asbestos waste. The availability of such a document makes it more likely that stakeholders are aware of the legal obligations and follow correct and good practice procedures when removing and disposing of asbestos-containing waste.

Landfill capacity may become an issue for a number of Member States. Estimations by the study team show that the remaining capacity in hazardous and non-hazardous waste landfills in some Member States is not sufficient for asbestos waste that is yet to be generated if all asbestos is to be removed from buildings over time. The estimations do not anticipate the increase in landfill capacity, but they show which countries would potentially need substantial expansion of their landfill capacity to allow for disposal of the remaining asbestos waste while avoiding long-distance transportation across the EU that is costly and polluting.

The asbestos waste recovery capacity in the EU is currently close to zero. There is only one industrial asbestos waste recovery facility, which uses thermal plasma vitrification and is licenced to treat 8,000 tonnes of asbestos waste per year. The cost of recovery is approximately 10-20 times higher than the average cost of disposal in the EU, and the technology is very energy intensive. Indeed, the facility works only for six months during summer to cope with energy prices. Its operation is therefore dependent on energy prices and comes with a large environmental footprint.

Research on asbestos waste treatment has mainly been focusing on thermal treatment technologies, followed by chemical treatment technologies. The review of scientific publications showed that thermal treatment was the most investigated treatment technology, with only few studies on chemical treatment. However, the number of patents for chemical treatment technologies was close to that of thermal treatment processes. This shows that these two technologies are receiving the most attention from the scientific community.

Several asbestos waste treatment technologies are emerging in the EU with the potential to be implemented at industrial scale in the near future. Literature and stakeholder consultation identified a number of treatment technologies that are likely to be implemented at industrial scale in some Member States in the next few years. However, providers of these technologies point to many barriers hindering implementation efforts, including the financial risks due to the large investments needed to build facilities (CAPEX) and the regulatory environment.

Asbestos waste recovery and disposal operations have different environmental, social and economic impacts which should be carefully balanced. Landfilling is considered an established practice with well-tried and tested control of risks to human health and the environment. Nevertheless, the asbestos legacy remains and is left to future generations to deal with the landfill sites, where full safety cannot be guaranteed in perpetuity. Existing and emerging asbestos waste recovery technologies have different adverse environmental impacts, mainly linked to very high energy consumption. These negative environmental impacts should be balanced against the benefits arising from the production of secondary materials (and therefore increased circularity), the opportunity of mitigating pollutant and greenhouse gas emissions through abatement measures and, importantly, the destruction of asbestos fibres down to their limit of detection.

A number of measures may be implemented at the EU and Member State level to boost the development and implementation of asbestos waste recycling solutions. These include fiscal incentives, certification of end products, standardisation of operations, dissemination of best practices, among other. The adoption or amendment of national legislation to allow the recycling of asbestos waste and the establishment of EU-wide criteria for what is considered a sustainable and technically feasible treatment solution can also play an important role.

8.2 Recommendations

Based on the outcome of the study, the following needs and potential solutions have been proposed.

There is a need for an **EU-level guidance or methodology for asbestos waste data collection and management** to ensure that data in Members States is consistent, coherent and reliable. Requiring Member States to report asbestos waste data to Eurostat separately from other mineral wastes would improve their quality and reliability.

There is a need of an **EU-level guidance and best practice for asbestos waste management, including the option for recycling** where and when the technology exists. The description of best practices could be added to the EU construction and demolition waste management protocol and guidelines. Greater EU-level co-ordination and promotion of best practices would ensure that Member States with no or less developed approaches benefit from Member States with more advanced practices in the identification and management of asbestos waste.

The development of the **EU-level framework for 'end of waste' criteria for secondary materials obtained through the recovery of asbestos waste** could increase the confidence in the end products and allow such products to move freely across the single market. This could be supplemented with standards for recovery operations that would ensure the reliability and safety of the process through regular testing, monitoring, record keeping and reporting.

The European Commission could consider **including recycled products or products with recycled content in Annex III of Directive 2006/112/EC on the common system of value added tax** to allow the application of a reduced VAT. This could potentially increase the demand of products made of secondary materials, including materials recovered through the treatment of asbestos waste.

The European Commission could consider developing **evaluation criteria for asbestos waste treatment technologies** to support Member States in assessing whether a technology meets the general environmental protection principles as laid out in the Waste Framework Directive and other environmental legislation.

9 References

Agency for Statistics of Bosnia and Herzegovina (2015). *Waste Weight Determination.* https://bhas.gov.ba/data/Publikacije/Metodologije/KFO_00_2015_MD_1_EN.pdf. Accessed on 31/05/2023.

APRE, CDTI (2022). *Guiding notes to use the TRL self-assessment tool.* https://horizoneuropencpportal.eu/sites/default/files/2022-12/trl-assessment-tool-guide-final.pdf. Accessed on: 31/05/2023.

ASBEST - Den grønne asbestvejledning og beskrivelse for udførelse af asbestsanering, 2019 (The green asbestos guide and description for the execution of asbestos remediation). Nedrivning og Miljøsanering - en sektion i Dansk Byggeri (Section for demolition and decontamination of the Danish Construction Federation). In Danish. https://www.danskindustri.dk/DownloadDocument?id=155130&docid=165599. Accessed on: 11/12/2023.

Asbestos (2023). *Guide to Handling, Disposing and Recycling Asbestos.* https://www.asbestos.com/exposure/handling-disposing-asbestos/. Accessed on: 31/05/2023.

AT-vejledninger – Asbest: Regler for ethvert arbejde med asbest og herunder reparation, vedligeholdelse og fjernelse af asbestholdige materialer, 2005, updated in 2019 (Asbestos: Rules for any work with asbestos, including the repair, maintenance and removal of asbestos-containing material). Danish Working Environment Authority (Arbejdstilsynet). In Danish. https://at.dk/regler/at-vejledninger/asbest-c-2-2/. Accessed on: 11/12/2023.

Baza Asbestova (n.d.). *Landfills.* https://bazaazbestowa.gov.pl/pl/usuwanie-azbestu/skladowiska. Accessed on: 11/12/2023.

Baza Asbestova (n.d.). *Statistical summary.* https://bazaazbestowa.gov.pl/en/. Accessed on: 11/12/2023.

Bekendtgørelse om deponeringsanlæg, 2019 (Statutory Order on Landfills). BEK nr 1253 af 21/11/2019. Danish Ministry of Environment (Miljøministeriet). In Danish. https://www.retsinformation.dk/eli/lta/2019/1253. Accessed on: 11/12/2023.

Bernasconi, A., Pellegrino, L., Vergani, F., Campanale, F., Marian, N. M., Galimberti, L., ... & Capitani, G. (2023). Recycling detoxified cement asbestos slates in the production of ceramic sanitary wares. *Ceramics International*, *49*(2), 1836-1845.

Bhattacharya, S., John, P. J., & Ledwani, L. (2021). Microbial siderophores an envisaged tool for asbestos bioremediation–A microcosm approach. *Materials Today: Proceedings*, *43*, 3110-3116.

Bloise, A., Kusiorowski, R., & Gualtieri, A. F. (2018). The effect of grinding on tremolite asbestos and anthophyllite asbestos. *Minerals, 8*(7), 274.

BMK (2023). *The inventory of Waste management in Austria - Status report 2023.* https://www.bmk.gv.at/themen/klima_umwelt/abfall/aws/bundes_awp/bawp2023.html. Accessed on: 31/05/2023.

BMNT (2017). *Federal Waste Management Plan 2017.* https://www.bmk.gv.at/en/topics/climate-environment/waste-resource-management/waste-management/fed-waste-mgt-plan.html. Accessed on 31/05/2023.

Boldrin, A., Maresca, A., Fauser, P., Sanderson, H., & Astrup, T. F. (Eds.) (2022). Waste containing asbestos and other environmentally problematic substances: Characterization, risks and management. Danish Environmental Protection Agency. Miljøprojekter No. 2216.

Borges, R., do Amaral, L. F. M., Ribeiro, V. P., de Oliveira-Paiva, C. A., Wypych, F., & Ribeiro, C. (2022). A Mechanochemical Route to Magnesium/Calcium Citrate Formation for Chrysotile/Asbestos Cement Correct Disposal as Agricultural Input. *Waste and Biomass Valorization*, 1-11.

Borges, R., Klaic, R., Farinas, C. S., & Ribeiro, C. (2022a). Biological treatment of asbestos cement wastes by Aspergillus niger and Acidithiobacillus thiooxidans. *Applied Clay Science*, *216*, 106375.

Bureau de recherches géologiques et minières (BRGM) (2017). *Collection of figures on asbestos waste deposits with regard to the treatment channels available Summary report.* https://www.aleacontroles.com/uploads/tinyBrowser/RP-66047-FR.pdf. Accessed on: 31/05/2023.

Bureau KLB (2018). *Practicable sustainable options for asbestos waste treatment.* https://www.asbeter.com/documents/KLB%20assessment-of-asbestos-waste-treatment-techniques.pdf. Accessed on: 30/05/2023.

Business.gov.nl (n.d.). *Landfill tax (waste disposal tax).* https://business.gov.nl/regulation/landfill-tax/. Accessed on: 11/12/2023.

Campanale, F., Vergani, F., Marian, N. M., Viti, C., Bianchi, A., Ferrario, S., ... & Capitani, G. (2023). Epoxy Resins for Flooring Applications, an Optimal Host for Recycling Deactivated Cement Asbestos. *Polymers*, *15*(6), 1410.

Carneiro, G. O., Santana, H. A., Ribeiro, D. V., Cilla, M. S., & Dias, C. M. (2022). One-part alkali-activated binder produced from inertized asbestos cement waste. *Journal of Cleaner Production*, *367*, 132966.

Carneiro, G. O., Santos, T. A., Simonelli, G., Ribeiro, D. V., Cilla, M. S., & Dias, C. M. (2021). Thermal treatment optimization of asbestos cement waste (ACW) potentializing its use as alternative binder. *Journal of Cleaner Production*, *320*, 128801.

CINDERELA (2021). *End of waste criteria protocol for waste used as aggregates.* https://www.cinderela.eu/The-project/Reports/D5.5-End-of-waste-criteria-protocol-for-waste-used-as-aggregates. Accessed on: 06/10/2023.

Collaboration for Environmental Evidence (2022). *Guidelines and Standards for Evidence Synthesis in Environmental Management.* https://environmentalevidence.org/information-for-authors/. Accessed on: 31/05/2023.

Council of the European Communities (1976). Council Directive of 27 July 1976 on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations, OJ L 262, 27.9.1976, p. 201, available at https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1976L0769:20081211:EN:PDF. Amended by Council Directive 91/338/EEC of 18 June 1991 amending for the 10th time Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations, OJ L 186, 12.7.1991, p. 59–63, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31991L0338. Accessed on: 31/05/2023.

Council of the European Communities (1987). Council Directive 87/217/EEC of 19 March 1987 on the prevention and reduction of environmental pollution by asbestos, OJ L 85, 28.3.1987, p. 40–45, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31987L0217. Accessed on: 31/05/2023.

Council of the European Communities (1989). Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A31989L0391 Accessed on: 31/05/2023.

Council of the European Union (1999). Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste. *Official Journal of the European Union,* 182. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01999L0031-20180704. Accessed on 06/10/2023.

Council of the European Union (2002). 2003/33/EC: Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC. *Official Journal of the European Union,* 011. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32003D0033. Accepted on: 11/12/2023.

Czech statistical office (2022). *Production, use and disposal of waste – 2021.* https://www.czso.cz/csu/czso/produkce-vyuziti-a-odstraneni-odpadu-mgyqmwjyr8. Accessed on: 31/05/2023.

Danish Environmental Protection Agency (n.d.) *Waste statistics.* https://mst.dk/affald-jord/affald/affaldsdatasystemet/find-affaldsdata/affaldsstatistikker/. Accessed on: 31/05/2023.

Data Public (2022). *Aggregate data on waste and resource management.* https://data.public.lu/fr/datasets/donnees-cumulees-concernant-la-gestion-des-dechets-et-des-ressources/. Accessed on: 31/05/2023.

David, S. R., Ihiawakrim, D., Regis, R., & Geoffroy, V. A. (2020a). Efficiency of pyoverdines in iron removal from flocking asbestos waste: An innovative bacterial bioremediation strategy. *Journal of hazardous materials*, *394*, 122532.

David, S. R., Ihiawakrim, D., Regis, R., & Geoffroy, V. A. (2020b). Iron removal from raw asbestos by siderophores-producing Pseudomonas. *Journal of hazardous materials*, *385*, 121563.

David, S. R., Jaouen, A., Ihiawakrim, D., & Geoffroy, V. A. (2021). Biodeterioration of asbestos cement by siderophore-producing Pseudomonas. *Journal of Hazardous Materials*, *403*, 123699.

Deloitte (2015). *Construction and Demolition Waste management in Estonia.* https://ec.europa.eu/environment/pdf/waste/studies/deliverables/CDW_Estonia_Factsheet_Final.pdf. Accessed on: 06/10/2023.

Deloitte (2015). *Construction and Demolition Waste management in Denmark.* https://ec.europa.eu/environment/pdf/waste/studies/deliverables/CDW_Denmark_Factsheet_Final.pdf. Accessed on: 06/10/2023.

Department of Environment (n.d.). *Waste management strategy.* http://www.moa.gov.cy/moa/environment/environmentnew.nsf/page20_gr/page20_gr?OpenDocument. Accessed on: 11/12/2023.

Destatis (n.d.). *Waste management.* https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Umwelt/Abfallwirtschaft/_inhalt.html. Accessed on: 31/05/2023.

DG Employment (2012). DG Employment, Social Affairs and Inclusion, Evaluation of the practical implementation of the EU occupational safety and health (OSH) directives in EU Member States; Directive 2009/148/EC on the Protection of Workers from the Risks related to Exposure to Asbestos at Work, September 2015; and European Commission, Practical guidelines for the information and training of workers involved with asbestos removal or maintenance work, 2012, available at: http://ec.europa.eu/social/BlobServlet?docId=7478&langId=en#page=5. Accessed on: 31/05/2023.

EC Cordis (2015). *Innovative Strategies for High-Grade Material Recovery from Construction and Demolition Waste.* https://cordis.europa.eu/project/id/265212/reporting. Accessed on: 31/05/2023.

EC Life Public Database (n.d.). *Asbestos denaturing with innovative ovensystems.* https://webgate.ec.europa.eu/life/publicWebsite/project/details/3100. Accessed on: 31/05/2023.

EnviroMaster (n.d.). *About EnviroMaster.* https://www.enviromaster.net.au/about/. Accessed on: 31/05/2023.

Environmental Protection Agency (2011). 61.155 Standard for operations that convert asbestos-containing waste material into nonasbestos (asbestos-free) material. https://www.govinfo.gov/content/pkg/CFR-2011-title40-vol8/pdf/CFR-2011-title40-vol8-sec61-155.pdf. Accessed on: 11/12/2023.

Espacenet (2020). *Harmless method of asbestos products using cement kiln and construction material manufacturing method using harmless asbestos products*. https://worldwide.espacenet.com/patent/search/family/071894291/publication/KR102136685B1?q=pn%3DKR102136685B1. Accessed on: 11/12/2023.

European Commission (1999). Commission Directive 1999/77/EC of 26 July 1999 adapting to technical progress for the sixth time Annex I to Council Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations (asbestos) (Text with EEA relevance), OJ L 207, 6.8.1999, p. 18–20, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31999L0077. Accessed on: 31/05/2023

European Commission (2000). Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste (notified under document number C(2000) 1147). *Official Journal of the European Union*, 226. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02000D0532-20231206. Accessed on: 11/12/2023.

European Commission (2006). Council Directive 2006/112/EC of 28 November 2006 on the common system of value added tax. *Official Journal of the European Union*, 347. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32006L0112. Accessed on: 06/10/2023.

European Commission (2016). Commission Regulation (EU) 2016/1005 of 22 June 2016 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards asbestos fibres (chrysotile) (OJ L 165, 23.6.2016, p. 4). Accessed on: 31/05/2023

European Commission (2018). *EU Construction and Demolition Waste Protocol and Guidelines.* https://single-market-economy.ec.europa.eu/news/eu-construction-and-demolition-waste-protocol-2018-09-18_en. Accessed on: 06/10/2023.

European Commission (2020). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives. *Official Journal of the European Union*, 662. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1603122220757&uri=CELEX:52020DC0662. Accessed on: 06/10/2023.

European Commission (2020). Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions: A new Circular Economy Action Plan for a cleaner and more competitive Europe. *Official Journal of the European Union,* 98. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0098. Accessed on: 06/10/2023.

European Commission (2020). *Study to assess member states (MS) practices on by-product (BP) and end-of waste (EoW).* https://op.europa.eu/en/publication-detail/-/publication/beb56eaa-9fc0-11ea-9d2d-01aa75ed71a1/language-en/format-PDF/source-130854906. Accessed on: 06/10/2023.

European Commission (2021). Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the energy performance of buildings (recast). *Official Journal of the European Union*, 802 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52021PC0802. Accessed on: 06/10/2023.

European Commission (2022). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS on working towards an asbestos-free future: a European approach to addressing the health risks of asbestos. *Official Journal of the European Union*, 488. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A488%3AFIN. Accessed on: 31/05/2023.

European Commission (n.d.). *Critical Raw Materials.* https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en. Accessed on: 06/10/2023.

European Commission (n.d.). *European Regional Development Fund (ERDF) – About the Fund.* https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/european-regional-development-fund-erdf_en. Accessed on 06/10/2023.

European Commission (n.d.). *Landfill waste.* https://environment.ec.europa.eu/topics/waste-and-recycling/landfill-waste_en#:~:text=The%20Landfill%20Directive%20aims%20to,soil%2C%20air%20and%20human%20health. Accessed on:11/12/2023.

European Commission (n.d.). *The Megatrends Hub.* https://knowledge4policy.ec.europa.eu/foresight/tool/megatrends-hub_en#:~:text=Megatrends%20are%20defined%20as%20long,identify%20probable%20and%20preferable%20futures. Accessed on: 19/10/2023.

European Economic and Social Committee (2015). *Freeing the EU from Asbestos.* https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/freeing-eu-asbestos. Accessed on: 06/10/2023.

European Economic and Social Committee (2015). *Working with Asbestos in Energy Renovation (Own-initiative opinion).* https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/working-asbestos-energy-renovation-own-initiative-opinion. Accessed on: 06/10/2023.

European Environment Agency (2014). Assessment of global megatrends — an update. Global megatrend 8: Growing pressures on ecosystems. https://www.eea.europa.eu/publications/global-megatrend-update-8. Accessed on: 19/10/2023.

European Parliament (2002). Regulation (EC) No 2150/2002 of the European Parliament and of the Council of 25 November 2002 on waste statistics. *Official Journal of the European Union*, 332. https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32002R2150. Accessed on: 31/05/2023.

European Parliament (2006). Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste. *Official Journal of the European Union*, 190. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32006R1013. Accessed on: 31/05/2023.

European Parliament (2008). DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on waste and repealing certain Directives. *Official Journal of the European Union*, 312. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN. Accessed on: 06/10/2023.

European Parliament (2013). European Parliament resolution of 14 March 2013 on asbestos related occupational health threats and prospects for abolishing all existing asbestos (2012/2065(INI)). *Official Journal of the European Union,* 36. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52013IP0093. Accessed on: 06/10/2023.

European Parliament (2021). Regulation (EU) 2021/1058 of the European Parliament and of the Council of 24 June 2021 on the European Regional Development Fund and on the Cohesion Fund. *Official Journal of the European Union*, 23. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021R1058. Accessed on: 06/10/2023.

European Parliament (2021a): Resolution of 20 October 2021 with recommendations to the Commission on protecting workers from asbestos, 2019/2181(INL), available at: https://www.europarl.europa.eu/doceo/document/TA-9-2021-0427_EN.html. Accessed on: 31/05/2023.European Parliament (2023, September 20). *Strategy for a Sustainable Built Environment. In "A European Green Deal".* https://www.europarl.europa.eu/legislative-train/theme-a-european-green-deal/file-strategy-for-a-sustainable-built-environment. Accessed on: 06/10/2023.

European Parliament and Council of the European Union (2004). Directive 2004/37/EC of the European Parliament and of the Council of 29 April 2004 on the protection of workers from the risks related to exposure to carcinogens or mutagens at work, OJ L 229, 29.6.2004, p. 23–34, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32004L0037R%2801%29. Accessed on: 31/05/2023.

European Parliament and Council of the European Union (2006). Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC (OJ L 396, 30.12.2006, p. 1). Accessed on: 31/05/2023.European Parliament and Council of the European Union (2018). Directive (EU) 2018/850 of the European Parliament and of the Council of 30 May 2018 amending Directive 1999/31/EC on the landfill of waste. *Official Journal of the European Union,* 150. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32018L0850. Accessed on: 11/12/2023.

European Parliament Panel for the Future of Science and Technology (STOA) (2021). *Guidelines for foresight-based policy analysis.* https://www.europarl.europa.eu/stoa/en/document/EPRS_STU(2021)690031. Accessed on: 31/05/2023.

European Union Council (2023). *Lower VAT rate for recyclates / recycled products - a possible economic tool to promote the circular economy - Information from the Czech delegation.* https://data.consilium.europa.eu/doc/document/ST-10397-2023-INIT/en/pdf. Accessed on: 06/10/2023.

Eurostat (2010). *Guidance on classification of waste according to EWC-Stat categories.* https://ec.europa.eu/eurostat/documents/342366/351806/Guidance-on-EWCStat-categories-2010.pdf/0e7cd3fc-c05c-47a7-818f-1c2421e55604. Accessed on: 31/05/2023.

Eurostat (2022). *Waste shipment statistics.* https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_shipment_statistics#:~:text=Between%202001%20and%202020%2C%20the,million%20tonnes%20(%2B22%20%25). Accessed on: 29/05/2023.

Fastmarkets (2023, March). *Europe magnesium supply uncertain despite inclusion in 'ambitious but doable' CRMA: sources.* https://www.fastmarkets.com/insights/europe-magnesium-supply-uncertain-despite-inclusion-in-ambitious-but-doable-crma-sources. Accessed on: 17/10/2023.

Fischer, C., Lehner, M., & Mckinnon, D. L. (2012). *Overview of the use of landfill taxes in Europe.* http://www.embopar.pt/folder/documento/99_Landfill%20taxes%20in%20Europe.pdf. Accessed on: 06/10/2023.

Garousi, V., Felderer, M., & Mäntylä, M. V. (2019). Guidelines for including grey literature and conducting multivocal literature reviews in software engineering. *Information and Software Technology, 106*, 101-121.

General Council for the Environment (2021). *A roadmap for the treatment of asbestos waste.* https://www.economie.gouv.fr/files/files/directions_services/cge/dechets-amiante.pdf?v=1667228240. Accessed on: 31/05/2023.

Generalitat de Catalunya (2022). *Els residus de la construcción gestionats a Catalunya l'any 2022.* https://residus.gencat.cat/web/.content/home/consultes_i_tramits_-_nou/estadistiques/estadistiques_de_runes/informe_runes_2022.pdf. Accessed on: 17/10/2023.

Gobierno de Navarra (2020). *Plan Director del proceso a desarrollar para la eliminación del amianto en Navarra.* https://oprec-navarra.com/wp-content/uploads/2021/02/PD-eliminacion-amianto.pdf. Accessed on: 17/10/2023.

Govern Illes Balears (2023). *Plan Director Sectorial de Prevención y Gestión de Residuos Peligrosos de las Illes Balears.* http://www.caib.es/govern/sac/fitxa.do?codi=4337931&coduo=2390691&lang=es. Accessed on 17/10/2023.

Government Gazette of the Kingdom of the Netherlands (2020), Pre-publication draft of the decision of ... amending the Asbestos Removal Decree 2005, the Landfills and Waste Dumping Bans Decree, the Building Decree 2012 and the Building Works and Living Environment Decree, 2020, 34238.

Government of the Republic of Croatia (2017). *Waste management plan of the Republic of Croatia for the period 2017-2022.* https://mingor.gov.hr/UserDocsImages/UPRAVA-ZA-PROCJENU-UTJECAJA-NA-OKOLIS-ODRZIVO-GOSPODARENJE-OTPADOM/Sektor%20za%20odr%C5%BEivo%20gospodarenje%20otpadom/Ostalo/management_plan_of_the_republic_of_croatia_for_the_period_2017-2022.pdf. Accessed on: 11/12/2023.

Hong, M. H., Choi, H. M., Yoon, J. H., & Kim, S. C. (2021). Detoxification of Asbestos and Recovery of Valuable Metals from Detoxified Asbestos. *Bulletin of the Korean Chemical Society*, *42*(6), 907-914.

Hong, M. H., Joo, S. Y., Kim, D. W., & Yoon, J. H. (2022). Optimized thermochemical detoxification of asbestos-containing waste using chemical additives and microwave heat treatment. *Journal of Material Cycles and Waste Management*, 1-10.

Hong, M. H., Joo, S. Y., Kim, S., Lee, C. G., Kim, D. W., & Yoon, J. H. (2020). Asbestos-containing waste detoxification by a microwave heat treatment using silicon carbide as an inorganic heating element. *Journal of Material Cycles and Waste Management*, *22*, 826-835.

Horizon Europe Open Portal (n.d.). *TRL Assessment.* https://horizoneuropencpportal.eu/store/trl-assessment. Accessed on: 31/05/2023.

Inertam (n.d.). *Our process.* https://www.inertam.com/notre-procede/. Accessed on: 30/05/2023.

Irish Environmental Protection Agency (2021). *National Hazardous Waste Management Plan 2021 – 2027.* https://www.epa.ie/publications/circular-economy/resources/NationalHazardousWasteManagementPlan_2021_2027.pdf. Accessed on: 11/12/2023.

ISPRA (2023). *Special Waste Report - 2023 Edition.* https://www.isprambiente.gov.it/it/pubblicazioni/rapporti/rapporto-rifiuti-speciali-edizione-2023. Accessed on: 06/10/2023.

Iwaszko, J. (2019). Making asbestos-cement products safe using heat treatment. *Case Studies in Construction Materials*, *10*, e00221.

Iwaszko, J., Lubas, M., Sitarz, M., Zajemska, M., & Nowak, A. (2021). Production of vitrified material from hazardous asbestos-cement waste and CRT glass cullet. *Journal of Cleaner Production*, *317*, 128345.

Iwaszko, J., Zawada, A., & Lubas, M. (2018a). Influence of high-energy milling on structure and microstructure of asbestos-cement materials. *Journal of Molecular Structure*, *1155*, 51-57.

Iwaszko, J., Zawada, A., Przerada, I., & Lubas, M. (2018a). Structural and microstructural aspects of asbestos-cement waste vitrification. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, *195*, 95-102.

Joint Research Centre (2018). *Best available techniques (BAT) reference document for waste treatment.* https://op.europa.eu/en/publication-detail/-/publication/782f0042-d66f-11e8-9424-01aa75ed71a1/language-en. Accessed on: 06/10/2023.

Joint Research Centre (n.d.). *End-of-waste.* https://joint-research-centre.ec.europa.eu/scientific-activities-z/less-waste-more-value/end-waste_en. Accessed on: 06/10/2023.

Junta de Andalucía (2021). *Plan Integral de Residuos de Andalucía. Hacia una Economía Circular en el Horizonte 2030.* https://www.juntadeandalucia.es/medioambiente/portal/documents/20151/26992373/2021_10_19_PIRec_completo5.pdf/6c1a646a-c293-79ca-c201-a913386b86ce. Accessed on: 17/10/2023.

Junta de Castilla y León (2014). *Plan Integral de Residuos de Castilla y León (PIRCyL).* https://medioambiente.jcyl.es/web/es/calidad-ambiental/plan-integral-residuos-castilla.html. Accessed on: 17/10/2023.

Keilany, M. A., Milhé, M., Bézian, J. J., Falcoz, Q., & Flamant, G. (2020). Experimental evaluation of vitrified waste as solid fillers used in thermocline thermal energy storage with parametric analysis. *Journal of Energy Storage*, *29*, 101285.

Latvian Environment, Geology and Meteorology Centre (n.d.). Public access to the national statistical reports "2-Air", "2-Water" and "3-Waste". https://videscentrs.lvgmc.lv/lapas/parskatu-ievadisana. Accessed on: 11/12/2023.

Lázár, M., Hnatko, M., Sedláček, J., Čarnogurská, M., & Brestovič, T. (2018). Upgrading the glassy slag from waste disposal by thermal plasma treatment. *Waste Management*, *78*, 173-182.

Legal Information Institute (n.d.). 40 CFR Subpart M - National Emission Standard for Asbestos. https://www.law.cornell.edu/cfr/text/40/part-61/subpart-M. Accessed on: 11/12/2023.

Legifrance (2020). LAW no. 2020-105 of February 10, 2020 relating to the fight against waste and the circular economy (1). https://www.legifrance.gouv.fr/jorf/article_jo/JORFARTI000041553879#:~:text=1%C2%B0%20L'identification%20des,solutions%20alternatives%20%C3%A0%20l'enfouissement. Accessed on: 11/12/2023.

Leitlinie für die Asbesterkundung zur Vorbereitung von Arbeiten in und an älteren Gebäuden. 1. Auflage. Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA), Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) und Umweltbundesamt (UBA) 2020. 29 Seiten, Guideline for asbestos surveys in preparation for work in and on older buildings. 1st edition. Federal Institute for Occupational Safety and Health (BAuA), Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) and Federal Environment Agency (UBA) 2020. 29 pp.. In German. https://www.baua.de/DE/Angebote/Publikationen/Kooperation/Asbesterkundung.pdf?__blob=publicationFile&v=2. Accessed on: 11/12/2023.

Li, S. (2019). Synthesis of layered double hydroxide from asbestos-containing waste and its adsorption property. *Journal of Material Cycles and Waste Management*, *21*(5), 1242-1249.

Ligabue, M. L., Gualtieri, A. F., Gualtieri, M. L., Malferrari, D., & Lusvardi, G. (2020). Recycling of thermally treated cement-asbestos for the production of porcelain stoneware slabs. *Journal of Cleaner Production*, *247*, 119084.

Ligabue, M. L., Saburit, A., Lusvardi, G., Malferrari, D., Garcia-Ten, J., & Monfort, E. (2022). Innovative use of thermally treated cement-asbestos in the production of foaming materials: Effect of composition, foaming agent, temperature and reaction time. *Construction and Building Materials*, *335*, 127517.

Likumi (2011). *Regulations of landfills*. https://likumi.lv/ta/id/242189-atkritumu-poligonu-noteikumi. Accessed on: 11/12/2023.

Lithuanian Environmental Protection Agency (2023). *Summary by waste codes.* https://aaa.lrv.lt/lt/veiklos-sritys/atliekos/atlieku-apskaita/atlieku-apskaitos-duomenys/suvestine-pagal-atlieku-kodus. Accessed on: 31/05/2023.

Luciano, A., Cutaia, L., Altamura, P., & Penalvo, E. (2022). Critical issues hindering a widespread construction and demolition waste (CDW) recycling practice in EU countries and actions to undertake: The stakeholder's perspective. *Sustainable Chemistry and Pharmacy*, *29*, 100745.

Maduta, C., Kakoulaki, G., Zangheri, P. and Bavetta, M., (2022). *Towards energy efficient and asbestos-free dwellings through deep energy renovation.* European Commission Joint Research Centre. https://publications.jrc.ec.europa.eu/repository/handle/JRC129218. Accessed on: 11/12/2023.

Malferrari, D., Bernini, F., Di Giuseppe, D., Scognamiglio, V., & Gualtieri, A. F. (2022). Al-substituted tobermorites: An effective cation exchanger synthesized from "end-of-waste" materials. *ACS omega*, *7*(2), 1694-1702.

Marian, N. M., Giorgetti, G., Magrini, C., Capitani, G. C., Galimberti, L., Cavallo, A., ... & Viti, C. (2021). From hazardous asbestos containing wastes (ACW) to new secondary raw material through a new sustainable inertization process: A multimethodological mineralogical study. *Journal of Hazardous Materials*, *413*, 125419.

Mercante, I., Ojeda, J. P., & Alejandrino, C. (2021). Life Cycle Assessment of Asbestos Waste Management Scenarios: Case Study in Argentina. *Journal of Hazardous, Toxic, and Radioactive Waste*, *25*(4), 05021007.

Milios, L. (2021). Towards a circular economy taxation framework: Expectations and challenges of implementation. *Circular Economy and Sustainability*, 1-22.

Ministry of Agriculture, Rural Development and Environment (2016). *Waste management plan (for other streams) 2016-2023.* http://www.moa.gov.cy/moa/environment/environmentnew.nsf/page20_gr/page20_gr?OpenDocument. Accessed on: 31/05/2023.

Ministry of Economic Development and Technology (2017-2022). *Baza Asbestowa.* https://www.bazaazbestowa.gov.pl/en/. Accessed on: 31/05/2023.

Ministry of Economy (2010). *Programme for Asbestos Abatement in Poland 2009-2032.* https://www.bazaazbestowa.gov.pl/images/do-pobrania/PROGRAM_ENG.pdf. Accessed on: 31/05/2023.

Ministry of Economy and Sustainable Development (2022). *Provisional data on construction waste management in 2021.* https://www.haop.hr/sites/default/files/uploads/dokumenti/021_otpad/Izvjesca/ostalo/Privremeno%202021_05%20final_0.pdf. Accessed on: 11/12/2023.

Ministry of Economy and Sustainable Development (2023). *Waste management. Reports.* https://www.haop.hr/hr/tematska-podrucja/otpad-registri-oneciscavanja-i-ostali-sektorski-pritisci/gospodarenje-otpadom-0. Accessed on: 31/05/2023.

Ministry of Environment and Nature Protection of Croatia (2016). *Rules on Construction Waste and Waste Containing Asbestos.* https://faolex.fao.org/docs/pdf/cro166787.pdf. Accessed on: 31/05/2023

Ministry of Infrastructure and Water Management of the Netherlands (2022). *Waste processing in the Netherlands, data 2020.*

Ministry of Infrastructure and Water Management of the Netherlands (n.d.). *Sector plan 37: Asbestos and asbestos-containing waste.* https://lap3.nl/sectorplannen/sectorplannen/asbest/. Accessed on: 31/05/2023.

Ministry of Innovation (2018). *National Waste Management Plan 2021-2027.* https://cdn.kormany.hu/uploads/document/9/92/921/921c2f798773d4336ee3f45884a662d3018bb3d7.pdf. Accessed on: 31/05/2023.

Ministry of the Environment (2022). *Report on the fulfilment of the objectives of the Waste Management Plan of the Czech Republic for the period 2019-2020.* https://www.mzp.cz/C1257458002F0DC7/cz/plneni_narizeni_vlady/$FILE/OODP-Hodnotici_zprava_POH_CR_2019_2020-20220807.pdf. Accessed on: 11/12/2023.

Ministry of the Environment (2022). *Waste Management Plan of the Czech Republic for the period 2015-2024.* https://www.mzp.cz/C1257458002F0DC7/cz/plan_odpadoveho_hospodarstvi_aj/$FILE/OODP-WMP_CZ_translation-20151008.pdf. Accessed on: 11/12/2023.

Monich, P. R., Romero, A. R., Rambaldi, E., & Bernardo, E. (2020). Case studies of up-cycling of partially crystallized ceramic waste in highly porous glass-ceramics. *Construction and Building Materials*, *261*, 119971.

Nabango, H., & Majale, C. (2022). Towards a Circular Economy: A Review on Asbestos Waste Management Regulations in Kenya. *East African Journal of Environment and Natural Resources, 5*(1), 34-47.

National Asbestos Profile for Germany, 1st edition. Dortmund: Federal Institute for Occupational Safety and Health 2014. ISBN: 978-3-88261-032-1, pages 70, paper, PDF file, article number: 3088. English Version. https://www.baua.de/DE/Angebote/Publikationen/Berichte/Gd80.pdf?__blob=publicationFile&v=2. Accessed on: 11/12/2023.

Nationales Asbest Profil Deutschland, 2. Auflage. Dortmund: Bundesanstalt für Arbeitsschutz und Arbeitsmedizin 2020. Seiten 78, PDF-Datei, DOI: 10.21934/baua:bericht20200427
National Asbestos Profile Germany, 2nd edition. Dortmund: Federal Institute for Occupational Safety and Health 2020. pages 78, PDF file, DOI: 10.21934/baua:bericht20200427. In German. https://www.baua.de/DE/Angebote/Publikationen/Berichte/Gd80-3.pdf?__blob=publicationFile&v=3. Accessed on: 11/12/2023.

Nationales Asbest-Profil Deutschland, 1. Auflage. Dortmund: Bundesanstalt für Arbeitsschutz und Arbeitsmedizin 2015, ISBN: 978-3-88261-150-2, Seiten 71, Papier, PDF-Datei, National Asbestos Profile Germany, 1st edition. Dortmund: Federal Institute for Occupational Safety and Health 2015, ISBN: 978-3-88261-150-2, pages 71, paper, PDF file. In German. https://www.baua.de/DE/Angebote/Publikationen/Berichte/Gd80-2.pdf?__blob=publicationFile&v=3. Accessed on: 11/12/2023.

Necasova, K., & Buchta, P. (2019, July). Chemical elimination of asbestos materials. In *IOP Conference Series: Materials Science and Engineering* (Vol. 583, No. 1, p. 012031). IOP Publishing.

Necasova, K., Buchta, P., Chromkova, I., Stanek, T., & Simbera, T. (2021, November). Decomposition of asbestos materials using fluoride wastes. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1205, No. 1, p. 012018). IOP Publishing.

Nzogo Metoule, C. T., Delaby, S., Ferrasse, J. H., & Boutin, O. (2019). Hydrothermal process development for the treatment of crocidolite asbestos waste. *Waste Management & Research*, *37*(9), 914-924.

Obmiński, A. (2021). Asbestos waste recycling using the microwave technique–Benefits and risks. *Environmental Nanotechnology, Monitoring & Management*, *16*, 100577.

Ongaro, E. (2009). A protocol for the extrapolation of 'best' practices: How to draw lessons from one experience to improve public management in another situation. In European Public Sector Award 2009, Final Symposium and Ceremony, Maastricht. http://epsa2009.eu/files/Symposium/An%20approach%20to%20the%20extrapolation%20of%20practices_EOngaro.pdf. Accessed on: 11/12/2023.

OVAM (2016). *State of the art: asbestos – possible treatment methods in Flanders: constraints and opportunities.* https://www.dnature.nl/wp-content/uploads/2020/07/State-of-the-art-asbestos-waste-treatement.pdf. Accessed on: 30/05/2023.

OVAM (n.d.). *Rates and capacities for dumping and incineration.* https://ovam.vlaanderen.be/tarieven-en-capaciteiten-voor-storten-en-verbranden?p_l_back_url=%2Fzoeken%3Fq%3Dtarieven%2Ben%2Bcapac. Accessed on: 11/12/2023.

Paolini, V., Tomassetti, L., Segreto, M., Borin, D., Liotta, F., Torre, M., & Petracchini, F. (2019). Asbestos treatment technologies. *Journal of Material Cycles and Waste Management*, *21*(2), 205-226.

Pawlikowski, M., Kamusiński, W., Pietrasz, A., & Wdowczyk, L. (2018). Mineralogical Engineering of Environment: Mineralogical Technology of Total Destruction of Asbestos. *J Waste Recycl, 3*(1), 4.

POCA (2017). *The National Plan of Waste Management.* http://mmediu.ro/app/webroot/uploads/files/PNGD_vers5.pdf. Accessed on: 31/05/2023.

Poniatowska, A., Andrzejewska-Górecka, D., Macherzyński, B., & Kisiel, M. (2019). Thermal Decomposition of Asbestos Fiber from Asbestos Cement Wastes. *Rocznik Ochrona Środowiska*, 21.

Portuguese Environment Agency (n.d.). *Construction and Demolition Waste with Asbestos*. https://apambiente.pt/residuos/residuos-de-construcao-e-demolicao-com-amianto. Accessed on: 31/05/2023.

RECORD (2016*). Gestion de la fin de vie des matériaux à base d'amiante et autres matériaux fibreux. Revue internationale des différents procédés de traitement.* https://record-net.org/storage/etudes/14-0333-1A/rapport/Rapport_record14-0333_1A.pdf. Accessed on: 26/06/2023.

Register of legal acts (1999). *Regarding the approval of the Waste Management Rules.* https://www.e-tar.lt/portal/lt/legalAct/TAR.38E37AB6E8E6/MuHiZUJPZZ. Accessed on: 11/12/2023.

Riigi Teataja (2004). Asbesti sisaldavate jäätmete käitlusnõuded. https://www.riigiteataja.ee/akt/119122015002. Accessed on 13/12/2023.

Ruiz, A. I., Ortega, A., Fernández, R., Miranda, J. F., Samaniego, E. L., & Cuevas, J. (2018). Thermal treatment of asbestos containing materials (ACM) by mixing with Na2CO3 and special clays for partial vitrification of waste. *Materials Letters*, *232*, 29-32.

Santana, H. A., Júnior, N. S. A., Carneiro, G. O., Ribeiro, D. V., Cilla, M. S., & Dias, C. M. (2023). Asbestos-cement wastes as supplementary precursors of NaOH-activated binders. *Construction and Building Materials*, *364*, 129921.

Schindler, S. (2016). *Asbestos – Not a problem of the past. European Trade Union Institute.* https://www.etui.org/topics/health-safety-working-conditions/hesamag/construction-workers-at-the-mercy-of-social-dumping/asbestos-not-a-problem-of-the-past. Accessed on: 06/10/2023.

Sikarwar, V. S., Hrabovský, M., Van Oost, G., Pohořelý, M., & Jeremiáš, M. (2020). Progress in waste utilization via thermal plasma. *Progress in Energy and Combustion Science*, *81*, 100873.

Slovenian Environment Agency (n.d.). *Waste-reports and publications.* https://www.arso.gov.si/varstvo%20okolja/odpadki/poro%c4%8dila%20in%20publikacije/. Accessed on: 11/12/2023.

Spasiano, D. (2018). Dark fermentation process as pretreatment for a sustainable denaturation of asbestos containing wastes. *Journal of Hazardous Materials*, *349*, 45-50.

Spasiano, D., & Pirozzi, F. J. J. O. E. M. (2017). Treatments of asbestos containing wastes. *Journal of environmental management*, *204*, 82-91.

Spasiano, D., Luongo, V., Race, M., Petrella, A., Fiore, S., Apollonio, C., ... & Piccinni, A. F. (2019). Sustainable bio-hydrothermal sequencing treatment for asbestos-cement wastes. *Journal of hazardous materials*, *364*, 256-263.

Stand der Behandlung und Entsorgung asbesthaltiger Reststoffe 1994 , I. Jovanovic , Projekt Schadstoff- und Abfallarme Verfahren, Kernforschungszentrum Karlsruhe, Status of the Treatment and Disposal of Residual Materials Containing Asbestos 1994 , I. Jovanovic , Project Low-Pollutant and Low-Waste Processes, Nuclear Research Centre Karlsruhe. In German (summary in English). https://publikationen.bibliothek.kit.edu/270036038/4146901. Accessed on: 11/12/2023.

Staněk, T., Boháč, M., Zezulová, A., & Rybová, A. (2018). Hydraulic Binder from Hazardous Waste. *Solid State Phenomena*, *276*, 3-8.

Staroń, A., Kijania-Kontak, M., Kozak, A., & Banach, M. (2020). Obtaining of oil blocks as a way to manage hazardous asbestos. *Waste Management*, *105*, 180-189.

Tableau Public (2022). *Types of waste 2020-2021 by Environment Agency.* https://public.tableau.com/app/profile/keskkonnaagentuur/viz/Jtmeliigid2020-2021/Riigitasand. Accessed on: 31/05/2023.

Talbi, G., Cambon, M., & Cambon, O. (2019). Virtuous cycle of destruction and total recycling of pure asbestos and asbestos-containing waste. *Journal of Material Cycles and Waste Management*, *21*, 1167-1176.

Thermal Recycling (n.d.). *Worlds first commercially viable asbestos recycling plant established in the UK.* https://www.thermalrecycling.co.uk/storage/media/content/files/ARCA%20NEWS%20Recycling%20article.pdf. Accessed on: 31/05/2023.

Tomassetti, L., Di Giuseppe, D., Zoboli, A., Paolini, V., Torre, M., Paris, E., ... & Gualtieri, A. F. (2020). Emission of fibres and atmospheric pollutants from the thermal treatment of asbestos containing waste (ACW). *Journal of Cleaner Production*, *268*, 122179.

Trancone, G., Spasiano, D., Race, M., Luongo, V., Petrella, A., Pirozzi, F., ... & Piccinni, A. F. (2022). A combined system for asbestos-cement waste degradation by dark fermentation and resulting supernatant valorization in anaerobic digestion. *Chemosphere*, *300*, 134500.

TRGS 517 Tätigkeiten mit potenziell asbesthaltigen mineralischen Rohstoffen und daraus hergestellten Gemischen und Erzeugnissen, Technische Regel für Gefahrstoffe, Ausgabe Februar 2013, GMBl 2013 S. 382-396 vom 09.04.2013 [Nr. 18], zuletzt geändert und ergänzt: GMBl 2015 S. 137-138 [Nr. 7] (vom 02.03.2015), TRGS 517 Activities involving mineral raw materials potentially containing asbestos and mixtures and products manufactured therefrom, Technical Rules for Hazardous Substances, February 2013 edition, GMBl 2013 pp. 382-396 of 09.04.2013 [No. 18], last amended and supplemented: GMBl 2015 pp. 137-138 [No. 7] (of 02.03.2015). In German. https://www.baua.de/DE/Angebote/Rechtstexte-und-Technische-Regeln/Regelwerk/TRGS/pdf/TRGS-517.pdf?__blob=publicationFile&v=1. Accessed on: 11/12/2023.

TRGS 519 Asbestos: Demolition, renovation or maintenance work, Technical Rule for Hazardous Substances, January 2014 edition, GMBl 2014 p. 164-201 of 20.03.2014 [No. 8/9], last amended and supplemented: GMBl 2022 pp. 269-272 of 31.03.2022 [No.12]. In German. https://www.baua.de/DE/Angebote/Rechtstexte-und-Technische-Regeln/Regelwerk/TRGS/pdf/TRGS-519.pdf?__blob=publicationFile&v=3. Accessed on: 11/12/2023.

TRGS 910 Risikobezogenes Maßnahmenkonzept für Tätigkeiten mit krebserzeugenden Gefahrstoffen, Technische Regel für Gefahrstoffe, Ausgabe Februar 2014, GMBl 2014 S. 258-270 vom 02.04.2014 [Nr. 12], zuletzt geändert und ergänzt: GMBl 2023, S. 627 [Nr. 30] (vom 20.04.2023), berichtigt: GMBl 2023, S. 679 [Nr. 32] (vom 05.05.2023), TRGS 910 Risk-related action concept for activities with carcinogenic hazardous substances, Technical Rule for Hazardous Substances, February 2014 edition, GMBl 2014 pp. 258-270 of 02.04.2014 [No. 12], last amended and supplemented: GMBl 2023, p. 627 [No. 30] (of 20.04.2023), corrected: GMBl 2023, p. 679 [No. 32] (of 5.05.2023). In German. https://www.baua.de/DE/Angebote/Rechtstexte-und-Technische-Regeln/Regelwerk/TRGS/pdf/TRGS-910.pdf?__blob=publicationFile&v=6. Accessed on: 11/12/2023.

VALAME (n.d.). *Valame's unique disposal solution*. https://www.valame.com/process/. Accessed on: 31/05/2023.

Vangelova, K., Dimitrova, S., & Dimitrova, I. (2015). *National asbestos profile of Bulgaria.* https://ncpha.government.bg/uploads/pages/3001/National%20Asbestos%20Profile_Bulgaria_2015-en.pdf. Accessed on: 31/05/2023.

VDI 3876:2018-11, Messen von Asbest in Bau- und Abbruchabfällen sowie daraus gewonnenen Recyclingmaterialien, Probenaufbereitung und Analyse Measurement of asbestos in construction and demolition waste and recycling materials produced thereof, Sample preparation and analysis

VDI 6202 Blatt 3 / Part 3:2021-09 Schadstoffbelastete bauliche und technische Anlagen, Asbest – Erkundung und Bewertung, Contaminated buildings and technical installations, Asbestos – Exploration and assessment.

Vergani, F., Galimberti, L., Marian, N. M., Giorgetti, G., Viti, C., & Capitani, G. C. (2022). Thermal decomposition of cement–asbestos at 1100° C: how much "safe" is "safe"?. *Journal of Material Cycles and Waste Management*, 1-14.

Verordnung zum Schutz vor Gefahrstoffen (Gefahrstoffverordnung – GefStoffV) vom 26. November 2010 (BGBl. I S 1643), geändert durch Artikel 2 des Gesetzes vom 28. Juli 2011 (BGBl. I S 1622), durch Artikel 2 der Verordnung vom 24. April 2013 (BGBl. I S 944), durch Artikel 2 der Verordnung vom 15. Juli 2013 (BGBl. I S 2514), durch Artikel 2 der Verordnung vom 03. Februar 2015 (BGBl. I S 49), durch Artikel 1 der Verordnung vom 15. November 2016 (BGBl. I S 2549), durch Artikel 148 des Gesetzes vom 29. März 2017 (BGBl. I S 626) und durch Artikel 2 der Verordnung vom 21. Juli 2021 (BGBl. I S 3115) TRGS 519 Asbest: Abbruch- Sanierungs- oder Instandhaltungsarbeiten, Technische Regel für Gefahrstoffe, Ausgabe Januar 2014, GMBl 2014 S. 164-201 vom 20.03.2014 [Nr. 8/9], zuletzt geändert und ergänzt: GMBl 2022 S. 269-272 vom 31.03.2022 [Nr.12], Ordinance on Protection against Hazardous Substances (Ordinance on Hazardous Substances - GefStoffV) of 26 November 2010 (BGBl. I p 1643), amended by Article 2 of the Act of 28 July 2011 (BGBl. I p 1622), by Article 2 of the Ordinance of 24 April 2013 (BGBl. I p 944), by Article 2 of the Ordinance of 15 July 2013 (BGBl. I S 2514), by Article 2 of the Ordinance of 03 February 2015 (BGBl. I p 49), by Article 1 of the Ordinance of 15 November 2016 (BGBl. I S 2549), by Article 148 of the Act of 29 March 2017 (Federal Law Gazette I p 626) and by Article 2 of the Ordinance of 21 July 2021 (BGBl. I S 3115). In German. Available at: https://www.baua.de/DE/Themen/Arbeitsgestaltung-im-Betrieb/Gefahrstoffe/Arbeiten-mit-Gefahrstoffen/pdf/Gefahrstoffverordnung.pdf?__blob=publicationFile&v=1

Vollzugshilfe zur Entsorgung asbesthaltiger Abfälle, Mitteilung der Bund/Länder-Arbeitsgemeinschaft Abfall (LAGA) 23, Stand November 2022, Implementation Guide for the Disposal of Waste Containing Asbestos, Communication of the Federal/State Working Group on Waste (LAGA) 23, as of November 2022. In German. Available at: https://www.laga-online.de/documents/laga-m23-vollzugshilfe-zur-entsorgung-asbesthaltiger-abfaelle-2022-11-29_1683724418.pdf

M. Wahlström, M. zu Castell-Rüdenhausen, P. Hradil, K.H. Smith, A. Oberender, M. Ahlm, J. Götbring, J.B. Hansen, Improving quality of construction & demolition waste- Requirements for pre-demolition audit, 2019. http://norden.diva-portal.org/smash/get/diva2:1294662/FULLTEXT01.pdf. Accessed on: 31/05/2023.

Wallonia Geoportal (2023). *Walloon Waste-Resources Plan - Industrial waste management sites.* https://geoportail.wallonie.be/catalogue/4e62a4b4-c8dc-421d-8ef0-e35d16d0e1db.html. Accessed on: 11/12/2023.

Waste Circular (n.d.). Landfill Decree and Waste Dumping Bans. https://www.afvalcirculair.nl/onderwerpen/afvalregelgeving/afval-storten/bssa/. Accessed on: 11/12/2023.

Waste Circular (n.d.). Publications Waste Circular. https://www.afvalcirculair.nl/onderwerpen/linkportaal/publicaties/. Accessed on: 31/05/2023.

Witek, J., Psiuk, B., Naziemiec, Z., & Kusiorowski, R. (2019). Obtaining an artificial aggregate from cement-asbestos waste by the melting technique in an arc-resistance furnace. *Fibers*, *7*(2), 10.

Zoraja, B., Živančev, M., Ubavin, D., & Nakomčić-Smaragdakis, B. (2021). Circular economy as possible solution for asbestos burden. In IOP Conference Series: Materials Science and Engineering (Vol. 1163, No. 1, p. 012033). IOP Publishing.

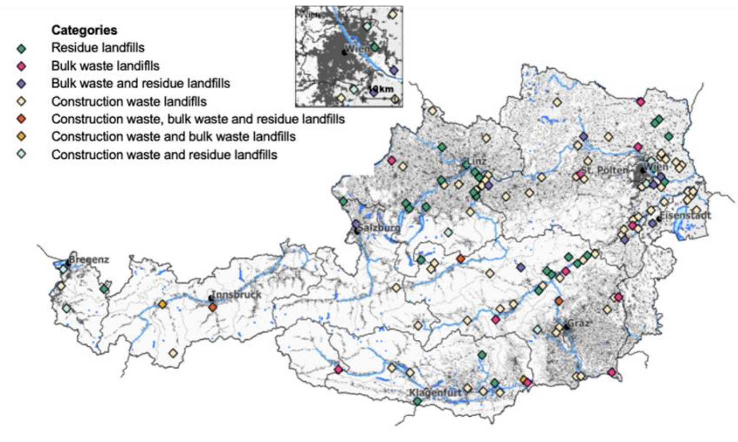
Annex 1 Member State country factsheets

COUNTRY PROFILE Austria

SOURCES OF ASBESTOS-CONTAINING WASTE

31412 – Asbestos cement
31437 - Asbestos waste, asbestos dust (starting in 2021, this includes the (new) specification 40 (Mineral fiber waste with hazardous fiber properties) in accordance with Waste Catalogue Ordinance 2020)

TREATMENT/DISPOSAL FACILITIES



Source: Umweltbundesamt, 2023

Both SN 31412 and SN 31437 are deposited in structurally separate compartment sections of construction waste landfills, residues landfills and bulk waste landfills.

FUTURE PROJECTIONS (2024-2050)

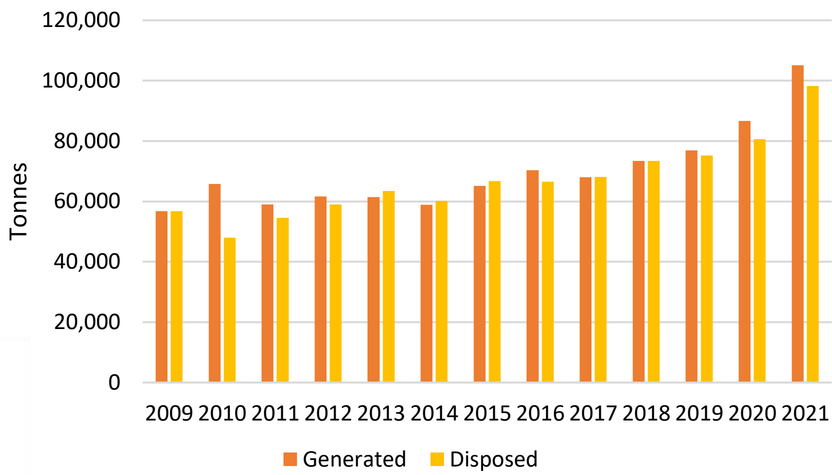
Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Austria	21 833 273	12 638 606	5 742 606

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	302 359	11 198
3x	604 718	22 397
4x	907 078	33 595

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Umweltbundesamt, 2023

ÖNORM S 2100 Code	Quantities (tonnes) 2009-2021	
	Generation	Disposal operations (landfill)
31412	839 900	806 380
31437	69 240	64 510
Total	**909 140**	**870 890**

Source: Umweltbundesamt, 2023

IMPORTS AND EXPORTS (2001-2020)

	Quantities (tonnes)	Countries
Imported	57 928	Italy, Slovenia
Exported	2 589	Germany, Italy

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste generated in 2009-2021

909 140 t

NATIONAL STRATEGY

- No targets for screening of public or private buildings identified
- No target dates for asbestos removal identified
- A guidance document on Asbestos Materials Waste Management was published by the Federal Environment Agency in 2008
- Waste containing asbestos may not be reused or recycled (recycling ban).

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- The Waste Treatment Regulation (2017) (Abfallbehandlungspflichtenverordnung)
- Austrian Landfill Ordinance (2008) (Deponieverordnung)
- Waste List Ordinance (2020) (Abfallverzeichnisverordnung)
- Waste Management Act (2002) (Abfallwirtschaftsgesetzes)

Guidance:

- Guidance on Asbestos Materials Waste Management (2008) published by Federal Environment Agency (Umweltbundesamt)

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: According to Austrian legislation, screening is mandatory for both visible and non-visible asbestos. All types of ACW are considered hazardous under the Waste Management Act.
- Guidance: It is mandatory to analyse building documentation, inspect the building and carry out material tests based on samples (the samples should be packed as airtight as possible and labeled). This is recorded in an asbestos inventory. A remediation concept or a work plan for demolition work must be drawn up and relevant authorities must be notified (i.e. the labor inspectorate as well as the provincial governor if the collection or treatment of hazardous waste is involved). The Annex of the Guidance on Asbestos Materials Waste Management (2008) presents photos of asbestos products and tables with detailed guidelines on the proper demolition of asbestos-containing materials and the proper collection and treatment of asbestos-containing waste. The Guidance stipulates that efforts shall be made to dispose of asbestos containing waste as early as possible.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Asbestos has to be removed before breaking down a building in order to get asbestos free demolition waste which can be recycled. The Waste Treatment Regulation (Abfallbehandlungspflichtenverordnung) provides minimum requirements for the storage, collection and treatment of special kinds of waste, such as electronic waste, accumulators, PCB and asbestos.
- Guidance: Asbestos cement and waste containing asbestos have to be removed, double bagged (in PE film or bags) and properly labelled. Removed waste then must be separated from each other on the site and given proper treatment. Absorbent asbestos waste (asbestos dust, sprayed asbestos) is treated with cement and water and if necessary with the addition of mixed oil, but without any additives. Non-absorbent asbestos-containing materials are sprayed with residual fiber binders. If a remediation zone has been established, conditioning takes place in the remediation zone before the asbestos waste is discharged. All work areas and work equipment shall be cleaned and maintained regularly, using vacuuming methods whenever possible.

TREATMENT & DISPOSAL

- Legislation: Since January 1, 2007, all asbestos waste is hazardous waste. According to the new Austrian Landfill Ordinance (2008), no type of asbestos containing waste may be reclassified as non-hazardous. However, all types of asbestos waste may still be put in landfills for non-hazardous waste, under certain conditions.
- Guidance: Waste containing asbestos must be removed from the economic cycle as early as possible discharged and must not be recycled. In Austria, asbestos is disposed of exclusively in landfills. Asbestos cement can be taken over, transported and disposed of by collectors and treaters of non-hazardous waste may continue to accept, transport and treat asbestos cement. Since the Landfill Ordinance came into force in 2008, asbestos waste must be deposited in separate, structurally segregated sections of landfills for non-hazardous waste. All other asbestos waste may, however, only be transported and treated by collectors and treaters who have a permit.

COUNTRY PROFILE Belgium

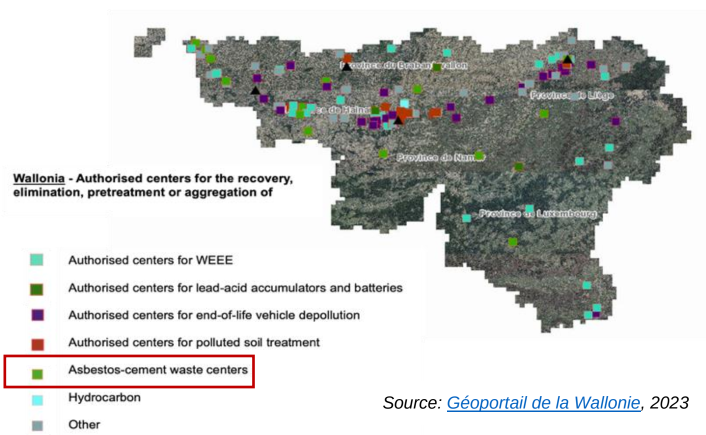
SOURCES OF ASBESTOS-CONTAINING WASTE

Asbestos cement waste
Other asbestos-containing waste

TREATMENT/DISPOSAL FACILITIES

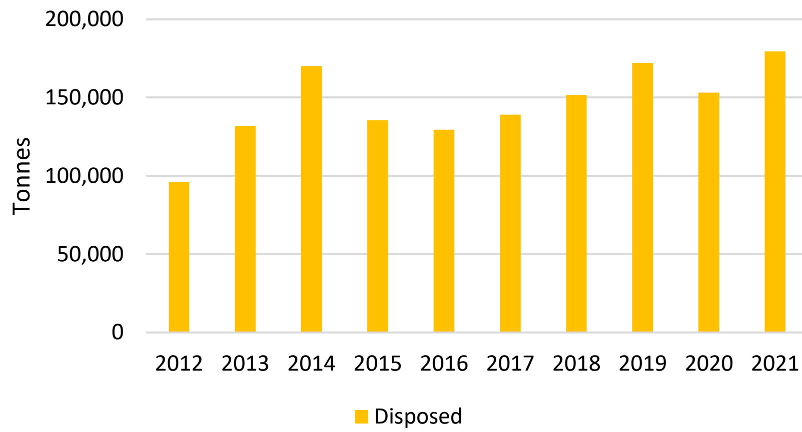
Flanders: Hazardous and non-hazardous waste landfills accepting asbestos waste

Source: own image from OVAM data, 2021



Source: Géoportail de la Wallonie, 2023

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Data was obtained by summing up data from Flanders, Wallonia and Brussels.
Source: OVAM data, 2021 and competent regional authorities

Type	Quantities (tonnes) 2012-2021	
	Generation	**Disposal operations (ladfilling)**
Asbestos cement waste	N/A	1 298 500
Other asbestos-containing waste	N/A	160 231
Total	**N/A**	**1 458 731**

Source: OVAM data, 2021 and competent regional authorities

	Quantities (tonnes)	Countries
Imported	11 370	Congo, France, Luxembourg, Netherlands
Exported	132 542	Czechia, France, Germany, Netherlands

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste disposed of in 2012-2021

1 458 731 t

FUTURE PROJECTIONS (2024-2050)

Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Belgium and Luxembourg	59 898 998	35 024 331	16 368 331

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	541 829	20 068
3x	1 083 659	40 136
4x	1 625 488	60 203

NATIONAL STRATEGY

- Asbestos strategy and waste management policy is the responsibility of the three regions (Flanders, Wallonia, Brussels). Environmental emissions and private citizens' exposure is a regional competence. Occupational exposure is a national competence.
- Inventory and removal targets differ by region. Flanders has two two deadlines: 2034 for removal of high risk asbestos and 2040 for removal of other asbestos that poses risk.
- Guidance documents or other guidance available
- Examples of economic stimuli include a requirement to remove asbestos from roofs before installing solar panels in Flanders.

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Wallonia: AGW du 27 fevrier 2003 fixant les conditions sectorielles d'exploitation des centres d'enfouissement technique (sectoral conditions for landfills, more general and not limited to asbestos obligations)
- Flanders: Flemish regulations regarding the sustainable management of material cycles and waste (VLAREMA)

Guidance:

- Wallonia: Environmental guide for construction companies 2014 (Walloon Region)'
- Flanders: Not a single guidance document but guidance is available

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Construction sites with asbestos must be declared in all three regions. However, strategies for the removal and the screening vary among the three regions. In Flanders, screening mandatory: owners-obligation: mandatory asbestos survey when selling and by 2032 including central data collection by OVAM. Local authorities in Flanders are supported by means of a being able to draw framework contract for asbestos screening services that is cheaper when compared with individual orders.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Asbestos containing materials have to be identified prior to demolition or construction work involving professionals to prevent occupational exposure (national requirements) Rules differ for private individuals. For example, in Flanders there are clear rules on when private individuals can remove asbestos themselves.

TREATMENT & DISPOSAL

- Legislation: The key legislation in Flanders (VLAREMA) sets out the obligation for landfills accepting ACW and also the more general obligations. In Wallonia, AGW od 27 February 2023 sets out sectoral conditions for landfills, more general and not limited to asbestos obligations.
- Common practice: ACW is landfilled. In Flanders, for ACW that is properly collected the tax for landfilling is set to 0. Wallonia is also considering potential incentives to promote selective collection of asbestos.

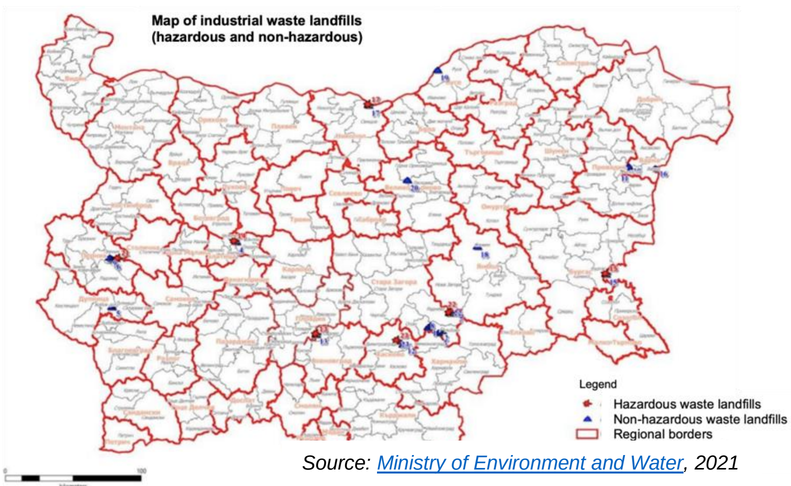
Additional sources (other than the legislation and guidance documents listed at the top of this page): Responses to DG Grow survey (2022), responses to RPA survey (2023)

COUNTRY PROFILE Bulgaria

SOURCES OF ASBESTOS-CONTAINING WASTE

15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES



Source: Ministry of Environment and Water, 2021

Information about which of these landfills accept asbestos-containing waste could not be found.

FUTURE PROJECTIONS (2024-2050)

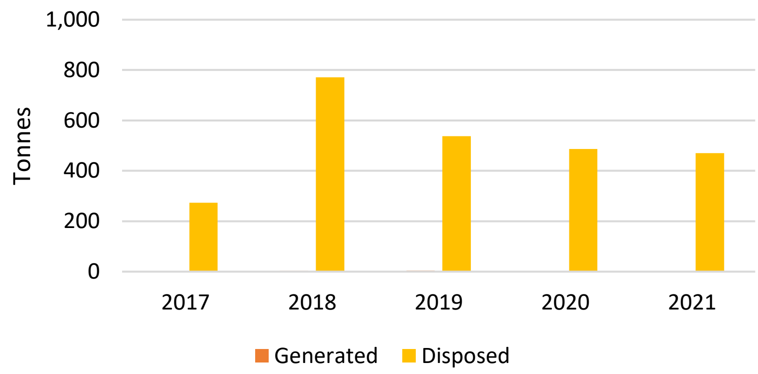
Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Bulgaria	N/A	N/A	N/A

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	N/A	N/A
3x	N/A	N/A
4x	N/A	N/A

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Executive Environment Agency, 2023

For generated waste, the quantities shown **do not include codes from the 17th group** "Construction and demolition waste (including soil excavated from contaminated sites)" because no monthly reporting is kept for these codes, and no annual reports are provided. According to Art. 44, para. 3 of the Waste Management Act, waste documentation is kept only for a period of 5 years.

A different set of data was found in the "National Asbestos Profile of Bulgaria", showing the total amount of asbestos-containing waste disposed of at 9 039 630 tonnes. The timeframe was not specified by the source.

LoW Code	Quantities (tonnes) 2017-2021	
	Generation	Disposal operations
15 01 11	N/A	N/A
16 01 11	N/A	N/A
16 02 12	N/A	N/A
17 06 01	N/A	N/A
17 06 05	N/A	N/A
Total	**9,28**	**2 539,66**

Source: Executive Environment Agency, 2023

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	N/A	N/A
Exported	N/A	N/A

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste disposed of 2017-2021

2 539 t

NATIONAL STRATEGY

- No national plan for asbestos removal identified
- No targets for screening of public or private buildings identified
- No target dates for asbestos removal identified
- Two guidance documents for construction waste exist (where asbestos is also covered)

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- *Waste Management Act*
- *Health Act*
- *Ordinance No.2, March 2004*
- *Ordinance No.9, August 2006*
- *Ordinance No. 267, December 2017*
- *Regulation No. 6 of 27.08.2013*

Guidance:

- *Guidance for construction waste management on the territory of the Republic of Bulgaria (ND).*
- *Practical guidelines for implementing the legislation related to the management of construction waste and recycled products from construction waste in the Republic of Bulgaria (2015)*

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Asbestos waste disposal must be documented, providing information on the type and content of asbestos and quantity of asbestos-containing waste.
- Guidance: Asbestos waste is generally considered as hazardous, but there are exceptions. Asbestos-containing building materials are considered as non-hazardous construction waste, whereas insulating materials containing asbestos and construction materials containing asbestos are considered hazardous and have a different disposal procedure. Removal depends on the categorisation of the waste. There are no inventories of buildings that contain asbestos.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Asbestos removal and disposal can only be carried out by licensed contractors equipped to handle hazardous materials. Removal of asbestos from structures can only be done after obtaining a permit from a reginal health inspectorate from the respective territory. The application for obtaining such permit, needs to include a removal work plan and the removal of the asbestos should not pose a greater risk (to workers) than its non-removal. Procedures that local authorities need to follow before making a decision are in place as well as safety measures are in place to protect workers.
- Guidance: Hazardous waste shall be treated by persons holding a permit. Furthermore, the collection and temporary storage of hazardous waste needs to be done separately in specialized receptacles and hazardous waste must be packaged, labelled, and transported in accordance with the international-law instruments on carriage of dangerous goods as have been ratified. Holders of waste have an obligation to take all measures to prevent the mixing of hazardous waste with other waste.

TREATMENT & DISPOSAL

- Legislation: Conditions and requirements for the construction and operation of landfills and other facilities and installations for the recovery and disposal of waste regulated disposal are in place. However, there are no specific provisions on disposal of asbestos waste. Waste is landfilled by specially approved providers.
- Common practice: Bulgaria does not seem to have authorised facilities dedicated solely to the disposal of asbestos waste and such waste is typically disposed in hazardous waste disposal facilities, that is landfills. When bagged, asbestos containing waste can be deposited in municipal waste landfills The Waste Management Act limits the units of hazardous waste disposed in landfills (Article 7).

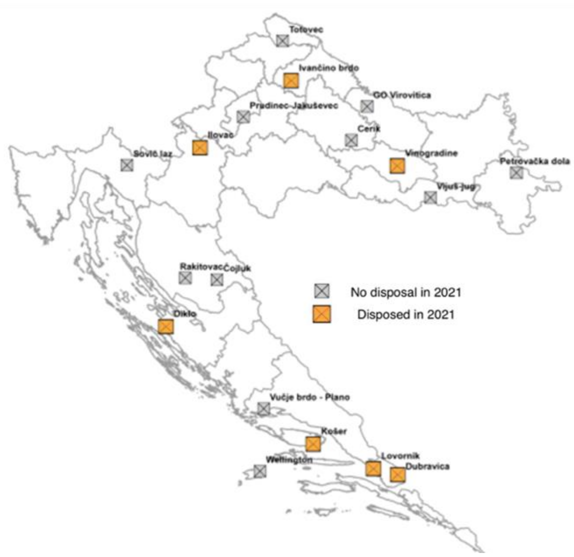
Additional sources (other than the legislation and guidance documents listed at the top of this page):
Responses to DG Grow Survey (2022), Responses to RPA Survey (2023), Bulgaria, interview, 3rd October 2023.

COUNTRY PROFILE Croatia

SOURCES OF ASBESTOS-CONTAINING WASTE

17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

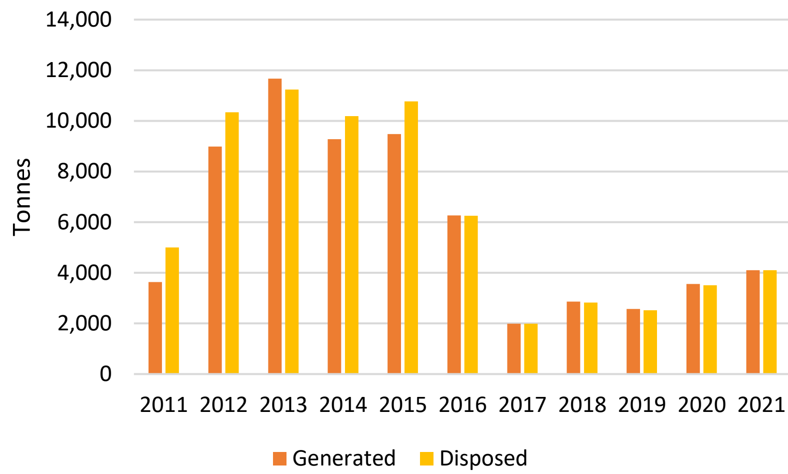
TREATMENT/DISPOSAL FACILITIES



Distribution of cassettes and disposal status of construction waste containing asbestos in 2021

Source: MINGOR, 2022

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: MINGOR

LoW Code	Quantities (tonnes) 2016-2021	
	Generation	**Disposal operations**
17 06 01	558	441
17 06 05	20 797	20 762
Total	**21 355**	**21 202**

Source: MINGOR

FUTURE PROJECTIONS (2024-2050)

Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Croatia	11 470 753	6 852 087	3 38 087

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	11 080	410
3x	22 160	821
4x	33 241	1 231

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	-	-
Exported	4 163	Germany

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste generated in 2016-2021

21 355 t

NATIONAL STRATEGY

- Asbestos is covered in the general plan on construction and demolition waste and annex I
- No targets for screening of public or private buildings identified
- No target dates for asbestos removal identified
- A guidance document for asbestos treatment exists (Ministry of Environmental Protection, Physical Planning and Construction, 2008)

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- *Waste Management Act (OG 84/21)*
- *Ordinance on construction waste and waste containing asbestos (OG 69/16)*
- *Rulebook on the protection of workers from risks due to exposure to asbestos, NN 40/2007*
- *Decision on adoption of Amendments to the Waste Management Plan of the Republic of Croatia for the period 2017-2022, NN 1/2022.*

Guidance:

- *Instruction for Waste Treatment Containing Asbestos (OG No. 89/08)*

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Assessment on whether asbestos might be present must be made. If asbestos is present, the owner/ user of the bulding muyst submit data as prescribed by law. The Environmental Protection and Energy Efficiency Fund is obliged to keep a register of the quantities and locations of construction waste containing asbestos.
- Guidance: Building owners are not supported financially for the screening and/or removal of asbestos but have been in the past through public calls. Rules that help with identification have the primary goal to protect workers and not to identify asbestos per se, as they are regulated with the Rulebook on the protection of workers.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Removal is mandatory during renovation of public and private buildings and waste management activities. Owners/ users of buildings must inspect and maintain asbestos-containing materials to prevent fiber release. When removal is necessary, it should be done to prevent asbestos dispersion. Only registered entities can perform asbestos-related work. Proper waste management is required to prevent environmental contamination.
- Guidance: The method of the asbestos waste management procedure must include measures to prevent the release of asbestos waste, asbestos fibres and asbestos dust into the environment (spraying with water, using binders, appropriate packaging and other means that achieve the prescribed purpose).

TREATMENT & DISPOSAL

- Legislation: It is forbidden to use the following asbestos waste management procedures prescribed by a special regulation governing waste management: D2, D3, D4, D7, D8, and all recovery procedures except procedures R1 and R13 for the purpose of recovery using procedure R1. Final waste disposal has to be done by licensed waste management companies.
- Common practice: Waste is either landfilled (17 asbestos landfills) or exported. As an illustration, in 2020, 3,497 tons in landfills and 23 tons exported.

Additional sources (other than the legislation and guidance documents listed at the top of this page):
Responses to DG Grow Survey (2022), Responses to RPA Survey (2023), Ministry of Science and Education, Environmental and Social Management Framework (2023), see Annex 4: https://mzo.gov.hr/UserDocsImages/dokumenti/Znanost/Projekt-digit/Digit-azurirano-11-10-2023/digit-esmf-11-10-2023.pdf, Decision on Environmental protection and energy efficiency Fund's procedures for implementing measures for the improvement of waste containing asbestos' management system (OG No. 58/11).

COUNTRY PROFILE Cyprus

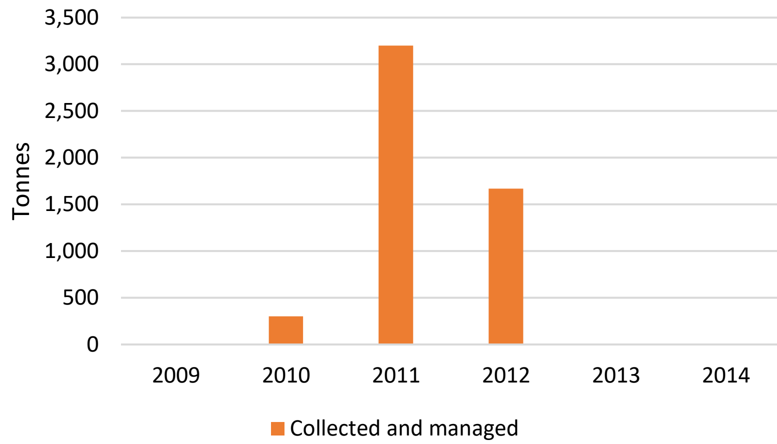
SOURCES OF ASBESTOS-CONTAINING WASTE

15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES

No information was found on landfills

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Ministry of Agriculture, Rural Development and Environment, 2016

LoW Code	Quantities (tonnes) 2009-2014	
	Generation	**Disposal operations**
15 01 11	N/A	N/A
16 01 11	N/A	N/A
16 02 12	N/A	N/A
17 06 01	N/A	N/A
17 06 05	N/A	N/A
Total	**5 167**	**N/A**

Source: Ministry of Agriculture, Rural Development and Environment, 2016

FUTURE PROJECTIONS (2024-2050)

Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Cyprus	11 114 083	6 666 083	3 330 083

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	N/A	N/A
3x	N/A	N/A
4x	N/A	N/A

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	-	-
Exported	4 055	Germany, United Kingdom

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste generated in 2009-2014

5 167 t

NATIONAL STRATEGY

- Organization and creation of facilities for asbestos containing waste disposal within the country by 2020
- No targets for screening of public or private buildings identified
- No target dates for asbestos removal identified
- One guidance document on Waste Management has been identified

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Safety and Health at Work (Minimum Requirements for Temporary or Mobile Worksites) Regulation 2015 (K.D.P. 410/2015

Guidance:

- Waste Management Plan (2016 – 2022)

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Guidance: Most of the work with asbestos waste in Cyprus concerns the removal and replacement of asbestos sheets from the roofs of buildings. A work plan must be prepared indicating all necessary precautionary measures for asbestos removal prior to demolition, such as the provision of appropriate equipment. According to the Waste Management Plan (2016 - 2022), an inventory and evaluation of the management of old industrial units that are inactive and contain hazardous or non-hazardous materials should be performed.
- Common practice: A recent initiative for the demolition and replacement of asbestos-made roofs in public buildings (governmental offices, schools, camps etc.) has been launched. A specific landfill site for asbestos waste resulting from demolitions has been designated in the Amiantos mine (Geological Survey Department, 2020).

REMOVAL, SEPARATION & COLLECTION

- Legislation: In case of demolition work or the removal of asbestos and/or asbestos-containing materials from buildings or other installations, such as the removal and/or replacement of asbestos sheets, the Safety and Health at Work (Minimum Requirements for Temporary or Mobile Worksites) Regulation 2015 (K.D.P. 410/2015), which set out specific procedures and measures to address the risks on construction sites, shall apply.
- Guidance: The collection of asbestos containing waste is carried out by licensed collectors - transporters, who pack the waste and store it in an appropriately marked area until they are authorised by the competent authority to transport and dispose of it either at the Asbestos Mine or to another place indicated by the competent authority. There are 11 authorised waste management operators in Cyprus. Permits are issued by the Department of Labor Inspection. Asbestos sheets must be removed and transported in such a way that they do not break or rub against each other or with other hard objects. The guidance describes measures to be taken to prevent the formation of suspended asbestos dust (e.g. by pressurized air, cleaning with water, use of vacuum cleaners with a suitable dust collection filters, which will then be treated as asbestos waste).
- Common practice: Removal of materials containing asbestos fibers is performed by a licensed contractor, as well as the subsequent management and storage of the asbestos wastes until their transfer to the Amiantos mine for their final disposal (Geological Survey Department, 2020).

TREATMENT & DISPOSAL

- Guidance: One of the aims described in the Waste Management Plan (2016 - 2022) is the organization and creation of facilities for asbestos containing waste disposal within the country by 2020. Asbestos waste shall be packaged in plastic and durable films of sufficient thickness to minimise the risk of tearing or rupture of the packaging. The packaged waste should be properly labelled.
- Common practice: Asbestos waste is stored inside closed ISO containers and the waste is transproted and buried at the Asbestos Mine in Amiantos Village when it is open, under the supercision of the Geological Survey Department of the Ministry of Agriculture, Natural Resources and Environment (M&R Asbestos, 2023).

COUNTRY PROFILE Czech Republic

SOURCES OF ASBESTOS-CONTAINING WASTE

15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES

Non-hazardous waste landfills (Groups S-OO1 and S-OO3)
Source: own map from http://mapaskladek.aspone.cz data, 2023

Asbestos-containing waste is disposed in separate sectors of landfills designated for non-hazardous waste (groups of landfills S-OO1 and S-OO3, according to the Decree 273/2021 Coll. on the Details of Waste Management)

FUTURE PROJECTIONS (2024-2050)

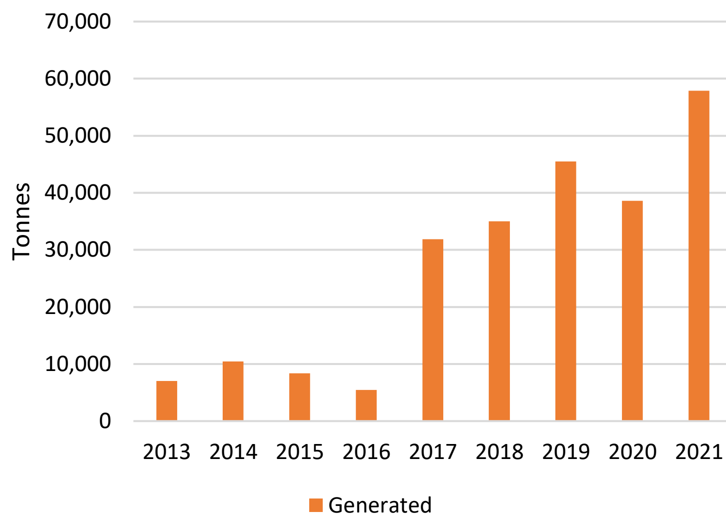
Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Czech Republic	11 706 414	6 885 080	3 269 080

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	15 248	565
3x	30 495	1 129
4x	45 743	1 694

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: [Ministry of Environment](#)

LoW Code	Quantities (tonnes) 2013-2021	
	Generation	**Disposal operations**
15 01 11	4 939	N/A
16 01 11	145	N/A
16 02 12	51	N/A
17 06 01	33 507	N/A
17 06 05	201 560	N/A
Total	**240 202**	**N/A**

Source: [Ministry of Environment](#)

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	476	Belgium, Germany, Poland
Exported	-	-

Source: [Eurostat Waste Shipments Statistics](#)

Asbestos-containing waste generated in 2013-2021

240 202 t

NATIONAL STRATEGY

- No national plan for asbestos removal identified
- No targets for screening of public or private buildings identified
- No target dates for asbestos removal identified
- A guidance document for asbestos removal exist (Ministry of Environment 2018)

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Waste Act (2020)
- Decree on waste management details (2021)

Guidance:

- Ministry of Environment Guideline on construction and demolition and management of asbestos-containing waste (2018)

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Screening mandatory where there is suspicion that asbestos had been used. A pre-demolition audit is required. A specific permitting procedure where asbestos can be present and there is a requirement to notify/provide information to the authorities. Employers must notify exposure to asbestos, except one-off and short-term exposure.
- Guidance: A pre-demolition audit can be complemented with a review existing documentation and interview the inhabitants/users as to the construction history of the building. ACW is defined as construction and demolition waste that contains the different asbestos fibres (there is no concentration threshold). If inconclusive, it is recommended to take samples. The guide provides examples of construction materials made in CZ (or Czechoslovakia) that contain asbestos, including the name of the manufacturer and the year in which production of asbestos containing materials was discontinued.

REMOVAL, SEPARATION & COLLECTION

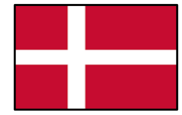
- Guidance: ACW must be removed before demolition or renovation. A controlled area must be established and ACW must be removed by methods that prevent release of asbestos fibres into the air. ACWshould be packed in sealed containers or packaging, an identification sheet should be attached and it should only be handed over to an authorised provider. The guide includes a list of good removal practices, including wet demolition, avoicance of the use electric tools in some instances, specific controls for dry demolition, wrap and cut methods, use of glovebags, etc. The guide includes some 'DO NOT DO' examples. The advice differentiates between high and low risk activities (activities for which notification is required and no notification required).

TREATMENT & DISPOSAL

- Legislation: Landfilling of asbestos containing waste only allowed in S-NO (hazardous waste) and some S-OO (other waste) landfills.
- Common practice: ACW only landfilled in the Czech Republic. When landfilled the asbestos-containing waste is landfilled only in special sectors reserved for asbestos-containing waste. Asbestos-containing waste when being landfilled is packed in sealed packaging or stored in sealed containers, and the landfill site is covered with technological material immediately after the landfilling.

COUNTRY PROFILE

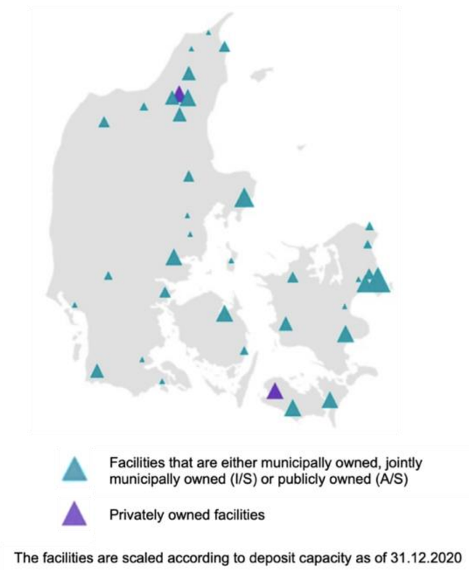
Denmark



SOURCES OF ASBESTOS-CONTAINING WASTE

06 13 04* - Wastes from asbestos processing
10 13 09* - Wastes from asbestos-cement manufacture containing asbestos
15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES



Source: BEATE, 2020

The map shows all Danish landfills approved to receive waste, however no information was found on which of these landfills accept asbestos-containing waste.

FUTURE PROJECTIONS (2024-2050)

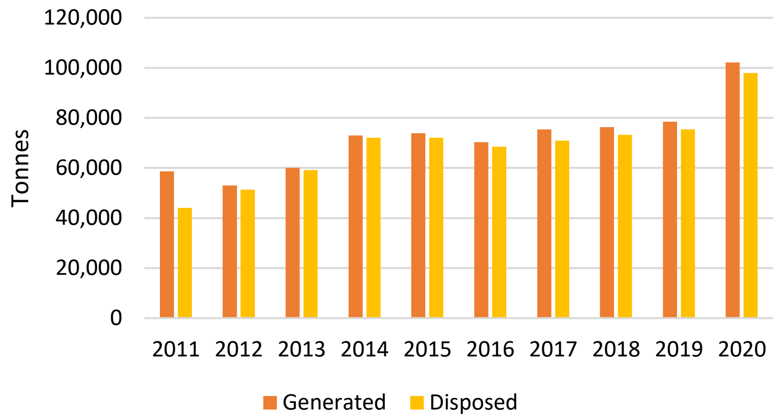
Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Denmark	18 534 554	10 683 887	4 795 887

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	145 478	5 388
3x	290 956	10 776
4x	436 433	16 164

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Danish Environmental Protection Agency

LoW Code	Quantities (tonnes) 2011-2020		
	Generation	**Disposal operations (D1, D3, D4, D5, D8, D9, D10, D12, D13, D14, D15)**	**Recovery operations (R1, R2, R3, R4, R5, R9, R10, R11, R12, R13)**
06 13 04	3	0	2
10 13 09	1	1	0
15 01 11	5 047	876	4 171
16 01 11	499	17	482
16 02 12	4 441	1	4 440
17 06 01	3 642	3 481	161
17 06 05	707 688	680 446	27 241
Total	**721 321**	**684 823**	**36 498**

Source: Danish Environmental Protection Agency

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	1 107	Italy
Exported	-	-

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste generated in 2011-2020

721 321 t

NATIONAL STRATEGY

- No national plan for asbestos removal identified
- No targets for screening of public or private buildings identified
- No target dates for asbestos removal identified
- Guidance available from the Danish Working Environment Authority (2005) (currently under revision)

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Statutory order on Landfilling (2019)
- Working Environment Authority's order no. 807 on asbestos in the working environment (2023)

Guidance:

- Danish Working Environment Authority (2005)
- ASBEST - Den grønne asbestvejledning og beskrivelse for udførelse af asbestsanering, 2019 (The green asbestos guide and description for the execution of asbestos remediation).
- Nedrivning og Miljøsanering - en sektion i Dansk Byggeri (Section for demolition and decontamination of the Danish Construction Federation).
- asbesthuset.dk
- renoversikkert.dk

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: In Denmark, the building owner/developer/client has an obligation to screen, map and notify the authorities about the materials containing asbestos and other environmentally problematic substances, so the waste can be sorted and handled accordingly.
- Guidance: Asbestos containing materials which are not dusty are classified as "non-hazardous", whereas asbestos containing materials which are dusty are classified as "hazardous".

REMOVAL, SEPARATION & COLLECTION

- Legislation: The demolition company must separate and remove asbestos and other environmentally problematic substances and hazardous waste from the building before the actual demolition work begins.

TREATMENT & DISPOSAL

- Legislation: Recycling not allowed, neither preparation for reuse. Landfilling of asbestos-containing waste must occur at approved facilities.
- Common practice: Mainly landfilled, in some cases export for special treatment. Incineration is not practiced.

COUNTRY PROFILE Estonia

SOURCES OF ASBESTOS-CONTAINING WASTE

16 01 11* - Brake pads containing asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES

Source: https://prygilad.keskkonnaagentuur.ee/, 2016

The map shows all working landfills in Estonia. Information about landfills accepting asbestos-containing waste could not be found.

FUTURE PROJECTIONS (2024-2050)

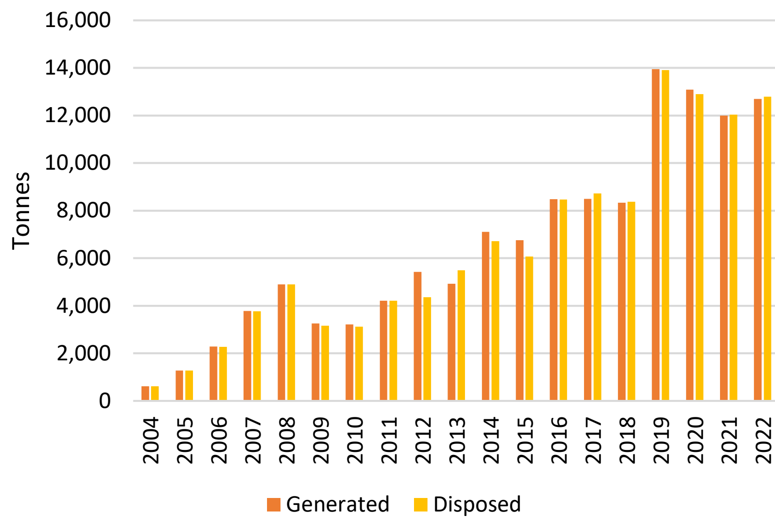
Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Estonia	1 128 550	627 217	251 217

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	36 108	1 337
3x	72 215	2 675
4x	108 323	4 012

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Ministry of Climate

LoW Code	Quantities (tonnes) 2004-2022		
	Generation	**Disposal operations (D1, D5, D13, D14)**	**Recovery operations (R5, R10, R12)**
16 01 11	3	0	1
17 06 01	9 691	9 663	10
17 06 05	115 090	113 524	787
Total	**124 783**	**123 187**	**798**

Source: Ministry of Climate

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	-	-
Exported	-	-

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste generated in 2004-2022

124 783 t

NATIONAL STRATEGY

- Replacing asbestos is included in the National Environmental Strategy 2030
- Screening of buildings mandatory before construction works
- No target dates for asbestos removal identified
- Two guidance documents for asbestos waste identified (not binding)

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Handling requirements for waste containing asbestos
- Health and safety requirements for asbestos work, adopted on 11.10.2007 No 224
- Waste act
- Occupational Health and Safety Act

Guidance:

- Work safety on the construction site
- Low-risk asbestos work methods for demolition, renovation and maintenance

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: When planning renovation or demolition work in a building, an asbestos survey is mandatory. The survey is aimed at identifying asbestos-containing materials that may be disturbed during the construction process. This requirement is in place to protect workers and ensure the proper handling and removal of asbestos.
- Guidance: This is based on a national strategy which aims to replace construction materials containing asbestos with healthier materials, controlled waste managment and monitoring. Records should be maintained to ensure traceability and compliance with regulations.

REMOVAL, SEPARATION & COLLECTION

- Legislation:The disposal of asbestos waste is subject to stringent regulations in Estonia. Requirements to ensure removal of asbestos prior to demolition and/or separation of asbestos containing waste from other waste are in place. Different types of asbestos waste must be separated and collected in sealable containers. Transport packaging for asbestos waste must be of sufficient strength and durability to prevent the release of asbestos fibers.
- Guidance: Building owners are supported through municipalities in collecting asbestos-containing roofing materials and in waste disposal of building materials containing asbestos.

TREATMENT & DISPOSAL

- Legislation: Recycling asbestos waste is prohibited. Asbestos waste is deposited in a hazardous waste landfill, but there are some expections, where it can be disposed in general waste landfil as precribed by law. Requirements on treatment before landfilling are in place for certain types of waste. Disposal is done in accordance with Regulation No. 148. When accepting asbestos waste into the landfill, the landfill operator checks the compliance of the processing and packaging of the waste with the requirements.
- Common practice: Currently, there are no feasible technologies for removing asbestos from asbestos-containing waste that would ensure the safety of materials obtained by recycling such waste.

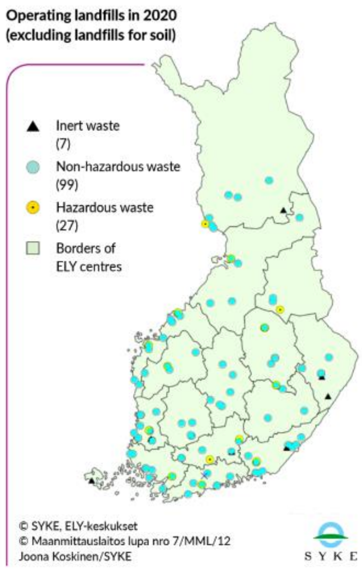
Additional sources (other than the legislation and guidance documents listed at the top of this page):
Responses to DG Grow Survey (2022), Responses to RPA Survey (2023), Regulation No. 148 of the Government of the Republic of December 8, 2011 «Lists of waste recycling and disposal operations», https://www.riigiteataja.ee/akt/104022020002?leiaKehtiv.

COUNTRY PROFILE Finland

SOURCES OF ASBESTOS-CONTAINING WASTE

06 13 04* - Wastes from asbestos processing
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES



Source: EastCham Finland, 2020

The map shows all landfills in Finland. Information about which landfills accept asbestos-containing waste could not be found.

FUTURE PROJECTIONS (2024-2050)

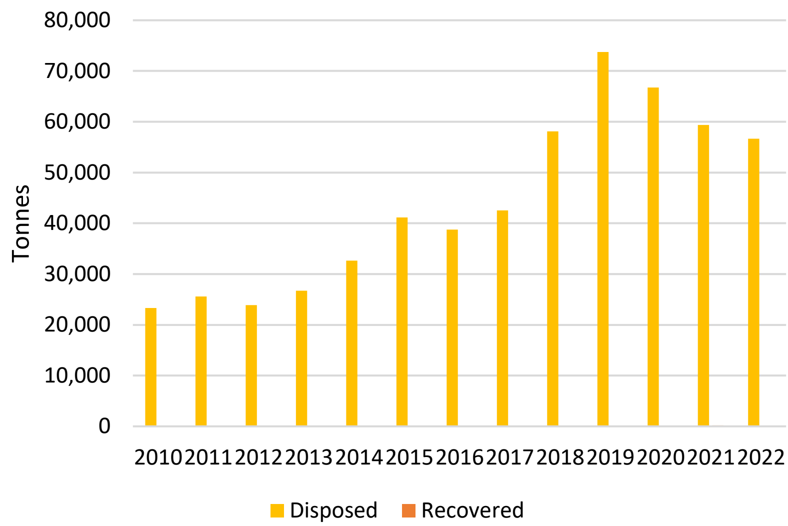
Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Finland	20 375 238	5 959 238	2 647 238

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	94 463	3 499
3x	188 925	6 997
4x	283 388	10 496

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Finnish Environment Institute

LoW Code	Quantities (tonnes) 2010-2022		
	Generation	Disposal operations (D1, D5, D6, D9, D10, D13, D14, D15)	Recovery operations (R052, R12, R13)
06 13 04	N/A	16	0
17 06 01	N/A	70 977	7
17 06 05	N/A	498 219	702
Total	**N/A**	**569 211**	**709**

Source: Finnish Environment Institute

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	39	Sweden
Exported	169	Czech Republic

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste disposed in 2010-2022

569 211 t

NATIONAL STRATEGY

- No national plan for asbestos removal identified
- Screening of buildings is requirement is a requirement prior to construction works
- No target dates for asbestos removal identified
- No guidance document for asbestos waste exists

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Waste Act (646/ 2011)
- Government Decree on waste (978/2021)
- Government Decree on the Safety of Asbestos Work (798/2015)
- Act on Certain Requirements Concerning Asbestos Removal Work (684/2015).
- Government Decree on Landfills 331/2013, as amended by 1030/2021

Guidance:

NA

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Identification of asbestos is triggered by renovation and demolition. It is not required to screen structures, which will remain intact during the renovation process. The party responsible for a construction project, which may involve asbestos removal, must ensure that the asbestos survey is conducted to identify, assess and determine whether the handling of asbestos will generate dust. Any person or organisation initiating a construction project, is obliged to ensure that this survey is made. These surveys are intended to identify and document the presence of asbestos-containing materials. Asbestos surveys and removal activities must be thoroughly documented and records kept for compliance and accountability.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Only those that hold a license for handling asbestos may carry out asbestos removal. A written safety plan must be made for the asbestos demilition work and prescribed removal procedures, including packing requirements must be followed.The waste holder shall ensure that asbestos waste generated from activities is collected and transported separately from other waste for treatment without delay. Asbestos waste must be packaged, labeled, and disposed of in authorized facilities designed to handle hazardous materials. Specialized disposal sites are used for asbestos waste. Tightly closed durable packaging shall be used for the storage and transport of asbestos waste, and package labelling shall indicate that the packages contain asbestos. To prevent breakage, these shall be handled with care and caution.

TREATMENT & DISPOSAL

- Legislation: Waste intended for inert landfills must be tested if there's suspicion of contamination or doubt regarding its conformity with inert waste criteria. Contaminated or materials with metals, asbestos, plastics, chemicals, or substances posing an increased risk cannot be accepted in inert landfills. Construction and demolition waste with asbestos can go to non-hazardous landfills without testing if they meet specific asbestos waste requirements. These requirements include no hazardous substances besides bound asbestos, daily covering, water sprinkling during depositing, capping to prevent asbestos fiber dispersion, and post-closure land use restrictions to prevent human contact with the waste.

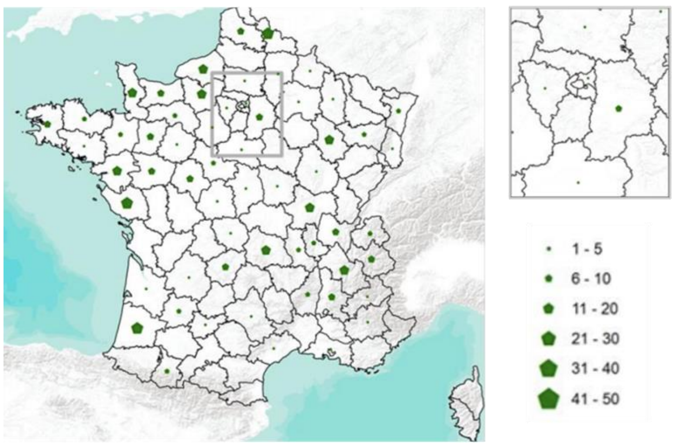
Additional sources (other than the legislation and guidance documents listed at the top of this page):
Responses to DG Grow Survey (2022), Responses to RPA Survey (2023), https://www.tyosuojelu.fi/web/en/working-conditions/construction-industry/asbestos

COUNTRY PROFILE France

SOURCES OF ASBESTOS-CONTAINING WASTE

10 13 09* - Wastes from asbestos-cement manufacture containing asbestos
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES



Landfills receiving asbestos-containing waste – Number by department

Source: Bureau de Recherches Géologiques et Minières (BRGM), 2015

FUTURE PROJECTIONS (2024-2050)

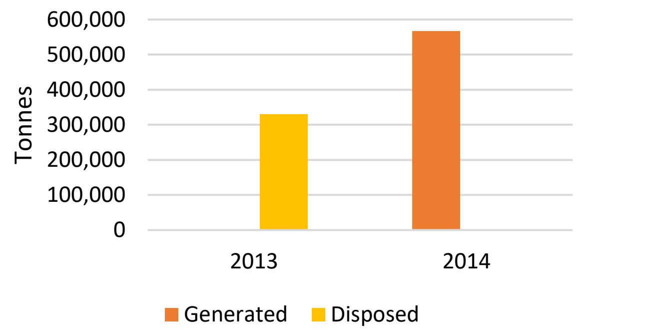
Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
France	119 662 696	68 825 363	30 697 363

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	1 707 825	63 253
3x	3 415 650	12 506
4x	5 123 474	189 758

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Bureau de Recherches Géologiques et Minières (BRGM) and Ministry of Ecological Transition and Territorial Cohesion

LoW Code	Quantities (tonnes)	
	Generation [2014]	**Disposal** [2013]
10 13 09	N/A	2
16 01 11	N/A	57
16 02 12	N/A	1 672
17 06 01	N/A	8 562
17 06 05	N/A	124 333
Non specific codes	N/A	~200 000
Total	**567,213**	**~330 000**

Source: Bureau de Recherches Géologiques et Minières (BRGM) and Ministry of Ecological Transition and Territorial Cohesion

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	17 823	Algeria, Andorra, Belgium, Gabon, Germany, Ireland, Italy, Luxembourg, Monaco, Morocco, Poland, Spain, Switzerland
Exported	18 767	Belgium, Germany, New Zealand, Spain

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste generated in 2013 - 2014

~900 000 t

NATIONAL STRATEGY

- No national plan for asbestos removal identified
- Screening is required under certain conditions
- Plans are in progress to remove asbestos by introducing a subsidy scheme
- No target dates for asbestos removal identified
- Several guidance documents of asbestos exist
- Other methods for treatment and disposal, in addition to landfilling are present

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Ministerial order on hazardous waste disposal facilities
- Ministerial order on non-hazardous waste disposal facilities
- Order from the 21 December 2021 on asbestos waste traceability
- Decree no. 2012-639 of 4 May 2012, on the management of asbestos-related health risks in roadworks
- Labour Code
- Public Health Code
- Environmental Code
- Hazardous waste landfill decree
- Non-hazardous waste landfill decree

Guidance:

- A roadmap for treatment of asbestos waste, 2021, Ministry of the Economy, Finance, and Recovery
- Asbestos waste management guide, 2017, Regional Department for the Environment, Planning and Housing
- Asbestos waste accepted in recycling centers – Good practice 2018

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: There is a national regulation obliging building or flat owners to screen and treat in certain cases asbestos in buildings. Screening is mandatory for residential buildings, and is triggered in specific circumstances, such as building selling, renting and demolition of a building or part of a building. In 2016 the 'El Khomri' law introduced the obligation to carry out a pre- construction survey. A lot of asbestos was used in road construction and compulsory for all road managers to report any presence of asbestos before any new work is carried out and remove asbestos. An important feature of the French regulations is that there is no threshold. A product is asbestos- containing as soon as the presence of asbestos fibres can be detected.
- Common practice: For demolition of a private building to start an authorisation is required, without authorisation demolition and construction cannot begin. For public buildings, the requirements are even more stringent. However, there are still many public buildings with asbestos in France. There is no national plan to remove asbestos by a certain date.

REMOVAL, SEPARATION & COLLECTION

- Legislation: The rules differentatie between 'free asbestos' and 'bound' asbestos. Several articles from the Labour Code regulate the risk of exposure to asbestos (R. 4412-94 to R. 4412-148) and the management of asbestos waste (R. 4412-121 et R. 4412-122). The operator at the waste storage facility enforces strict measures for asbestos-containing waste, requiring double-sealed packaging with clear "asbestos" labels and numbered seals. The accompanying asbestos waste tracking slip must detail the project owner, asbestos removal company, and waste transporter. To reduce asbestos inhalation risk for facility staff, certain requirements are exempted, provided the previous conditions are met. The facility operator must maintain precise records of storage locations and seal numbers and issue a receipt upon waste acceptance. Non-compliance or missing documents result in immediate refusal of waste.
- Guidance: Removal of asbestos from households will be subsidised via a new scheme on building and construction materials and products.

TREATMENT & DISPOSAL

- Legislation: Asbestos waste has to be handled by specialized entreprises with accreditated workers in order to avoid any dispersion of fibers during decontamination, dismantling and packaging steps. In addition to landfilling, other forms of treatment are also allowed.
- Common practice: Individuals usually use sorting centres or nearest landfills. Companies that deal with asbestos waste can use any landfill. Less than 1% of asbestos waste is treated by vitrification. There is one unit in the south of France that treats asbestos waste by vitrification but it is very costly and involves transport. Landfilling is cheaper. Recycling not mature enough as a viable option. A 2021 report from the French Ministry of the Environment estimates that it is premature to favour or develop the recovery of asbestos due to the lack of information and feedback from existing pilots. Other projects focused on treatment and disposal are also in development.

Additional sources (other than the legislation and guidance documents listed at the top of this page):

Responses to DG Grow Survey (2022), Responses to RPA Survey (2023), France, interview, 6th October 2023, https://www.economie.gouv.fr/files/files/directions_services/cge/dechets-amiante.pdf

COUNTRY PROFILE Germany

SOURCES OF ASBESTOS-CONTAINING WASTE

06 07 01* - Wastes containing asbestos from electrolysis
06 13 04* - Wastes from asbestos processing
10 13 09* - Wastes from asbestos-cement manufacture containing asbestos
15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES

No information at national level was found

FUTURE PROJECTIONS (2024-2050)

Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Germany	233 870 613	136 622 613	63 686 613

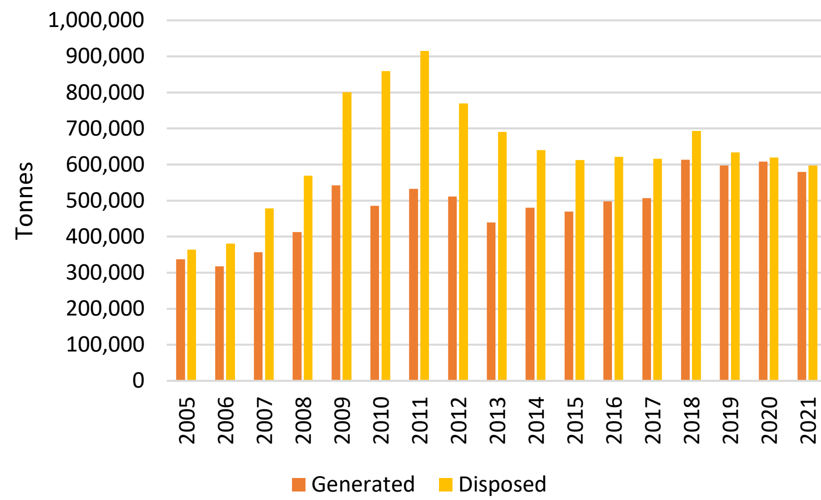
Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	1 514 880	56 107
3x	3 029 760	112 213
4x	4 544 640	168 320

Asbestos-containing waste generated in 2005-2021

8 287 600 t

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: German Environment Agency (Umweltbundesamt – UBA)

LoW Code	Quantities (tonnes) 2005-2021	
	Generation	Disposal operations
06 07 01	0	600
06 13 04	15 500	15 500
10 13 09	100	100
15 01 11	16 800	42 100
16 01 11	300	500
16 02 12	128 700	129 800
17 06 01	118 700	316 900
17 06 05	8 007 500	10 354 900
Total	**8 287 600**	**10 860 400**

Source: German Environment Agency (Umweltbundesamt – UBA)

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	3 515 850	Afghanistan, Austria, Belgium, Bosnia and Herzegovina, Côte d'Ivoire, Croatia, Cyprus, Denmark, Finland, Former Sebia and Montenegro (before 2006), France, Greece, Hungary, Ireland, Italy, Kosovo, Kuwait, Luxembourg, Malta, Montenegro, Netherlands, North Macedonia, Norway, Pkistan, Poland, Portugal, Serbia, Slovenia, Spain, Sudan, Sweden, Switzerland, Turkey, United Kingdom, Unites States
Exported	4 805	Czechia, France, Netherlands

Source: Eurostat Waste Shipments Statistics

NATIONAL STRATEGY

- No blanket national targets for screening of all buildings or asbestos removal identified
- Several guidance documents are available. TRGS 519 also provides detailed instructions to enable companies to be in compliance with the applicable legislation.

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- German Hazardous Substances Ordinance (GefStoffV)
- Technical Rules for Hazardous Substances 519 (TRGS 519)

Guidance:

- VDI 6202 Sheet 3 (Guidance) on screening and mapping: collect information, visual inspection, samples taken and tested, evaluate the results of analysis
- BAuA and UBA Guideline to determination of asbestos in older buildings (2020)

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: No blanket binding duty to binding duty to investigate asbestos in structural and technical installations (no mandatory screening in all cases). ACW defined as waste containing >0.1% asbestos The planning of asbestos removal is legally anchored only to a limited extent in Germany. While there are guidelines and recommendations in place, there is no comprehensive legal framework specifically governing the planning process.
- Guidance: Incident-related investigations (surveys) prior to activities or construction measures are established

REMOVAL, SEPARATION & COLLECTION

- Legislation: Requirements on operators allowed to remove asbestos. In case of full demolition of buildings the demolition company must separate and remove asbestos and other environmentally problematic substances and hazardous waste from the building before the actual demolition work begins
- Guidance: Asbestos waste has to be collected properly during demolition, remediation and maintenance works. The asbestos containing waste has to be sealed, labelled, and disposed of in accordance with the requirements of the TRGS 519 and the new LAGA M23.
- Common practice: The disposal of asbestos in Germany involves a comprehensive monitoring process that incorporates the use of the electronic waste management system (eANV).

TREATMENT & DISPOSAL

- Legislation: Recycling hazardous asbestos-containing waste is not allowed in Germany, and the same holds for preparation for reuse. Landfilling of asbestos-containing waste must occur at approved facilities.
- Guidance: LAGA M 23 includes an assessment value (Beurteilungswert 0.010 %) which links recyclability to a concrete value with the help of a clear definition of "asbestos-free".
- Common practice: The main treatment for asbestos-containing waste in Germany is landfilling and in some cases in underground storage facilities. Incineration of asbestos-containing waste is also not practiced due to past bad experience and no incineration plant in Germany is willing to accept ACW.

Additional sources (other than the legislation and guidance documents listed at the top of this page):
Responses to DG Grow Survey (2022), LAGA M23 is available hre: https://www.laga-online.de/Publikationen-50-Mitteilungen.html

COUNTRY PROFILE

Greece

SOURCES OF ASBESTOS-CONTAINING WASTE

15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES

No information found

FUTURE PROJECTIONS (2024-2050)

Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Greece	N/A	N/A	N/A

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	N/A	N/A
3x	N/A	N/A
4x	N/A	N/A

QUANTITIES OF ASBESTOS-CONTAINING WASTE

No information found

LoW Code	Quantities (tonnes) 2011-2021	
	Generation	**Disposal operations**
15 01 11	N/A	N/A
16 01 11	N/A	N/A
16 02 12	N/A	N/A
17 06 01	N/A	N/A
17 06 05	N/A	N/A
Total	N/A	N/A

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	7	Albania
Exported	23 578	Germany, Norway, Spain, United Kingdom, Portugal

Source: [Eurostat Waste Shipments Statistics]

Asbestos-containing waste generated in 2011-2021

NATIONAL STRATEGY

- No specific national inventory or asbestos removal targets identified.
- The National Waste Management Plan (NWMP) provides some principles/requirements for the management of asbestos-containing CDW.
- No guidance documents have been identified but a Circular has been issued to interpret HMD 4229/395/15-2-2013.

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Law on Waste Management No. 4042/2012 (GG A' 24/2012)
- JMD 4229/395/2013 (GGD 318/B`/15.2.2013): Requirements for the establishment and operation of enterprises carrying out demolition and asbestos removal works and/or materials containing asbestos from buildings, structures, facilities and vessels, as well as maintenance, coating and encapsulation of asbestos and/or materials containing asbestos
- Circular 5885/557/4-3-2013: Adoption of the JMD 4229/395/15-2-2013 concerning the determination of the legal conditions for the establishment and operation of enterprises dealing with asbestos management works

Guidance:

- None identified.

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- No specific requirements identified.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Companies that carry out asbestos removal work must hold a licence issued by the Ministry of Labor, Social Security and Welfare. ACW must be packed and placed in containers for transfer to interim storage or final disposal.
- Guidance: Emissions of asbestos fibres into the air must be prevented.

TREATMENT & DISPOSAL

- Common practice: CDW containing asbestos was according to reports published in 2015 and 2021 exported for final disposal (D1 and D5) in Germany. Greece lacks capacity in terms of hazardous waste landfilling and the existing landfills that can accept ACW are private and for the owner's needs only.

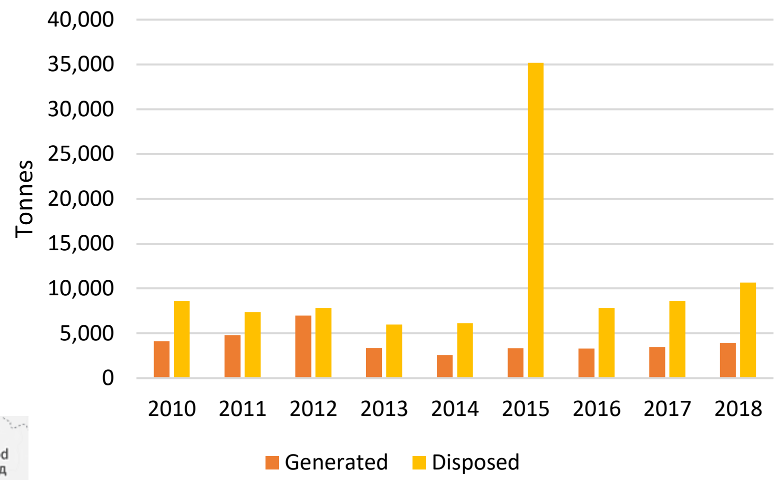
Additional sources (other than the legislation and guidance documents listed at the top of this page):
https://ec.europa.eu/environment/pdf/waste/studies/deliverables/CDW_Greece_Factsheet_Final.pdf
https://www.giz.de/de/downloads/Final%20Report%20CDW%20management%20EN.pdf
https://ypen.gov.gr/wp-content/uploads/2021/09/FR_Hazardous_waste_contaminated_soil_EN.pdf

COUNTRY PROFILE Hungary

SOURCES OF ASBESTOS-CONTAINING WASTE

06 13 04* - Wastes from asbestos processing
10 13 09* - Wastes from asbestos-cement manufacture containing asbestos
15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

QUANTITIES OF ASBESTOS-CONTAINING WASTE

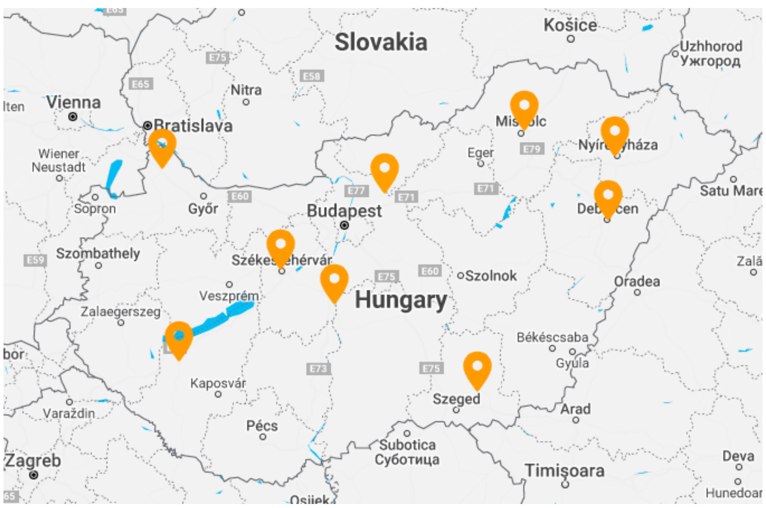


Source: Ministry of Innovation and Technology

LoW Code	Quantities (tonnes) 2010-2018		
	Generation	**Disposal operations (D5, D9, D10)**	**Recovery operations (R1, R4, R10, R11, R12)**
06 13 04	5	N/A	N/A
10 13 09	1	N/A	N/A
15 01 11	3 628	N/A	N/A
16 01 11	71	N/A	N/A
16 02 12	55	N/A	N/A
17 06 01	1 626	N/A	N/A
17 06 05	30 499	N/A	N/A
Total	**35 885**	**98 198**	**495**

Source: Ministry of Innovation and Technology

TREATMENT/DISPOSAL FACILITIES



Landfills suitable for disposal of hazardous construction and demolition waste containing asbestos

Source: own map from Ministry of Innovation and Technology data, 2018

Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Hungary	25 720 365	15 405 698	7 669 698

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	9 489	351
3x	18 978	703
4x	18 467	1 054

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	-	-
Exported	-	-

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste generated in 2010-2018

35 885 t

NATIONAL STRATEGY

- No specific national inventory or asbestos removal targets identified.
- The National Waste Management Plan includes a chapter on asbestos
- No guidance documents for asbestos waste management identified, other than a Hungarian translation of the Practical guide to asbestos preventing or reducing the risks of good practice to be followed in order to (potential) asbestos risk work - for employers, workers and workers and labour inspectors for workers and workers' inspectors Senior labour inspectors Committee (SLIC)

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Decree 20/2006 (IV. 5.) KvVM on waste depositing and the specific rules and conditions that refer to waste deposit sites
- Decree 225/2015. (VIII. 7) on the detailed rules for certain activities related to hazardous waste

Guidance:

- None identified, other than a translation of the EU guide published by SLIC

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- No information identified.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Asbestos removal from private buildings appears to be voluntary. When demolishing buildings, professional demolition of asbestos-containing construction material and the removal of asbestos is required. CDW containing asbestos is treated as hazardous waste.

TREATMENT & DISPOSAL

- Legislation: CDW containing asbestos can be disposed of in landfills of subcategory B1b if the waste does not contain any other hazardous substances and the asbestos is covered with a polymer or held together with a binder. CDW containing asbestos may be deposited only in a separate basin for asbestos waste.
- Common practice: ACW is disposed of primarily by means of D5 (Specially engineered landfill).

Additional sources (other than the legislation and guidance documents listed at the top of this page):
Association of Hungarian Asbestos Removers https://azbesztmentes.hu
https://azbeszt.nhkv.hu/azbeszt/ *and* https://azbeszt.nhkv.hu/gyik/#6

COUNTRY PROFILE

Ireland

SOURCES OF ASBESTOS-CONTAINING WASTE

15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES

There are no landfills in Ireland accepting asbestos waste – it is exported to Northern Ireland, Sweden and Germany.

FUTURE PROJECTIONS (2024-2050)

Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Ireland	10 941 113	6 546 446	3 250 446

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	N/A	N/A
3x	N/A	N/A
4x	N/A	N/A

QUANTITIES OF ASBESTOS-CONTAINING WASTE

The only data found on asbestos-containing waste is that the amount of Construction and Demolition waste containing asbestos disposed of in 2014 was 6246 tonnes.

LoW Code	Quantities (tonnes) 2011-2021	
	Generation	**Disposal operations**
15 01 11	N/A	N/A
16 01 11	N/A	N/A
16 02 12	N/A	N/A
17 06 01	N/A	N/A
17 06 05	N/A	N/A
Total	N/A	N/A

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	-	-
Exported	123 856	Denmark, France, Germany, Norway, Netherlands, Sweden, United Kingdom

Source: *Eurostat Waste Shipments Statistics*

Asbestos-containing waste generated in 2011-2021

NATIONAL STRATEGY

- National Hazardous Waste Management Plan 2017 – 2027 was published by the Environmental Protection Agency in 2021
- No targets for screening of public or private buildings identified
- No target dates for asbestos removal identified
- A guidance document on ACM Management and Abatement was published by the Irish Health and Safety Authority in 2013

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Chemicals (Asbestos Articles) Regulations 2011 (S.I. No. 248 of 2011)
- The Safety, Health and Welfare at Work (Exposure to Asbestos) (Amendment) Regulations, 2010 (S.I. No. 589 of 2010)
- The Safety, Health and Welfare at Work (Exposure to Asbestos) Regulations, 2006 (S.I. No. 386 of 2006)
- Safety, Health and Welfare at Work (Construction) Regulations, 2013 (S.I. No. 291 of 2013)

Guidance:

- Practical Guidelines on ACM Management and Abatement, 2013, Irish Health and Safety Authority
- National Hazardous Waste Management Plan 2017 – 2027

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: According to Irish national asbestos legislation, a written risk assessment is required to determine the presence of asbestos containing materials prior to any refurbishment, demolition and maintenance activities of pre-2000 buildings. Suitable plan of work shall be drawn up specifying all preventative measures. Asbestos or asbestos-containing products shall be removed so far as is reasonably practicable before refurbishment or demolition techniques are applied.
- Common practice: It is common practice to conduct a management survey, including a minor disturbance of asbestos to make a materials assessments.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Asbestos containing waste has to be collected and removed from the place of work as soon as possible in suitable sealed packing with labels clearly indicating that it contains asbestos (other than in respect of mining activities carried on at that place). Every employer needs to ensure that protective clothing that came into contact with materials containing asbestos is either disposed of as asbestos waste or adequately cleaned.
- Guidance: Any asbestos waste, debris or contaminated material should be placed into a suitable, UN-approved red bag which contains the appropriate asbestos warning label, and then sealed with duct tape. The red bag should then be wiped clean before being carefully placed into a suitable, approved clear asbestos bag which should then also be sealed. A specific protocol set by the Guidance should be followed for bagging (or wrapping) asbestos waste. A separate protocol should be followed for slates and broken sheeting, and/or for wrapping a large object, e.g. asbestos cement, which cannot fit into the asbestos waste bags. Waste should be stored for the minimum period feasible on-site. Collection, transport and disposal of asbestos waste should only be undertaken by an authorised waste collection permit holder.

TREATMENT & DISPOSAL

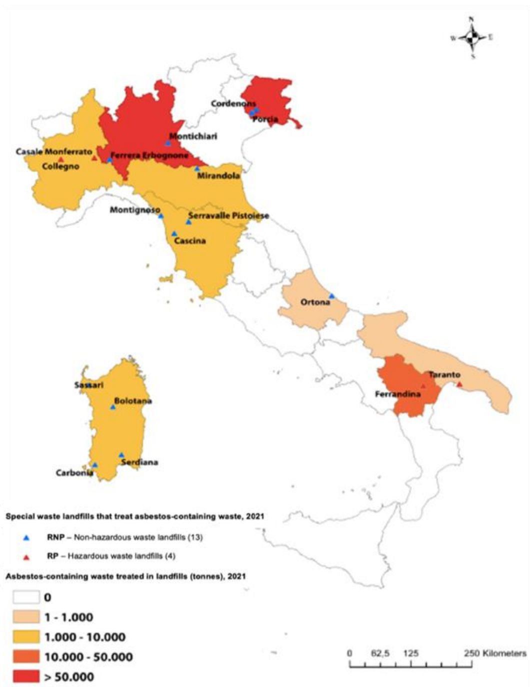
- Guidance: A sealed bulkhead to segregate passengers from waste must be provided in vehicles used to transport asbestos waste. Tools and other equipment should also be segregated to prevent bags being ruptured during transit.
- Prior to any removal work, as part of developing the plan of work, a suitable facility for disposal should be identified. Asbestos waste should be sent to an appropriately authorised facility that accept asbestos-containing waste and then arrange to have the waste disposed of at an appropriate facility abroad. Information on hazardous waste transfer stations is available from the Environmental Protection Agency (EPA). Asbestos waste is exported abroad and disposed of through landfill. The transfrontier shipment of asbestos waste is subject to control procedures under EU and national legislation. All transfrontier shipments of waste originating in any local authority area must be notified to and through Dublin City Council.
- According to the National Hazardous Waste Management Plan (2017 - 2027), the issue related to increasing self-sufficiency needs to be addressed if additional hazardous waste is to be treated in Ireland and export reduced. This includes for instance the development of landfill capacity to manage non-recoverable and non-combustible hazardous wastes and residues, including asbestos.

COUNTRY PROFILE Italy

SOURCES OF ASBESTOS-CONTAINING WASTE

15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES



Source: Italian Institute for Environmental Protection and Research (ISPRA), 2023

FUTURE PROJECTIONS (2024-2050)

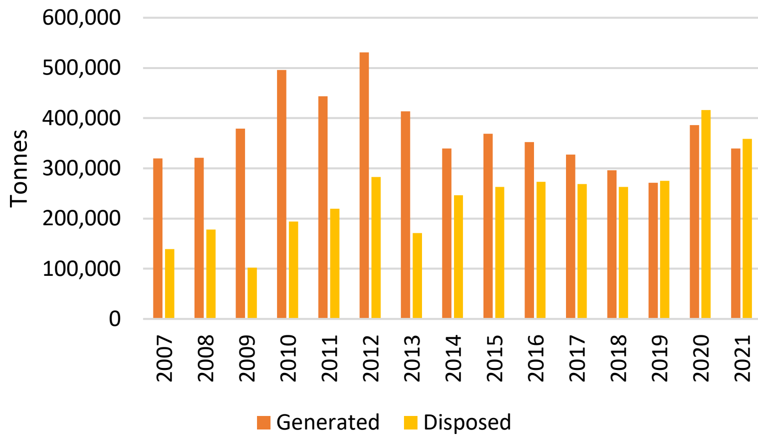
Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Italy	121 149 400	70 109 400	31 829 400

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	1 712 521	63 427
3x	3 425 042	126 853
4x	5 137 563	190 280

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Italian Institute for Environmental Protection and Research (ISPRA)

LoW Code	Quantities (tonnes) 2007-2021	
	Generation	**Disposal operations (D1, D5, D9, D13, D14, D15)**
15 01 11	18 389	19 342
16 01 11	360	338
16 02 12	6 194	7 752
17 06 01	311 818	158 245
17 06 05	5 247 946	3 464 428
Total	**5 584 707**	**3 650 105**

Source: Italian Institute for Environmental Protection and Research (ISPRA)

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	8 718	Croatia, San Marino, Senegal, Germany
Exported	3 569 531	Austria, Denmark, France, Germany, Switzerland

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste generated in 2007-2021

5 584 707 t

NATIONAL STRATEGY

- The National Asbestos Plan defines priorities such as the mapping of materials containing asbestos, the speeding up of the decontamination process, etc.
- Ministero per la Transizione Ecologica (MiTE) and the regions are responsible for mapping the presence of asbestos in Italy within the framework of the National Asbestos Plan. However, the data in the Asbestos Database appear to be patchy.
- INAIL provided a user friendly guideline in order to ease ACW classification and management, but also mapping of contaminated sites, asbestos remediation planning and accurate definition of suitable temporary or preliminary storage as well as landfill disposal.

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Law n. 257/1992
- Legislative Decree n. 36/2003
- Ministerial Decree 101/2003
- Ministerial Decree 248/2004
- Legislative Decree n. 152/2006
- Ministerial Decree 308/2006
- Ministerial Decree 27th September 2010
- Ministerial Decree 21st September 2016

Guidance:

- INAIL DIT (Department of Technological Innovation) Guidelines for classifying and managing asbestos-containing waste (2021)

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Identification of abestos materials is compulsory for public buildings, premises open to the public and for collective use and for apartment blocks, while it is optional for the owners of individual units.
- Common practice: The data in the Asbestos Database is patchy.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Removal of asbestos from buildings is not mandatory. By law there are three systems for dealing with asbestos in buildings, namely the actual removal, the reclamation by overcovering and that by encapsulation; the first one of these generates asbestos waste. Where removal of ACW takes place, it has to be mandatorily performed by certified operators.

TREATMENT & DISPOSAL

- Legislation: ACW may be either landfilled or sent to recovery facilities. Landfilling of ACW must occur at licensed facilities. ACW may be landfilled at hazardous waste landfills or non-hazardous waste landfills (in non-hazardous waste landfills only in case of LoW 17.06.05* and in the case of other ACW provided that they have been treated in accordance with Ministerial Decree 248/2004 and comply with specific limits for asbestos content: 1) Asbestos (% in weight) <30% 2) Apparent density (g/cm3) >2; Relative density (%) > 50; Leachate index <0.6). ACW must be disposed in dedicated cells by means of sectors or trenches positioning. LoW code 15.02.02* may also be landfilled at non-hazardous landfills.
- Common practice: The main method of disposal of construction and demolition ACW in Italy is landfilling.

Additional sources (other than the legislation and guidance documents listed at the top of this page): Responses to DG Grow Survey (2022), Responses to RPA Survey (2023)

COUNTRY PROFILE Latvia

SOURCES OF ASBESTOS-CONTAINING WASTE

06 13 04* - Wastes from asbestos processing
10 13 09* - Wastes from asbestos-cement manufacture containing asbestos
15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES

Landfills accepting asbestos-containing waste

Source: own map from Ministry of Environmental Protection and Regional Development data, 2020

FUTURE PROJECTIONS (2024-2050)

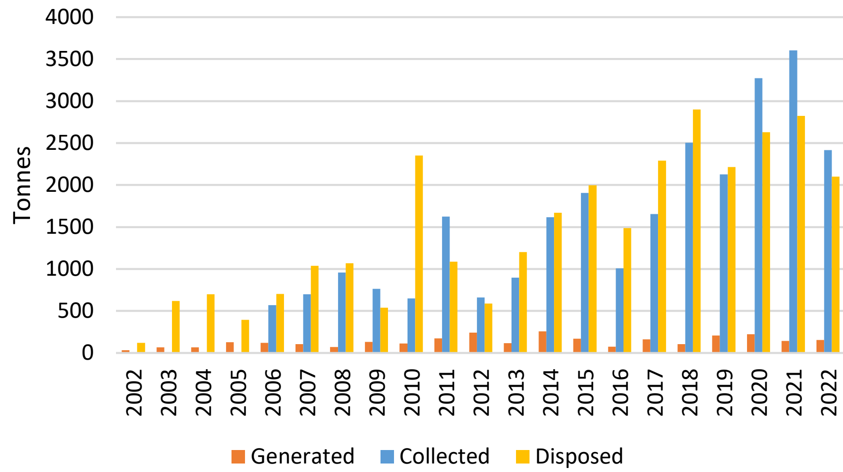
Additional asbestos waste generated due to renovation wave

% asbestos in waste	3%	5%	10%
Latvia	2 905 303	1 731 970	851 970

Asbestos-containing waste that would be generated by total removal of remaining asbestos

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	2 446	91
3x	4 891	181
4x	7 337	272

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Latvian Environment, Geology and Meteorology Center

LoW Code	Quantities (tonnes) 2002-2022			
	Generation	Collection	Disposal operations (D1, D5)	Recovery operations (R12, R13)
06 13 04	7	1	0	1
10 13 09	10	0	0	0
15 01 11	2	0	0	0
16 01 11	790	665	468	0
16 02 12	0	0	0	0
17 06 01	499	2 435	3 072	39
17 06 05	1 568	23 839	26 991	132
Total	**2 876**	**26 938**	**30 531**	**172**

Source: Latvian Environment, Geology and Meteorology Center

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	-	-
Exported	-	-

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste generated and collected in 2002-2022

29 814 t

NATIONAL STRATEGY

- In accordance to State waste management plan for 2021-2028, the proposal for support mechanism for the management of population-specific hazardous waste (containing asbestos) will be developed by the end of 2023.
- Past and current initiatives (e.g. strategies, programmes, subsidies) to encourage and support the removal of asbestos in Latvia have been identified.
- Safe collection, transportation and disposal of household hazardous waste (asbestos) will be ensured by 2028 and environmental and health risks due to asbestos pollution eliminated by implementing safe management activities by 2028.

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Waste Management Law
- Natural Resources Tax Law
- Regulations Regarding Landfill Sites
- Law On Pollution
- Regulation No.301 "Regulations Regarding Environmental Pollution from Production of Asbestos and Asbestos-based Products and Management of Asbestos Waste"
- Regulation No. 1082 "Procedure by Which Polluting Activities of Category A, B and C Shall Be Declared and Permits for the Performance of Category A and B Polluting Activities Shall Be Issued"
- Regulation No. 1032 "Regulations Regarding Landfill Sites"

Guidance:

- No guidance documents identified.

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Asbestos-containing waste in Latvia is managed in accordance with the "Waste Management Law" (as amended, which entered into force on 01.01.2018) and regulations no. 301 "Rules on environmental pollution caused by the production of asbestos and asbestos products and asbestos waste management".

REMOVAL, SEPARATION & COLLECTION

- Legislation: Asbestos-containing materials must be collected and stored as hazardous waste under controlled conditions. The recommended packaging for asbestos-containing waste is bags made of polypropylene material. This packaging should minimise the release of asbestos fibres into the environment, therefore double packaging is also recommended for wastes where asbestos fibres are weakly bonded.
- Common practice: A number of past and current initiatives (e.g. strategies, programmes, subsidies) to encourage and support the removal of asbestos in Latvia have been identified: "Assessment of asbestos-containing waste volumes in Latvian municipalities, the need for management and determining the amount of potential support for households", "Implementation of projects and measures of other European Union policy instruments", "LIFE program IP project Nr.LIFE20 IPE/LV/000014" is under development , and "Waste as resources in Latvia - Promotion of regional sustainability and circulation by introducing the concept of using waste as resources".

TREATMENT & DISPOSAL

- Legislation: Building construction materials containing asbestos are considered hazardous waste. Asbestos waste may be handed over to waste and construction waste collection merchants that have a permit for the management of waste containing asbestos. When transporting and disposing of waste containing asbestos fibres or dust, the transporter or operator shall treat, package and cover it in such a way as to prevent the release of asbestos fibres or dust into the environment. The waste producer must bear the cost of disposing of asbestos waste. Asbestos waste is accepted by seven landfills in Latvia (these are household waste landfills with separate compartments and/or landfills that only accept asbestos-containing waste).
- According to data on waste landfills in Latvia, a large amount of asbestos-containing waste was accepted and buried. It is estimated that a large amount of asbestos waste still remains in the country, it is predicted that its complete disposal will take several decades, thus maintaining it as a relatively common occupational environmental risk factor (Working Conditions and Risks in Latvia, 2017-2018).
- Common practice: It is possible that there have been some small scale projects aiming to recycle asbestos, but in recent years, the waste statistics do not show any activities carried out with asbestos waste.

COUNTRY PROFILE Lithuania

SOURCES OF ASBESTOS-CONTAINING WASTE

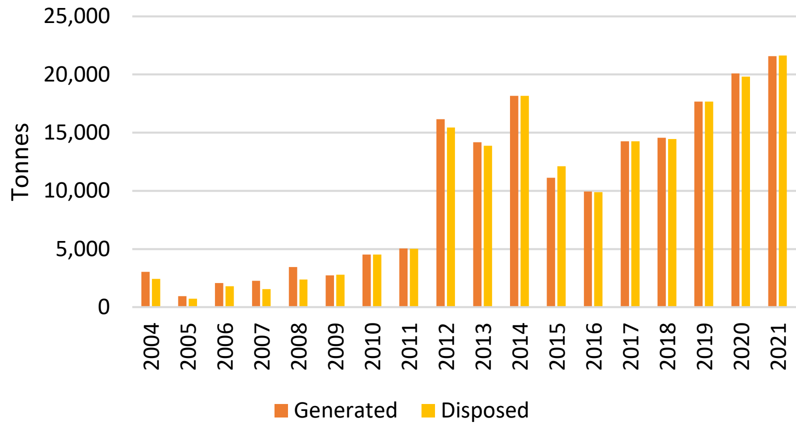
10 13 09* - Wastes from asbestos-cement manufacture containing asbestos
15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES

Landfills accepting asbestos-containing waste

Source: own map from Ministry of the Environment data, 2023

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Environmental Protection Agency

LoW Code	Quantities (tonnes) 2004-2021			
	Generation	**Processing operations (D8, D9, R12, SS)**	**Disposal operations (D1, D5, D10, D14, D15)**	**Recovery operations (R5, R13)**
10 13 09	2 115	0	1 506	0
15 01 11	319	207	16	0
16 01 11	8	2	0	0
16 02 12	0	0	0	0
17 06 01	17 730	48	17 183	3
17 06 05	161 657	1	159 787	15
Total	**181 828**	**258**	**178 493**	**18**

Source: Environmental Protection Agency

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	10	Georgia
Exported	-	-

Source: Eurostat Waste Shipments Statistics

FUTURE PROJECTIONS (2024-2050)

Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Lithuania	4 597 313	2 677 313	1 237 313

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	55 769	2 066
3x	111 538	4 131
4x	167 307	6 197

Asbestos-containing waste generated in 2004-2021

181 828 t

NATIONAL STRATEGY

- Asbestos-related information is provided every 2 years by municipalities to the Environment Protection Agency
- No targets for screening of public or private buildings identified
- No target dates for asbestos removal identified
- Lithuania has a National Waste Prevention and Management Plan (2021-2027). It includes measure to finance the disposal of asbestos waste generated in households to ensure safe disposal of asbestos waste.
- The Ministry of the Environment provides support for the replacement of asbestos roofs.
- One Guidance document on the identification, detection and prevention of exposure to asbestos fibres has been identified

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Law on waste management
- Rules on construction waste management
- Provisions on working with asbestos

Guidance:

- Institute of Hygiene Practical guidelines for the identification, detection and prevention of exposure to asbestos fibres

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: When planning activities that may pose a risk to workers or residents due to asbestos fibers (building demolition, repair, asbestos removal), it is necessary:to gather information about asbestos-containing materials from available documentation; perform qualitative asbestos tests in the absence of data on the composition of the material in the material; identify workplaces where workers may be exposed to asbestos dust; draw up a work plan, and submit samples to the laboratory for qualitative asbestos testing.
- Guidance: The aim of the Guidance is to provide information on asbestos, asbestos fibres identification and detection of asbestos asbestos in the environment, the risk of exposure to asbestos, its reduction or elimination and safe working with asbestos.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Asbestos removal works can be carried out by companies that meet the Competency requirements and are approved by the Minister of Social Security and Labor of the Republic of Lithuania.
- When carrying out work on the removal, demolition or repair of asbestos roofs (slate) coatings and other products containing asbestos, it is necessary to comply with the requirements for safe operation and to ensure that asbestos fibres do not get into the environment. This waste must be collected separately so as not to mix with other waste. Asbestos-containing construction waste generated on a construction site in bulk (emitting asbestos fibres) must be moistened and packaged in sealed plastic containers (double plastic bags, barrels, containers, etc.).
- Packaged construction waste containing asbestos must be labelled and may be temporarily stored on the construction site for a maximum of 6 months after its generation, but not longer than until the completion of construction works.

TREATMENT & DISPOSAL

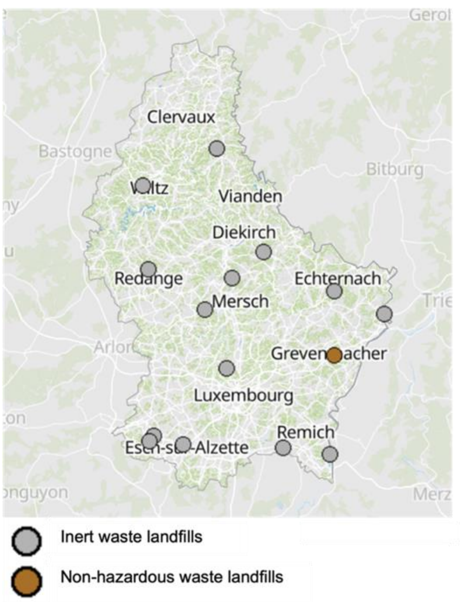
- Legislation: Hazardous waste in Lithuania is landfilled. Construction waste containing asbestos must be disposed of in accordance with the requirements laid down in the Rules for the installation, operation, closure and after-closure maintenance of waste landfills. The requirements state that asbestos waste must be disposed of in a separate section installed at a landfill of any class in accordance with the requirements of inert waste landfills and marked with warning signs.
- Common practice: There is no capacity of asbestos-containing waste recovery in Lithuania.

COUNTRY PROFILE Luxembourg

SOURCES OF ASBESTOS-CONTAINING WASTE

15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES



Information about which of these landfills accept asbestos-containing waste was not found.

Source: www.geoportail.lu

FUTURE PROJECTIONS (2024-2050)

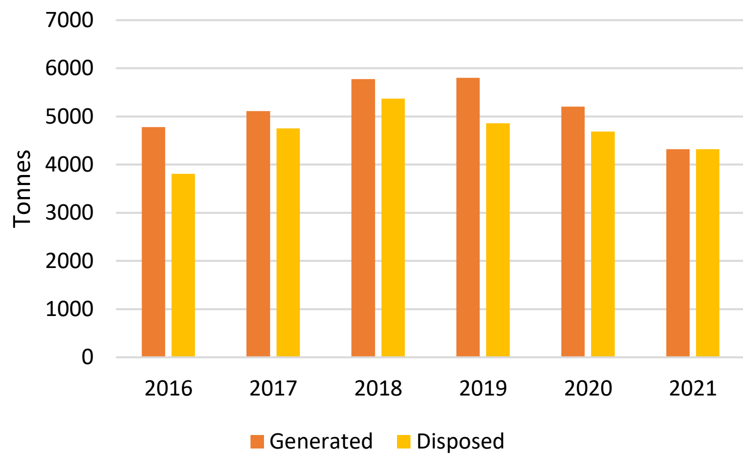
Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Belgium and Luxembourg	59 898 998	35 024 331	16 368 331

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	18 698	693
3x	37 397	1 385
4x	56 095	2 078

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Environment Agency

LoW Code	Quantities (tonnes) 2016-2021		
	Generation	Disposal operations (D1, D5, D12, D13, D15)	Recovery operations (R1, R3, R5, R13)
15 01 11	2	0	0
16 01 11	4	6	0
16 02 12	49	17	5
17 06 01	1 327	947	7
17 06 05	29 613	26 832	953
Total	**30 995**	**27 802**	**964**

Source: Environment Agency

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	-	-
Exported	102 322	Belgium, France, Germany

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste generated in 2016-2021

30 995 t

NATIONAL STRATEGY

- No national plan for asbestos removal identified
- No targets for screening of public or private buildings identified
- No target dates for asbestos removal identified
- One guidance document on work involving asbestos cement has been identified.

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Loi modifie du 21 mars 2012 relative aux dechets: Concerning the Protection of Workers against the Risks Related to Exposure to Asbestos during Work
- Title V, Book III of the Labour Code on the Protection of Workers against Risks Related to Exposure to Chemical, Physical and Biological Agents

Guidance:

- L'amiante – ciment, 2018, Inspection du Travail et des Mines

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Screening is mandatory in Luxembourg. Before starting work, the employer must notify the territorial labor inspectorate and perform a risk assessment. The employer must give a new notification whenever a change in working conditions is likely to lead to a significant increase in exposure to dust arising from asbestos or materials containing asbestos.
- Guidance: Asbestos cement can be recognized by its characteristic embossed texture. Corrugated sheets almost all contain asbestos, especially if it is a fairly old product. In case of doubt, an analysis of the suspect product must be carried out. The Guidance indicates that as soon as the presence of asbestos fibers is suspected, it is strongly recommended to commission an approved organization to carry out an asbestos inventory. The inventory, location and nature of the visible applications of asbestos must be established and a risk assessment must be carried out to recommend response times for the removal of applications containing asbestos.

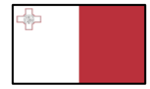
REMOVAL, SEPARATION & COLLECTION

- Legislation: A work plan has to be drawn up before commencing work on the demolition or removal of asbestos and/or materials containing asbestos from buildings and other installations. Asbestos waste must be collected and removed from the workplace as quickly as possible in suitable sealed packaging and properly labelled.
- Guidance: When removing asbestos cement in the open air, a work plan must be submitted for approval to the labor and mining inspectorate. If prevention and protection measures are applied, certain materials containing asbestos can be removed without great risk (e.g. asbestos cement). Waste contaminated with asbestos is considered hazardous waste. It must always be packaged in waterproof plastic bags.
- Common practice: Asbestos waste must be specially packaged in dust- and tear-resistant bags, which are available from approved companies. These must eventually be given to one of the following: approved transport/trading companies (CED2:170605); Recycling center (for smaller quantities) or mobile locations.

TREATMENT & DISPOSAL

- Legislation: Asbestos waste or other asbestos-containing materials must be stored and transported in appropriate closed packaging.
- Guidance: Asbestos waste must be deposited in a specific landfill or undergo treatment by vitrification. The transfer of asbestos waste can only be done by a transport company approved by the Ministry of Environment.
- Common practice: Products or elements containing asbestos must be disposed of properly by an approved company.

COUNTRY PROFILE Malta



SOURCES OF ASBESTOS-CONTAINING WASTE

17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES

Civic Amenity Sites in Malta
Source: Ministry for the Environment, Energy and Enterprise, 2023

Information about which, if any, of these landfills accept asbestos-containing waste was not found.

FUTURE PROJECTIONS (2024-2050)

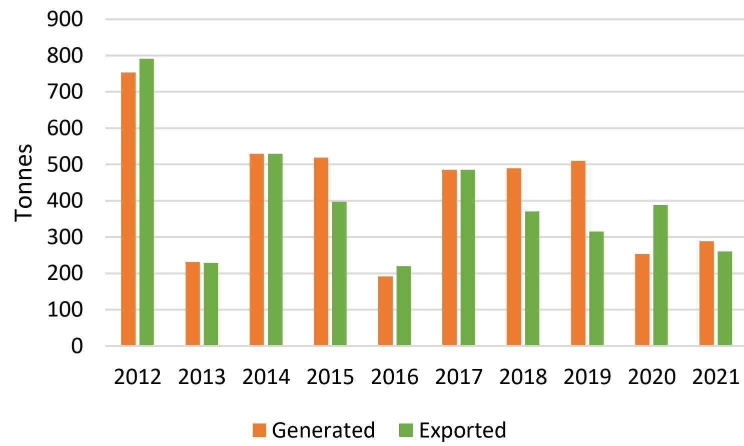
Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Malta	N/A	N/A	N/A

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	682	25
3x	1 365	51
4x	2 047	76

QUANTITIES OF ASBESTOS-CONTAINING WASTE



No asbestos waste was treated locally during these years – all was exported to be disposed of in landfills (D5)

Source: Environment and Resources Authority, 2023

LoW Code	Quantities (tonnes) 2012-2021		
	Generation	Disposal operations	Exported (for D5)
17 06 01	N/A	0	N/A
17 06 05	N/A	0	N/A
Total	**4 251**	**0**	**3 987**

Source: Environment and Resources Authority, 2023

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	-	-
Exported	4 784	Germany, Portugal, Spain

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste generated in 2012-2021

4 251 t

NATIONAL STRATEGY

- Long Term Waste Management Plan (2021 – 2030) was published by the Ministry for the Environment, Climate Change and Planning in December 2020
- No targets for screening of public or private buildings identified
- No target dates for asbestos removal identified
- No guidance document on asbestos removal has been identified

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Protection of Workers from the Risks Related to Exposure to Asbestos at Work Regulations 424.23, 2006
- Waste Regulations, S.L. 549.63, 2011

Guidance:

- No guidance document on asbestos removal identified.

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Before the removal of asbestos by workers, the Environment & Resources Authority must be notified and workers must comply with national legislation regarding safe removal of asbestos.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Asbestos or dust-generating asbestos-containingmaterial must be stored and transported in suitable sealed packing as approved by the Maltese Environment and Planning Authority for such purpose. Waste must be collected and removed from the place of work as soon as possible in suitable sealed packing with labels indicating that it contains asbestos, in accordance with applicable laws and regulations that regulate the disposal of toxic or hazardous materials.
- The Waste Regulations include specific obligations concerning labelling and packaging of hazardous wastes, record keeping as well as monitoring and control procedures on transfers of such wastes within the Maltese Islands. Hazardous wastes are subject to a strict control regime covering their entire life-cycle, from generation to final disposal or recovery (the so-called "from cradle to grave" approach (ERA, 2023)).

TREATMENT & DISPOSAL

- Legislation: Due to the dangerous nature of this group of waste, all hazardous construction and demolition waste is reported and appropriately managed according to Maltese regulations. The main hazardous waste type from construction and demolition is asbestos-containing waste.
- Common practice: Due to lack of appropriate facilities for hazardous waste handling, hazardous construction and demolition waste is exported for landfilling or recovery. Long Term Waste Management Plan (2021 - 2030) stipulates that a mechanism to facilitate access to EU funds for appropriate management of problematic waste streams (including asbestos containing waste) should be set up. Government shall set a mechanism in order to facilitate the access to EU funds for all private operators so such waste streams, which are problematic to manage in an environmental manner are aptly catered for in the Maltese Islands.

COUNTRY PROFILE Netherlands

SOURCES OF ASBESTOS-CONTAINING WASTE

15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES

Landfills that accepted asbestos-containing waste in 2020

Source: own map from [Waste processing in the Netherlands: data for 2020](), 2022

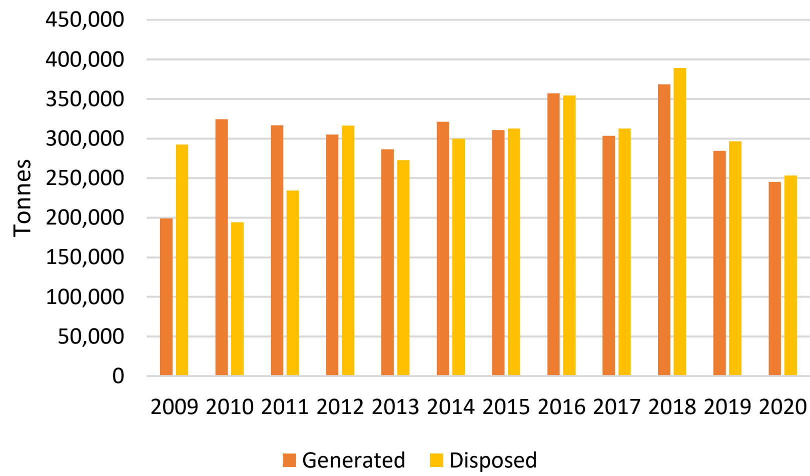
Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Netherlands	14 326 169	6 624 836	848 836

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	1 036 682	38 396
3x	2 073 364	76 791
4x	3 110 046	115 187

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Ministry of Insfrastructure and Water Management, 2023

LoW Code	Quantities (tonnes) 2009-2020	
	Generation	Disposal operations (landfilling)
15 01 11	N/A	N/A
16 01 11	N/A	N/A
16 02 12	N/A	N/A
17 06 01	N/A	N/A
17 06 05	N/A	N/A
Total	**3 623 550**	**3 275 779**

Source: Ministry of Insfrastructure and Water Management, 2023

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	116 056	Belgium, Germany, Norway, Former Netherlands Antilles, United Kingdom
Exported	50 754	Belgium, China (including Hong Kong), Germany, Denmark, Turkey

Source: [Eurostat Waste Shipments Statistics]()

Asbestos-containing waste generated in 2009-2020

3 623 550 t

NATIONAL STRATEGY

- No blanket national strategy for inventorising asbestos in buildings or removal targets. However, there is a focus on removal of asbestos roofs because they can become weathered and damaged.
- In the past, there was a national subsidy for voluntary removal of asbestos roofs. Whilst the national subsidy has been discontinued, some regional governments (provinces, municipalities) still offer local subsidies.
- Several guidance documents identified but these do not provide detailed instructions for asbestos removal and waste management

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Asbestos removal decree (2005)
- Regulation concerning asbestos in products
- National waste management plan: Sector Plan 37
- Other legislation concerning asbestos

Guidance:

- Milieucentraal - Asbestos roof
- Step-by-step plan published by the Central Government

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Screening mandatory before renovation and demolition when asbestos can be expected to be present due to the age of the building (built before 1994) but there are exemptions in Artile 4 of Asbestor Removal Decree 2005. The results must be documented in a report that is provided to the authorities as part of the demolition notice. The screening report and removal is recorded in the national asbestos tracking system (LAVS).

REMOVAL, SEPARATION & COLLECTION

- Legislation: There is clear advice on when private individuals can remove their own asbestos roofs and when they have to engage a professional company.
- Common practice: There is a publicly accessible register of certified asbestos removal companies.

TREATMENT & DISPOSAL

- Legislation: A landfill ban is already introduced in Dutch national legislation. The landfill ban for asbestos cement waste has not come into force yet, because there is no recycling plant/technique available in the Netherlands. For future initiatives, as a technique is operational, this technique has to treat 75 percent of the total amount of asbestos that is yearly produced. The 75 percent is the share of the market that has to be recycled before a landfill ban can come into force.
- Common practice: Currently, asbestos is being landfilled at one of the 18 operational landfill sites in the Netherlands.

Additional sources (other than the legislation and guidance documents listed at the top of this page): Responses to DG Grow Survey (2022), Responses to RPA Survey (2023)

Central Government: The most important asbestos rules, see https://www.rijksoverheid.nl/onderwerpen/asbest/asbestregels

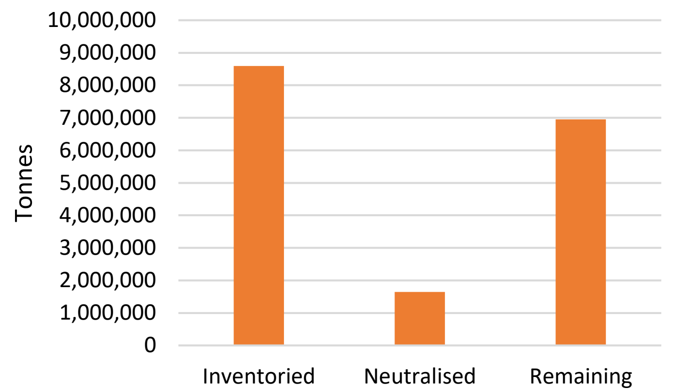
Ascert Foundation register of certified asbestos removal companies: https://www.ascert.nl/zoek-een-certificaat .

COUNTRY PROFILE Poland

SOURCES OF ASBESTOS-CONTAINING WASTE

16 01 11* - Brake pads containing asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos
15 02 02* - Absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances
16 02 13* - Discarded equipment containing hazardous components other than those mentioned in 16 02 09 to 16 02 12
17 09 03* - Other construction and demolition wastes (including mixed wastes) containing dangerous substances
20 01 35* - Discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Polish Asbestos Database, 2023

LoW Code	Quantities (tonnes) as of 06/10/2023		
	Inventoried	**Neutralised**	**Remaining**
16 01 11	14	9	4
17 06 01	44 038	12 942	31 096
17 06 05	8 465 487	1 627 978	6 837 537
15 02 02	195	83	112
16 02 13	4	3	1
17 09 03	112	34	78
20 01 35	5	5	0
No code	86 607	6 907	79 700
Total	**8 596 460**	**1 647 960**	**6 948 528**

Source: Polish Asbestos Database, 2023

Statistics on asbestos-containing waste are published using 22 product codes, categorised under 3 asbestos-specific LoW codes and 4 other LoW codes.

TREATMENT/DISPOSAL FACILITIES

Source: own map from https://bazaazbestowa.gov.pl/pl/ data, 2023

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	-	-
Exported	6 031	Germany, France, Czechia

Source: Eurostat Waste Shipments Statistics

FUTURE PROJECTIONS (2024-2050)

Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Poland	N/A	N/A	N/A

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	N/A	N/A
3x	N/A	N/A
4x	N/A	N/A

Asbestos-containing waste inventoried as of 06/10/2023

8 596 460 t

NATIONAL STRATEGY

- A national plan for asbestos removal exists, but the goals set in it are unlikely to be achieved by 2032 as planned.
- Screening of asbestos containing products exists and divided by areas, the removal progress can be tracked online
- Guidance documents for the management of asbestos waste exist

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Waste Act
- Environmental Protection Law
- Construction Law
- Act of 19 June 1997, Act on the prohibition of the use of asbestos-containing products
- Regulation of 2 April 2004 of the Minister of Labour, Economy and Social Policy concerning conditions of safe use and elimination of products containing asbestos (Text No. 649).

Guidance:

- Guides to the management of asbestos waste (2010)
- National program to manage installed asbestos containing materials 2009-2032 (Council of Ministers, 2002)

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Building owners are often required to maintain registers or records of identified ACMs. These records should include the location, condition, and type of asbestos-containing materials within the building. When asbestos is identified and may be disturbed during renovation or demolition, the responsible party must notify the relevant authorities, such as the local environmental or occupational safety agencies. Assessment of the condition and feasibility of safe use of asbestos-containing products is made on the basis of an on-site inspection and laboratory tests of asbestos-containing products and their places of use in the building under examination.
- Guidance: Information on asbestos-containing products is updated on the map of asbestos-containing objects in the territory of the Republic of Poland.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Removal must be carried out by licensed and certified asbestos removal contractors following strict safety procedures. After removal and before deposition, asbestos waste must be wrapped with polyethylene foil.
- Guidance: The National Fund for Environmental Protection and Water Management allocated funds for for dismantling, export and disposal of asbestos-containing waste for 2016-2021, but the co-financing does not cover purchasing replacement materials, which reduces interest.

TREATMENT & DISPOSAL

- Legislation: The sole legally sanctioned method for dealing with asbestos waste in Poland involves its containment in designated hazardous waste landfills or specific sections within landfills reserved for non-hazardous and inert waste. This waste should be placed within specialized subterranean storage units known as "cells."
- Common practice: Out of the planned 84 asbestos-related landfills in Poland, there are currently 59 in existence. Of these, only 31 are accessible for use, while the rest are either closed, serving as on-site storage areas (3 landfills), or are only in the planning stage (2 landfills). Landfills are not evenly distributed across the country. Another concern is the insufficient number of landfills in regions with the highest volumes of asbestos waste.

Additional sources (other than the legislation and guidance documents listed at the top of this page):

Responses to DG Grow Survey (2022), https://www.tf.lbtu.lv/conference/proceedings2023/Papers/TF188.pdf, https://bazaazbestowa.gov.pl//pl/, https://esip.bazaazbestowa.gov.pl/analizy.html, https://www.sciencedirect.com/science/article/pii/S2772912523000118#:~:text=Since%20the%20end%20of%20the,expected%20to%20end%20by%202032, https://www.sciencedirect.com/science/article/pii/S2772912523000118#bib3, https://www.sciencedirect.com/science/article/abs/pii/S030147971730823X, https://link.springer.com/article/10.1007/s10163-018-0796-4 , https://gsm.min-pan.krakow.pl/The-pace-of-removing-asbestos-containing-products-in-Poland-and-the-forecast-time,152824,0,2.html.

COUNTRY PROFILE Portugal

SOURCES OF ASBESTOS-CONTAINING WASTE

17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES

Source: own map from [Environment Agency data](), 2022

FUTURE PROJECTIONS (2024-2050)

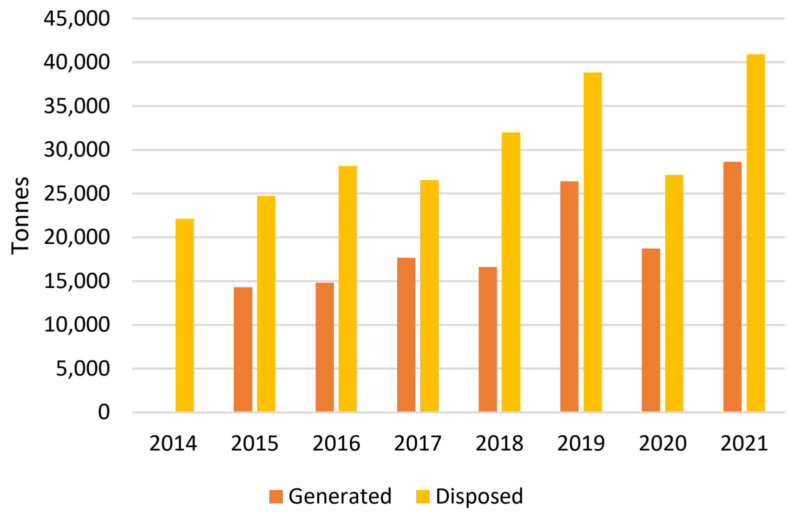
Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Portugal	11 726 665	6 905 332	3 289 332

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	46 053	1 706
3x	92 107	3 411
4x	138 160	5 117

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: [Environment Agency]()

LoW Code	Quantities (tonnes) 2014-2021	
	Generation	Disposal operations (D1, D15)
15 01 11	N/A	N/A
16 01 11	N/A	N/A
16 02 12	N/A	N/A
17 06 01	N/A	N/A
17 06 05	N/A	N/A
Total	**137 185**	**240 437**

Source: [Environment Agency]()

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	5 059	Greece, Malta, Nigeria, Oman
Exported	3 279	Germany, Spain

Source: [Eurostat Waste Shipments Statistics]()

Asbestos-containing waste generated in 2015-2021

137 185 t

NATIONAL STRATEGY

- No blanket national targets for screening of buildings or asbestos removal identified
- There is an ongoing government programme to remove asbestos from schools. The Heritage Rehabilitation and Conservation Fund finances asbestos removal from public (and similar) buildings. Schools are a particular focus.
- Work undertaken the Portuguese Quality Institute TC 214 on standardisation of inventory, screening, risk assessment, removal, exposure assessment and decontamination.

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Portaria (ordinance) n.¬∫ 40/2014 on the removal of materials containing asbestos and for the conditioning, transportation and management of the generated CDW
- Decreto-lei (decree-law) n.¬∫ 102-D/2020
- Decreto-lei (decree-law) n.¬∫ 178/2006 on the management of CDW
- The Heritage Rehabilitation and Conservation Fund, Decree-Law No. 24/2009 and Despacho (Official Communication) n¬∫ 6573-A/2020

Guidance:

- Work undertaken by the Portuguese Quality Institute Technical Committee TC 214 Asbestos, with experts that are developing technical standards for defining the best methods

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Prior to the start of the work, all suspected asbestos containing materials must be identified, differentiating between friable and non-friable asbestos. In case of doubt, samples must be analysed. All asbestos containing materials in the building in question must be inventoried.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Asbestos-containing materials must be removed prior to demolition,except where this is technically impossible. Prior written agreement between the company responsible for removal of asbestos containing materials and the final recipient of ACW (landfill) must be in place. ACW must be kept intact, not be fragmented or shredded to avoid the dispersion of fibers and debris. There are detailed rules on packaging and transport of ACW.

TREATMENT & DISPOSAL

- Legislation: The reuse of asbestos containing materials, recycling or other forms of valorisation of ACW is prohibited, without prejudice to eventual adaptation to scientific and technical progress. ACW must be diisposed of by landfilling or other processes or methods that are shown to be adequate.
- Common practice: For construction and demolition waste with asbestos (17 06 01 and 17 06 05 from the list of Europen Waste Codes) there is only the possibility of 2 D Codes: D1 - Landfill and D15 - Storage before going to the landfill in waste data from the Portugese Environment Agency (APA). There is no possibility of treatment or recycling of ACW in Portugal.

Additional sources (other than the legislation and guidance documents listed at the top of this page):

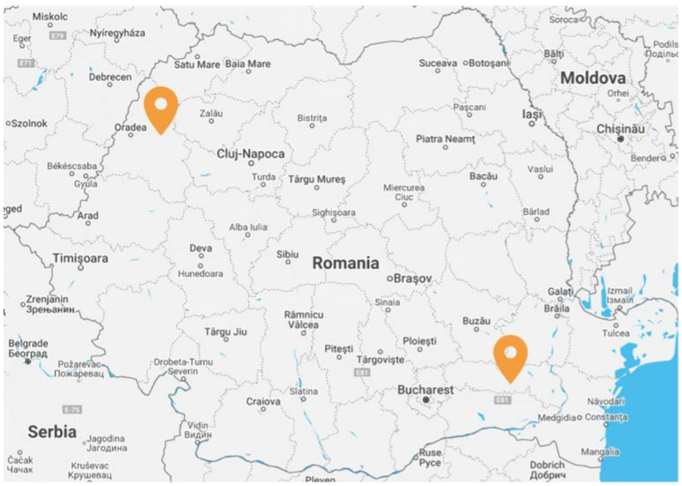
Responses to RPA Survey (2023)

COUNTRY PROFILE Romania

SOURCES OF ASBESTOS-CONTAINING WASTE

15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES



Non-hazardous waste landfills equipped with special cells to store asbestos-containing waste

Source: own map from *Planul Național de Gestionare a Deșeurilor (PNGD)* *data, 2017*

FUTURE PROJECTIONS (2024-2050)

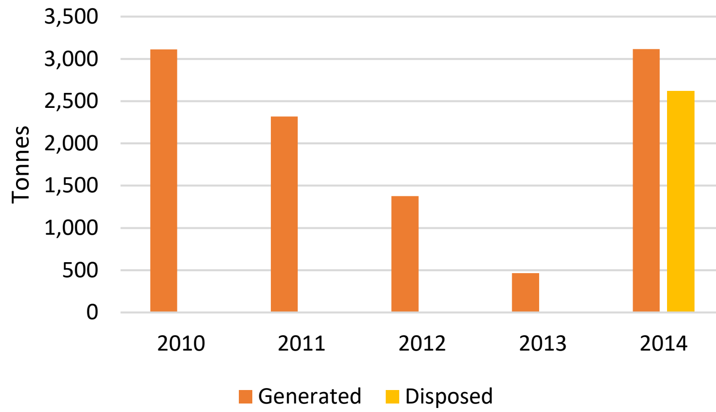
Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Romania	9 263 261	5 540 594	2 748 594

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	4 282	159
3x	8 563	317
4x	12 845	476

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Planul Național de Gestionare a Deșeurilor (PNGD), 2017

LoW Code	Quantities (tonnes) 2010-2014	
	Generation	**Disposal operations (D5, D10)** [only for 2014]
15 01 11	N/A	N/A
16 01 11	N/A	N/A
16 02 12	N/A	N/A
17 06 01	N/A	N/A
17 06 05	N/A	N/A
Total	**3 117**	**2 622**

Source: Planul Național de Gestionare a Deșeurilor (PNGD), 2017

The plan specifies the amounts of asbestos-containing waste reported for the period 2010 – 2014 are estimated.

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	-	-
Exported	-	-

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste generated in 2010-2014

3 117 t

NATIONAL STRATEGY

- National Plan for Waste Management (2014 – 2020) has been identified
- Additional collection and transfer network centres are planned to be created by the end of 2025
- No targets for screening of public or private buildings identified
- No target dates for asbestos removal identified
- A guidance document on asbestos containing waste management was published by the National Agency for Environmental Protection in 2007

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- HOTĂRÂRE nr. 1.875 din 22 decembrie 2005 on the protection of health and safety of workers from the risks due to exposure to asbestos
- Collection and storage of asbestos waste (dust, fibres, scrap) | Norm, 1996

Guidance:

- Guide to asbestos containing waste management, 2007, National Agency for Environmental Protection

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Screening is mandatory in Romania. Before starting work, the employer must notify the territorial labor inspectorate and perform a risk assessment. The employer must give a new notification whenever a change in working conditions is likely to lead to a significant increase in exposure to dust arising from asbestos or materials containing asbestos. Employers shall, where necessary, request information from the owners of buildings in order to identify materials presumed to contain asbestos.

REMOVAL, SEPARATION & COLLECTION

- Legislation: A work plan has to be drawn up before commencing work on the demolition or removal of asbestos and/or materials containing asbestos from buildings and other installations. Workers must wear protective suit, respiratory protection, gloves, glasses, work shoes. During the work, dust production should be eliminated as much as possible, the product is moistened with a binding agent. Asbestos or materials emitting asbestos dust or containing asbestos must be stored and transported in suitable sealed packaging. Waste must be collected and removed from the place of work as soon as possible in suitable sealed packaging with labels indicating that it contains asbestos. Asbestos containing waste must be subsequently treated in accordance with the legal provisions relating to hazardous waste. The National Plan for Waste Management, 2014 - 2020 stipulates that additional collection and transfer network (collection/storage centres) are planned to be created or extended (i.e. the existing ones) to take small quantities of asbestos-containing waste by 2025.
- Common practice: Products with asbestos fibres are disposed of by qualified specialists (with proof of expertise).

TREATMENT & DISPOSAL

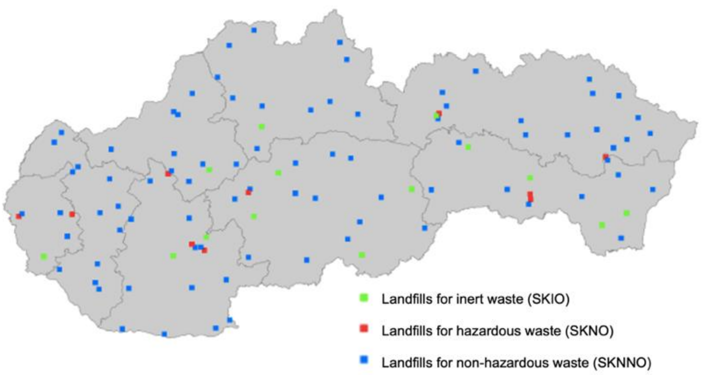
- Legislation: Recycling of waste containing asbestos is prohibited by law due to the toxicity and hazardousness of the material. Romanian legilation indicates that asbestos waste shall be transported to the points of deposition in such a way that no emissions of asbestos dust occur during transport.
- Guidance: In 2014, 99% asbestos-containing waste in Romania was disposed of in landfill, i.e. approximately 2,600 tonnes. 22 tonnes of asbestos waste was incinerated (The National Plan for Waste Management, 2014 - 2020). At national level there are two non-hazardous waste landfills equipped with special cells for the storage of asbestos-containing waste and other hazardous waste. They cover complex waste management activities including take-over, transport, temporary or final storage, processing, etc. The total designed capacity of the two depots is 114,158 m3 (135,491 tonnes).

COUNTRY PROFILE Slovak Republic

SOURCES OF ASBESTOS-CONTAINING WASTE

15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

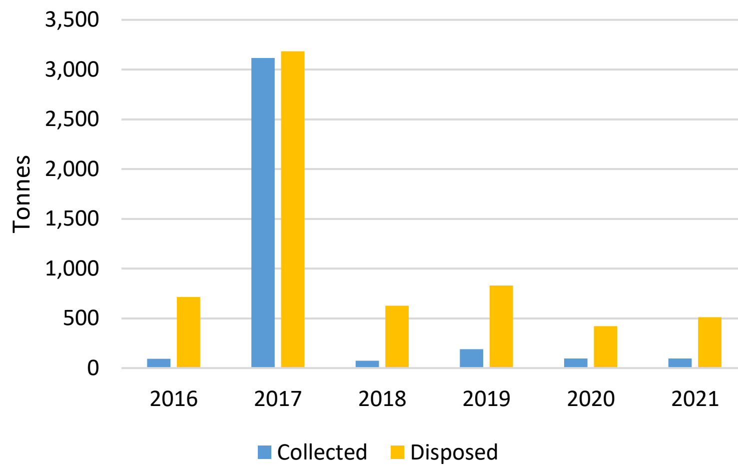
TREATMENT/DISPOSAL FACILITIES



Information on which of these landfills accept asbestos-containing waste could not be found.

Source: [Waste management program of the Slovak Republic for the years 2021-2025](), 2019

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Ministry of Environment, 2023

LoW Code	Quantities (tonnes) 2016-2021			
	Generation	**Collection**	**Disposal operations (D1, D2, D9, D10, D12, D13, D14, D15)**	**Recovery operations (R1, R4, R5, R9, R10, R11, R12, R13)**
15 01 11	N/A	176	351	75
16 01 11	N/A	6	28	2
16 02 12	N/A	0	0	1
17 06 01	N/A	51	369	0
17 06 05	N/A	3 431	5 540	28
Total	**N/A**	**3 664**	**6 288**	**105**

Source: Ministry of Environment, 2023

FUTURE PROJECTIONS (2024-2050)

Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Slovak Republic	34 635 513	20 779 513	10 387 513

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	336	12
3x	671	25
4x	1 007	37

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	-	-
Exported	-	-

Source: [Eurostat Waste Shipments Statistics]()

Asbestos-containing waste generated in 2016-2021 t

NATIONAL STRATEGY

- No national plan for asbestos removal identified
- Screening of buildings is mandatory before construction works
- No target dates for asbestos removal identified
- No guidance document for asbestos waste identified

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- Law No. 79/2015 Z. z. Waste Act and Amendment and Supplements.
- Regulation of the Government of the SR No. 253/2006 Coll. on the protection of workers from the risks related to exposure to asbestos at work (Governmental Decree)
- Act No. 355/2007 Coll. on protection, promotion and development of public health and on change and amendment to some acts in wording of later regulations
- Regulation of the Government of the SR No. 253/2006 Coll. on the protection of workers from the risks related to exposure to asbestos at work

Guidance:

NA

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Screening for asbestos in buildings is mandatory. Before starting demolition work or maintenance work, the employer is obliged to take all available measures to identify materials with a presumed asbestos content, including obtaining the necessary information from building owners. Property owners and developers planning construction, renovation, or demolition projects in Slovakia are typically required to conduct asbestos surveys to identify and document the presence of asbestos-containing materials in buildings and structures.
- Guidance: Both visible and non-visible asbestos is screened and a certificate is issued upon completion.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Only licenced companies perform removal of asbestos. Proposal for removal of asbestos from buildings submitted by licenced companies. After removing asbestos from the building, authorized companies submit a notification to the regional public health office, which includes, for example, the type of asbestos removed, the number of workers, and the amount of asbestos removed. Record keeping requirements are in place.
- Guidance: The removal of asbestos-containing material is done by a company that must be licensed by the Public Health Authority. Asbestos waste must be securely packaged and labeled to prevent the release of asbestos fibers during transport and disposal. This typically involves double-bagging or double-wrapping the waste in sealed, airtight containers. The waste is stored in plastic bags so that the asbestos fibres do not spread into the air.

TREATMENT & DISPOSAL

- Legislation: In the Slovak Republic, according to the law, only landfilling of asbestos-containing waste is allowed. The waste can be disposed only at a hazardous waste landfill.
- Common practice: The country has specific facilities and landfills that are authorized to accept and handle asbestos waste. These facilities are equipped to handle hazardous materials, including asbestos, in compliance with safety and environmental regulations.

Additional sources (other than the legislation and guidance documents listed at the top of this page): Responses to DG Grow Survey (2022), Responses to RPA Survey (2023)

COUNTRY PROFILE

Slovenia

SOURCES OF ASBESTOS-CONTAINING WASTE

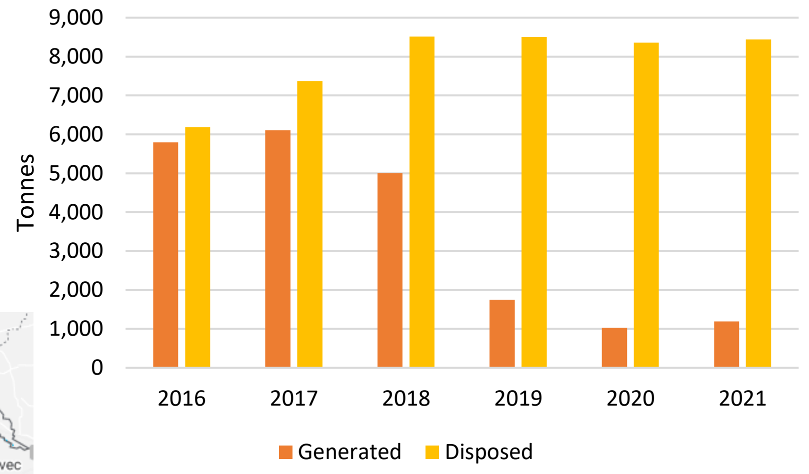
06 13 04* - Wastes from asbestos processing
10 13 09* - Wastes from asbestos-cement manufacture containing asbestos
15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES

Landfills with an environmental permit for asbestos-containing waste disposal as of July 2023

Source: own map from [Ministry of the Environment, Climate and Energy data](), 2023

QUANTITIES OF ASBESTOS-CONTAINING WASTE



Source: Slovenian Environment Agency

LoW Code	Quantities (tonnes) 2016-2021		
	Generation	**Disposal operations (D1, D9, D12, D13)**	**Recovery operations (R12, R13)**
06 13 04	2	0	0
10 13 09	1	0	0
15 01 11	104	259	0
16 01 11	1	2	0
17 06 01	54	43	0
17 06 05	20 723	47 074	908
Total	**20 884**	**47 378**	**908**

Source: Slovenian Environment Agency

FUTURE PROJECTIONS (2024-2050)

Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Slovenia	15 587 536	9 326 202	4 630 202

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	16 897	626
3x	33 793	1 252
4x	50 690	1 877

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	-	-
Exported	2 953	Austria, Germany

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste generated in 2016-2021

20 884 t

NATIONAL STRATEGY

- No specific national plan for asbestos removal identified but asbestos removal is included in the waste management and prevention programme.
- No targets for screening of public or private buildings identified
- No target dates for asbestos removal identified
- No guidance document for asbestos removal exist

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- *Waste Regulation (37/2015 and 69/2015)*
- *Decree on management of waste containing asbestos (Official Gazette of the Republic of Slovenia, no. 34/08 and 44/22 – ZVO2)*
- *Decree on waste landfill (Official Gazette of the Republic of Slovenia, no. 10/14, 54/15, 36/16,37/18, 13/21 and 44/22 – ZVO-2*

Guidance:

NA

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Asbestos is considered as hazardous waste, which needs special treatment and disposal. According to the Waste Regulation stipulates that the original generators and operators of waste treatment must report the amount of waste by individual waste number and their handling, precisely per statistical region. The obligation to report on the generated waste and how to deal with it is for all business entities that have produced 10 tons or more of non-hazardous waste or 5 kg or more of hazardous waste during their activities, or if they employed 10 or more people in the previous year. The obligation to report on treated waste belongs to all treatment providers who are entered in the register of treatment providers (processors, disposers) at the Agency of the Republic of Slovenia for the Environment. Reporting takes place once a year, until March 31 of the current year for the previous year. The data is thus updated annually.

REMOVAL, SEPARATION & COLLECTION

- Legislation: All types of asbestos waste must be treated with processes of hardening or destruction of asbestos fibres or packed in bags in such a way as to prevent the release of asbestos fibres into the environment. There are specific criteria on what materials the packages used to package different asbestos waste are made of and for the solidification of asbestos waste. It is prohibited to mix asbestos waste with other waste, both hazardous and non-hazardous. If asbestos waste intended for collection, transport or processing is mixed with other waste, substances or objects, their separation must be ensured. Containers and bags in which asbestos waste is stored must be clearly marked.
- Common practice: The Republic of Slovenia is currently offering a loan for the replacement of asbestos roofing at a favourable interest rate, with a repayment period of up to 10 years.

TREATMENT & DISPOSAL

- Legislation: The treatment of asbestos-containing waste is prohibited, except for the consolidation of asbestos waste or the destruction of asbestos fibres. Specifically, the reuse of asbestos-cement products and the preparation of asbestos waste for their reuse are prohibited as is the recycling of asbestos waste. Permitted processes for the processing of asbestos waste are: hardening and destruction of asbestos fibres.
- Common practice: In general, asbestos-containing waste is disposed of, mainly by landfilling in hazardous waste landfills. Asbestos-cement waste may be disposed of in non-hazardous waste landfills under the conditions laid down in the Decree on waste landfill.

Additional sources (other than the legislation and guidance documents listed at the top of this page):
Responses to DG Grow Survey (2022), Responses to RPA Survey (2023)

COUNTRY PROFILE Spain

SOURCES OF ASBESTOS-CONTAINING WASTE

15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
16 02 12* - Discarded equipment containing free asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

QUANTITIES OF ASBESTOS-CONTAINING WASTE

No information was found at national level.

LoW Code	Quantities (tonnes) 2011-2021	
	Generation	**Disposal operations**
15 01 11	N/A	N/A
16 01 11	N/A	N/A
16 02 12	N/A	N/A
17 06 01	N/A	N/A
17 06 05	N/A	N/A
Total	**N/A**	**N/A**

TREATMENT/DISPOSAL FACILITIES

Source: https://sig.mapama.gob.es/geoportal/

The map shows all landfills in Spain. Information about which of these landfills accept asbestos-containing waste could not be found.

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	17 277	Andorra, Greece, Italy, Portugal, United Kingdom, Malta
Exported	2 001	Czechia, Germany

Source: Eurostat Waste Shipments Statistics

FUTURE PROJECTIONS (2024-2050)

Asbestos-containing waste that would be generated by total removal of remaining asbestos

% asbestos in waste	3%	5%	10%
Spain	N/A	N/A	N/A

Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	N/A	N/A
3x	N/A	N/A
4x	N/A	N/A

Asbestos-containing waste generated in 2011-2021

NATIONAL STRATEGY

- No national plan for asbestos removal identified
- Act 7/2022 law includes screening of buildings by municipalities but is yet to be implemented
- No target dates for asbestos removal identified
- A guidance document for asbestos waste exist (Ministry of Employment and Social Security 2016)

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- [Act 7th December 2001 on limitations for commercialization and use of several substances and dangerous compounds]
- [Royal Decree 105/2008, on the regulation of production and management of construction and demolition waste]
- [Act 7/2022 on residues and contaminated soils in a circular economy approach]
- [Order MAM/304/2002]
- [Law 22/2011, of July 28, on waste and contaminated soils]

Guidance:

- [Asbestos Waste from the Producer to the Manager]
- [Norma UNE 171370-2 "Asbestos. Part 2: Localisation and diagnosis of asbestos.]

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: Identification of asbestos containing waste during demolition and renovation work is mandatory. There is an obligation to separate asbestos containing waste during demolition and to remove it. The 2022 Law on Waste and Contaminated Soils for a Circular Economy obliges municipalities to take measures in terms of screening and managing high risk facilities by 2028.
- Guidance: There is a register RERA Registro de empresas con riesgo amianto (register of companies with asbestos exposure risk) which is publicly available.

REMOVAL, SEPARATION & COLLECTION

- Legislation: In Spanish law, the local authorities have to collect hazardous waste from citizens. The removal and disposal of asbestos containing waste has to be mandatorily performed by certified operators.
- Guidance: In practice, collection is done either by providing collection points or organising collections from the citizens.

TREATMENT & DISPOSAL

- Legislation: Non friable asbestos waste can be disposed in non-hazardous landfills. Building materials containing asbestos and other asbestos waste may be disposed of in landfills for non-hazardous waste, without prior testing, if efforts are made to prevent fiber dispersion by using sealed waste, covering the storage area daily and after compaction, and avoiding activities that might release fibers. Post-closure measures include keeping records of asbestos waste locations and limiting land use to avoid human contact with the waste, ensuring safety and environmental protection during disposal.
- Common practice: Some hazardous substances can be deposited in landfills for non-hazardous waste but they have to be deposited in a specific cell.

Additional sources (other than the legislation and guidance documents listed at the top of this page):
Responses to DG Grow Survey (2022), Responses to RPA Survey (2023), Spain, interview, 3rd October 2023, https://www.insst.es/materias/riesgos/riesgos-quimicos/amianto, Order AAA/661/2013.

COUNTRY PROFILE Sweden

SOURCES OF ASBESTOS-CONTAINING WASTE

15 01 11* - Metallic packaging containing a dangerous solid porous matrix (e.g., asbestos)
16 01 11* - Brake pads containing asbestos
17 06 01* - Insulation materials containing asbestos
17 06 05* - Construction materials containing asbestos

TREATMENT/DISPOSAL FACILITIES

Source: Naturvårdsverket, 2022

As of 2018, there were 265 landfills in operation in Sweden: 60 hazardous waste landfills, 133 non-hazardous waste landfills and 72 inert waste landfills. Information about which of these landfills accept asbestos-containing waste could not be found.

FUTURE PROJECTIONS (2024-2050)

Asbestos-containing waste that would be generated by total removal of remaining asbestos

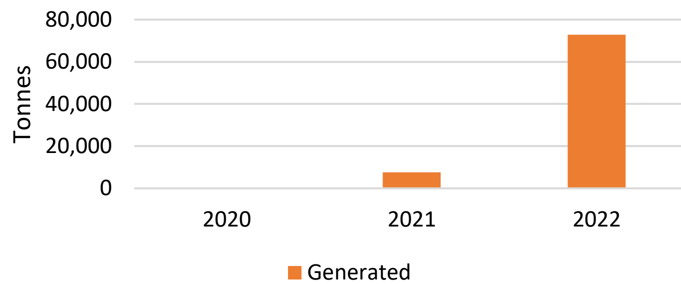
% asbestos in waste	3%	5%	10%
Sweden	13 348 892	7 834 225	3 698 225

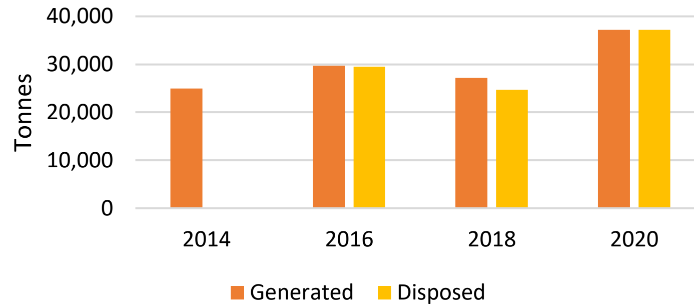
Additional asbestos waste generated due to renovation wave

Renovation rate	Total additional waste generated (t)	Annual average increase (t)
2x	82 142	3 042
3x	164 283	6 085
4x	246 425	9 127

QUANTITIES OF ASBESTOS-CONTAINING WASTE

Two different sets of data were found, shown in the two graphs. Only the first set classified waste according to the LoW.





LoW Code	Quantities (tonnes) 2020-2022	
	Generation	Disposal operations
15 01 11	97	N/A
16 01 11	0	N/A
17 06 01	4 776	N/A
17 06 05	75 933	N/A
Total	**80 806**	**N/A**

Source: Swedish Environmental Protection Agency, 2023

IMPORTS AND EXPORTS (2001 – 2020)

	Quantities (tonnes)	Countries
Imported	3 396	Ireland
Exported	30	Finland, Denmark

Source: Eurostat Waste Shipments Statistics

Asbestos-containing waste generated in 2020-2022

80 806 t

NATIONAL STRATEGY

- No national or regional targets for screening of buildings identified
- No target dates for asbestos removal identified
- A number of guidance documents exist, including a detailed guide from the Swedish Waste Management Association on the handling of asbestos waste at civic amenity sites that contains useful advice on identification, handling and disposal of ACW

NATIONAL LEGISLATION AND GUIDANCE ON ASBESTOS WASTE MANAGEMENT

Legislation:

- SEPA's regulations on deposit and receiving of waste at disposal facilities
- The Environmental Code and its Ordinances (provisions on handling hazardous waste)
- Regulation of the transportation of hazardous waste and its traceability
- The Swedish Work Environment Authority's regulations on asbestos and general advice on the application of the regulatio 2006 (amended in 2019) (includes guidance)

Guidance:

- Swedish Waste Management Association: 2020:13: Handling of asbestos at Civic Amenity Sites
- Swedish Waste Management Association: Construction and reuse guide
- Swedish Waste Management Association: 2017:21 Where is the hazardous waste destined? A compilation on the treatment of hazardous waste in Sweden and Europe

ASBESTOS WASTE MANAGEMENT PRACTICES

IDENTIFICATION

- Legislation: It is mandatory to screen the possible presence of asbestos before any construction or demolition work is carried out in a building or facility where asbestos may be present. This relates to oth visible and non-visible materials. When there is the slightest doubt as to whether a building or a technical device contains asbestos or asbestos-containing material, the employer must request clarification from the owner of the building or the technical device. Demolition involving asbestos must be notified to the Swedish Work Environment Authority in advance.

REMOVAL, SEPARATION & COLLECTION

- Legislation: Materials containing > 1% w/w of asbestos, construction and demolition work requires a permit from the Swedish Working Environment Authority. ACW must be, as far as possible, be removed before demolition of other parts of the building begins. Rules on training, access to the site and working procedures (reduce dust generation, PPE/hygiene, etc.), etc. are provided in the Swedish Work Environment Authority's regulation and guidance on asbestos. The regulations do not apply to private individuals handling asbestos.

TREATMENT & DISPOSAL

- Common practice: ACW is landfilled (including in non-hazardous landfills)

Additional sources (other than the legislation and guidance documents listed at the top of this page):

Responses to DG GROW Survey (2022), Responses to RPA Survey (2023)

https://www.av.se/en/production-industry-and-logistics/asbestos/permits-notifications-and-forms-concerning-asbestos/

Annex 2 Methodology for estimating future trends and projections

Estimating and projecting the future generation of asbestos waste requires some knowledge of the likely quantity of asbestos that has been used in construction in the past, the amount that has been removed and, therein, the likely quantity likely to be remaining *in situ*. This, then, provides a basis for examining and predicting future scenarios and the likely impact of building renovation and 'the renovation wave'.

The Maduta et al. (2022) report 'Towards energy efficient and asbestos free dwellings through deep energy renovation' and the subsequent 2023 report 'Identification of vulnerable EU regions considering asbestos presence and seismic risk' provide an excellent starting point. The authors conducted a data search on asbestos consumption in Europe and found that a US Geological Survey Circular on worldwide asbestos supply and consumption trends from 1900 through 2003[200] provided the most comprehensive data on asbestos production, imports and exports.

Combining these data with data on building construction, the authors produced a number of figures detailing estimated quantity of asbestos in dwellings and, in combination with population data, data endpoints such as kg per capita per year for each member State (MS). These data were then used to produce composite indicators to highlight Europe's regions in need of renovation (for the purpose of energy saving potential and in relation to seismic risk).

From these reports, data on the quantity of asbestos embedded in buildings in different MS is clearly of relevance. However, given the large amount of data that would have been generated and the need to focus on the subject of the reports (i.e., energy efficiency and seismic risk depending on the report) the authors present summary data in units relevant to the respective studies (such as kg/capita per year or kg/dwelling per year) and usually in the form of figures (as opposed to tables of data).

It is thus difficult to extract and use the data as presented and re-engineer it into more convenient units of more relevance to this particular projection. In order to get around this issue we have reproduced some of the work undertaken by the authors by going back to their primary data source, namely the US circular (Virta, 2006) and so to build our own dataset and model tailored to the purpose.

A2.1 Consumption of raw asbestos

The US circular provides the available data on the 'apparent consumption[201]' of raw asbestos in countries worldwide since 1920. This is provided at 10 yearly intervals from 1920 to 1970, five yearly from 1970 to 1995 and annual data from 1995 to 2003. As with the Maduta *et al* work, we have interpolated the intervening years using a linear method to produce a full dataset for all years of apparent consumption of raw asbestos from 1920 to 2003. Reflecting the geopolitical changes (particularly in Europe) over the period, the US Circular provides data for the Soviet Union, Czechoslovakia and Yugoslavia in the relevant years. These data have been divided between the relevant member states by using the data provided in the circular for the first few years of independence. Particularly given the age of some of the underlying statistical data sources and the need to interpolate and apportion data to former 'Eastern Bloc' MS, the resulting data set should be

[200] Virta, R., 2006. Worldwide Asbestos Supply and Consumption Trends from 1900 through 2003 (Circular 1298). US Geological Survey

[201] Production plus imports minus exports

regarded as an estimate (albeit the best available estimate) of raw asbestos consumption in Europe since 1920.

The resulting total apparent consumption since 1920, 1930, 1940, 1945 and 1950 are provided in Table A2-1 below.

Table A2-1: Cumulative total apparent consumption of raw asbestos (t rounded to nearest 1 000)

	Since 1920	since 1930	Since 1940	Since 1945	Since 1950
Austria	862,000	840,000	810,000	805,000	792,000
Belgium and Luxembourg	2,332,000	2,247,000	2,054,000	1,953,000	1,848,000
Bulgaria	244,000	244,000	244,000	243,000	241,000
Croatia	433,000	431,000	430,000	428,000	424,000
Cyprus	417,000	387,000	320,000	286,000	252,000
Czech Republic	452,000	448,000	439,000	431,000	415,000
Denmark	736,000	731,000	723,000	711,000	675,000
Estonia	47,000	47,000	46,000	46,000	45,000
Finland	414,000	408,000	382,000	358,000	318,000
France	4,766,000	4,720,000	4,580,000	4,464,000	4,299,000
Germany	9,117,000	9,018,000	8,893,000	8,754,000	8,409,000
Greece	498,000	498,000	498,000	497,000	496,000
Hungary	967,000	967,000	964,000	957,000	939,000
Ireland	412,000	407,000	379,000	355,000	329,000
Italy	4,785,000	4,733,000	4,634,000	4,556,000	4,448,000
Latvia	110,000	109,000	108,000	107,000	106,000
Lithuania	180,000	180,000	179,000	178,000	176,000
Netherlands	722,000	715,000	710,000	699,000	673,000
Poland	2,368,000	2,361,000	2,350,000	2,341,000	2,322,000
Portugal	452,000	452,000	449,000	445,000	435,000
Romania	349,000	348,000	348,000	347,000	344,000
Slovakia	1,299,000	1,288,000	1,263,000	1,238,000	1,193,000
Slovenia	587,000	585,000	583,000	581,000	575,000
Spain	2,133,000	2,097,000	2,052,000	2,041,000	2,023,000
Sweden	517,000	510,000	491,000	470,000	430,000
TOTAL	**35,199,000**	**34,771,000**	**33,929,000**	**33,291,000**	**32,207,000**

A2.2 Asbestos in buildings

Data are available on age and construction of different building types covering the same period as the asbestos consumption data. As such, in theory it would be possible to combine these datasets and so model the distribution of the consumed asbestos into buildings of different types, age, etc. in the same/similar way as the Maduta *et al* work. Here, for example, Maduta *et al* applied the estimate that around 70% to 90% of raw asbestos was employed in asbestos cement products[202] when aggregating to produce their figures for asbestos in dwellings.

[202] WHO (Ed.), 2014. Chrysotile asbestos. World Health Organization, Geneva

For the purpose projecting the quantities of asbestos waste from renovation etc. in this study, however, it was decided that combining these datasets to produce information on asbestos in different buildings by age (while interesting) would not provide any greater insight into the waste issue of concern (quantity of asbestos waste generated). Further, any inaccuracies and uncertainties in the building stock data would be added to the uncertainties in the raw asbestos consumption data. These would be added to again if one were then seeking to use the resulting combined dataset to estimate renovation waste generated by applying assumptions on, for example, the age or type of building stock.

Particularly as the available statistics on building renovation from the Building Stock Observatory (BSO)[203] provide information only at the level of residential versus non-residential buildings (i.e., no differentiation by age or other categorisation), it is enough to assume that 80% of the estimated raw asbestos consumed since 1920 was used in construction and, hence, was/is embedded in building fabric. Renovation/demolition of these buildings will result in the generation of asbestos waste. Modelling the distribution of asbestos in buildings by age or other category will not improve the resolution or accuracy of the estimate for our purposes (and possibly the opposite).

Table A2-2 provides the total asbestos in buildings in MS assuming 80% of raw asbestos was used in construction.

Table A2-2: Total asbestos used in buildings (t rounded to nearest 1 000)

	Since 1920	since 1930	Since 1940	Since 1945	Since 1950
Austria	689,600	672,000	648,000	644,000	633,600
Belgium and Luxembourg	1,865,600	1,797,600	1,643,200	1,562,400	1,478,400
Bulgaria	195,200	195,200	195,200	194,400	192,800
Croatia	346,400	344,800	344,000	342,400	339,200
Cyprus	333,600	309,600	256,000	228,800	201,600
Czech Republic	361,600	358,400	351,200	344,800	332,000
Denmark	588,800	584,800	578,400	568,800	540,000
Estonia	37,600	37,600	36,800	36,800	36,000
Finland	331,200	326,400	305,600	286,400	254,400
France	3,812,800	3,776,000	3,664,000	3,571,200	3,439,200
Germany	7,293,600	7,214,400	7,114,400	7,003,200	6,727,200
Greece	398,400	398,400	398,400	397,600	396,800
Hungary	773,600	773,600	771,200	765,600	751,200
Ireland	329,600	325,600	303,200	284,000	263,200
Italy	3,828,000	3,786,400	3,707,200	3,644,800	3,558,400
Latvia	88,000	87,200	86,400	85,600	84,800
Lithuania	144,000	144,000	143,200	142,400	140,800
Netherlands	577,600	572,000	568,000	559,200	538,400
Poland	1,894,400	1,888,800	1,880,000	1,872,800	1,857,600
Portugal	361,600	361,600	359,200	356,000	348,000
Romania	279,200	278,400	278,400	277,600	275,200
Slovakia	1,039,200	1,030,400	1,010,400	990,400	954,400
Slovenia	469,600	468,000	466,400	464,800	460,000
Spain	1,706,400	1,677,600	1,641,600	1,632,800	1,618,400

[203] https://building-stock-observatory.energy.ec.europa.eu/database/

Table A2-2: Total asbestos used in buildings (t rounded to nearest 1 000)					
	Since 1920	**since 1930**	**Since 1940**	**Since 1945**	**Since 1950**
Sweden	413,600	408,000	392,800	376,000	344,000
TOTAL	**28,159,200**	**27,816,800**	**27,143,200**	**26,632,800**	**25,765,600**

A2.2.1 Asbestos-containing waste generated/removed since 2004

Data are available on the quantities of ACW generated/disposed of since 2004 for all MS other than Bulgaria, Greece, Poland and Spain. For some MS, data are not present in the raw dataset for every year. In addition, some report waste generated, others waste disposed and others both. We have interpolated and extrapolated missing values using linear methods, drawing on waste generated where present and waste disposed of where not. This produced a complete data set for all MS (other than those already mentioned) for ACW 'removed' since 2004.

Table A2-3 provides these data listed by the MS as grouped in the US circular raw data on consumption (where, Belgium and Luxembourg are reported together and no information at all is provided for Malta).

Table A2-3: Total quantity of ACW removed 2004—2022	
Country	**Quantity (t)**
Austria	1,153,394
Belgium and Luxembourg	2,287,669
Bulgaria	No data
Croatia	75,913
Cyprus	5,917
Czech Republic	346,920
Denmark	1,092,113
Estonia	124,783
Finland	664,762
France	7,430,637
Germany	9,249,387
Greece	No data
Hungary	66,302
Ireland	45,554
Italy	6,450,600
Latvia	28,030
Lithuania	202,687
Netherlands	4,927,164
Poland	No data
Portugal	326,668
Romania	43,406
Slovakia	4,487
Slovenia	65,798
Spain	No data
Sweden	437,775
(Sub) TOTAL	**35,029,966**

A2.2.2 Asbestos removed 2004-2022

The data in Table 3 (above) relates to ACW (as opposed to asbestos itself). Overall content of asbestos in ACW varies by construction application which, in turn, is influenced in any MS by the main uses to which the asbestos-containing materials were put. A review of available information suggests that, on average, the asbestos content of ACW is unlikely to be greater than 10% and probably a lot less. For the purpose of estimating the quantity of asbestos that has already been removed (since 2004) 3%, 5% and 10% asbestos content of ACW has been assumed. This provides the estimates of raw asbestos removed since 2004 in Table A2-4.

Table A2-4: Estimated total quantity of raw asbestos removed from buildings 2004-2022 (t)

	Tonnes ACW removed 2004-2022	Implied tonnes raw asbestos removed 2004-2022		
Assumed content of asbestos in construction waste		**3%**	**5%**	**10%**
Austria	1,153,394	34,602	57,670	115,339
Belgium and Luxembourg	2,287,669	68,630	114,383	228,767
Bulgaria	No data			
Croatia	75,913	2,277	3,796	7,591
Cyprus	5,917	178	296	592
Czech Republic	346,920	10,408	17,346	34,692
Denmark	1,092,113	32,763	54,606	109,211
Estonia	124,783	3,743	6,239	12,478
Finland	664,762	19,943	33,238	66,476
France	7,430,637	222,919	371,532	743,064
Germany	9,249,387	277,482	462,469	924,939
Greece	No data			
Hungary	66,302	1,989	3,315	6,630
Ireland	45,554	1,367	2,278	4,555
Italy	6,450,600	193,518	322,530	645,060
Latvia	28,030	841	1,402	2,803
Lithuania	202,687	6,081	10,134	20,269
Netherlands	4,927,164	147,815	246,358	492,716
Poland	No data			
Portugal	326,668	9,800	16,333	32,667
Romania	43,406	1,302	2,170	4,341
Slovakia	4,487	135	224	449
Slovenia	65,798	1,974	3,290	6,580
Spain	No data			
Sweden	437,775	13,133	21,889	43,777
(Sub) TOTAL	**35,029,966**	**1 050 899**	**1 751 498**	**3,502,997**

A2.2.3 Implied asbestos remaining in buildings

Simple subtraction of the estimated amounts of asbestos removed (2004-2022) from the estimated total asbestos consumed and used in construction since 1920 provides a rough estimation of the quantity of asbestos currently embedded in buildings in EU MS. Clearly, this does not account for removal before 2004 through re-construction and renovation but, none-the-less, it provides some indication of the distance yet to travel with asbestos removal and relative progress from one MS to another. These data are provided as Table A2-5.

Table A2-5: Rough estimation of the quantity of asbestos currently embedded in buildings in EU MS (t)				
	Total raw asbestos used in buildings Since 1920	**Implied quantity of asbestos in situ (in buildings)**		
Assumed content of asbestos in construction waste		**3%**	**5%**	**10%**
Austria	689,600	654,998	631,930	574,261
Belgium and Luxembourg	1,865,600	1,796,970	1,751,217	1,636,833
Bulgaria	195,200			
Croatia	346,400	344,123	342,604	338,809
Cyprus	333,600	333,422	333,304	333,008
Czech Republic	361,600	351,192	344,254	326,908
Denmark	588,800	556,037	534,194	479,589
Estonia	37,600	33,857	31,361	25,122
Finland	331,200	311,257	297,962	264,724
France	3,812,800	3,589,881	3,441,268	3,069,736
Germany	7,293,600	7,016,118	6,831,131	6,368,661
Greece	398,400			
Hungary	773,600	771,611	770,285	766,970
Ireland	329,600	328,233	327,322	325,045
Italy	3,828,000	3,634,482	3,505,470	3,182,940
Latvia	88,000	87,159	86,598	85,197
Lithuania	144,000	137,919	133,866	123,731
Netherlands	577,600	429,785	331,242	84,884
Poland	1,894,400			
Portugal	361,600	351,800	345,267	328,933
Romania	279,200	277,898	277,030	274,859
Slovakia	1,039,200	1,039,065	1,038,976	1,038,751
Slovenia	469,600	467,626	466,310	463,020
Spain	1,706,400			
Sweden	413,600	400,467	391,711	369,823
TOTAL	**28,159,200**	**22,913,901**	**22,213,302**	**20,461,803**

The data on total asbestos and asbestos currently embedded in buildings in EU MS (in Table) can also be expressed as a percentage. Table A2-6 provides the implied percentage of asbestos used in buildings in each MS since 1920 that remains ***in situ***.

Table A2-6: Implied percentage of asbestos used in buildings in each MS since 1920 that remains *in situ*			
Assumed content of asbestos in construction waste	**3%**	**5%**	**10%**
Austria	95%	92%	83%
Belgium and Luxembourg	96%	94%	88%
Bulgaria			
Croatia	99%	99%	98%
Cyprus	100%	100%	100%
Czech Republic	97%	95%	90%
Denmark	94%	91%	81%

Table A2-6: Implied percentage of asbestos used in buildings in each MS since 1920 that remains *in situ*			
Assumed content of asbestos in construction waste	**3%**	**5%**	**10%**
Estonia	90%	83%	67%
Finland	94%	90%	80%
France	94%	90%	81%
Germany	96%	94%	87%
Greece			
Hungary	100%	100%	99%
Ireland	100%	99%	99%
Italy	95%	92%	83%
Latvia	99%	98%	97%
Lithuania	96%	93%	86%
Netherlands	74%	57%	15%
Poland			
Portugal	97%	95%	91%
Romania	100%	99%	98%
Slovakia	100%	100%	100%
Slovenia	100%	99%	99%
Spain			
Sweden	97%	95%	89%
TOTAL	**81%**	**79%**	**73%**

The data on quantity of asbestos currently embedded in buildings in EU MS (in Table) can also be converted to an estimate of the quantity of ACW that would be generated if all currently embedded asbestos in buildings were to be removed completely and disposed of as per the current methods. Table A2-7 and Table A2-8 provide conversions of the tonnes of raw asbestos in remaining buildings (in Table A2-5) into quantity of ACW that would be generated expressed in tonnes (in Table A2-7) and in m^3 (in Table A2-8), in both cases using the 3%, 5% and 10% asbestos waste content assumptions. For the conversion of tonnes of ACW to m^3 in Table A2-8, a conversion factor for 'construction materials containing asbestos' of 0.91 m^3/t has been used.

Table A2-7: Implied total quantity of ACW that would be generated by total removal of remaining asbestos with current methods (t)			
Assumed content of asbestos in construction waste	**3%**	**5%**	**10%**
Austria	21,833,273	12,638,606	5,742,606
Belgium and Luxembourg	59,898,998	35,024,331	16,368,331
Bulgaria			
Croatia	11,470,753	6,852,087	3,388,087
Cyprus	11,114,083	6,666,083	3,330,083
Czech Republic	11,706,414	6,885,080	3,269,080
Denmark	18,534,554	10,683,887	4,795,887
Estonia	1,128,550	627,217	251,217
Finland	10,375,238	5,959,238	2,647,238
France	119,662,696	68,825,363	30,697,363
Germany	233,870,613	136,622,613	63,686,613
Greece			
Hungary	25,720,365	15,405,698	7,669,698
Ireland	10,941,113	6,546,446	3,250,446
Italy	121,149,400	70,109,400	31,829,400

Table A2-7: Implied total quantity of ACW that would be generated by total removal of remaining asbestos with current methods (t)			
Assumed content of asbestos in construction waste	**3%**	**5%**	**10%**
Latvia	2,905,303	1,731,970	851,970
Lithuania	4,597,313	2,677,313	1,237,313
Netherlands	14,326,169	6,624,836	848,836
Poland			
Portugal	11,726,665	6,905,332	3,289,332
Romania	9,263,261	5,540,594	2,748,594
Slovakia	34,635,513	20,779,513	10,387,513
Slovenia	15,587,536	9,326,202	4,630,202
Spain			
Sweden	13,348,892	7,834,225	3,698,225
TOTAL	**763,796,701**	**444,266,034**	**204,618,034**

Table A2-8: Implied volume of ACW that would be generated by total removal of remaining asbestos with current methods (m^3 using a conversion factor of 0.91 m^3/t)			
Assumed content of asbestos in construction waste	**3%**	**5%**	**10%**
Austria	19,868,279	11,501,132	5,225,772
Belgium and Luxembourg	54,508,088	31,872,141	14,895,181
Bulgaria			
Croatia	10,438,385	6,235,399	3,083,159
Cyprus	10,113,815	6,066,135	3,030,375
Czech Republic	10,652,836	6,265,423	2,974,863
Denmark	16,866,444	9,722,337	4,364,257
Estonia	1,026,981	570,767	228,607
Finland	9,441,466	5,422,906	2,408,986
France	108,893,053	62,631,080	27,934,600
Germany	212,822,258	124,326,578	57,954,818
Greece			
Hungary	23,405,532	14,019,185	6,979,425
Ireland	9,956,413	5,957,266	2,957,906
Italy	110,245,954	63,799,554	28,964,754
Latvia	2,643,826	1,576,092	775,292
Lithuania	4,183,555	2,436,355	1,125,955
Netherlands	13,036,814	6,028,601	772,441
Poland			
Portugal	10,671,265	6,283,852	2,993,292
Romania	8,429,567	5,041,940	2,501,220
Slovakia	31,518,317	18,909,357	9,452,637
Slovenia	14,184,657	8,486,844	4,213,484
Spain			
Sweden	12,147,491	7,129,145	3,365,385
TOTAL	**695,054,998**	**404,282,091**	**186,202,411**

A2.3 Impact of renovation and renovation wave on asbestos waste generation

A2.3.1 Increase in energy renovation rate

The Commission Communication *A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives*[204] sets out objectives for increasing the annual energy renovation rate of residential and non-residential buildings. It identifies the objective as "*to at least double the annual energy renovation rate of residential and non-residential buildings by 2030 and to foster deep energy renovations…The increased rate and depth of renovation will have to be maintained also post-2030 in order to reach EU-wide climate neutrality by 2050*".

The Building Stock Observatory (BSO)[205] database provides information on building renovation rates as well as number and floor area of buildings renovated for both residential and non-residential buildings in each MS. Annual deep renovation rates and annual total renovation rates are only available for 2016. Annual energy renovation rates are not provided in the statistics but as will be described, the BSO deep renovation and total renovation rates provide a starting point for further analysis.

The asbestos and asbestos waste analysis described above does not distinguish between residential and non-residential buildings and so, to combine with the asbestos data, the BSO renovation rates given for residential and non-residential buildings need to be expressed as a combined average for 'buildings' (i.e., residential and non-residential combined). This has been achieved by using the BSO statistics for floor area of residential and non-residential buildings renovated in 2016 in each MS to produce weighted average deep renovation and total renovation rates for each MS.

In its supporting text the communication provides the following statistics (but with no reference to their source):

- 11% of the EU existing building stock undergoes some level of renovation each year;
- the weighted annual energy renovation rate is low at some 1%; and
- deep renovations are carried out only in 0.2% of the building stock per year.

Thus, if the energy renovation rate is reported in the Commission Communication as 1%; deep renovation at 0.2%; and total renovation at 11% then:

- The energy renovation rate is 5 x the deep renovation rate (0.2%); and/or
- The energy renovation rate 9.1% of the total renovation rate (11%).

These factors have been applied to the weighted average deep renovation and total renovation rates to produce two estimates of the energy renovation rate. The average of the two values has been taken as the estimated building energy renovation rate in each MS at present.

In terms of changes to be brought about through a 'renovation wave', the Commission Communication identifies the objective "*to at least double the annual energy renovation rate of residential and non-residential buildings by 2030 and to foster deep energy renovations…The increased rate and depth of renovation will have to be maintained also post-2030 in order to reach EU-wide climate neutrality by 2050*". Thus, with the annual energy renovation of 1% given in the communication, *at least doubling* would mean an energy renovation rate of 2% in 2030 (and

[204] COM/2020/662 final - https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0662
[205] https://building-stock-observatory.energy.ec.europa.eu/database/

maintained to 2050); in other words, 1% more than at present. Other scenarios for bigger increases in rates are possible. These have been taken as:

- A tripling (x3) of the energy renovation rate – which, using the value in the communication, would result in a 3% energy renovation rate in 2030; in other words, 2% more than at present; and
- A quadrupling (x4) of the energy renovation rate – which, using the value in the communication, would result in a 4% energy renovation rate in 2030; in other words, 3% more than at present.

Taking these 2x, 3x and 4x scenarios, Table A2-9 provides the estimated annual building energy renovation rates at present and in 2030 under the renovation wave scenarios.

Table A2-9: Estimated annual building energy renovation rates at present and in 2030 (and following years) under the renovation wave scenarios

	Present	2030 based on x2	2030 based on x3	2030 based on x4
Austria	0.67%	1.34%	2.01%	2.68%
Belgium	1.71%	3.43%	5.14%	6.85%
Bulgaria	1.04%	2.09%	3.13%	4.18%
Croatia	0.75%	1.49%	2.24%	2.98%
Cyprus	2.37%	4.75%	7.12%	9.50%
Czech Republic	0.73%	1.46%	2.19%	2.93%
Denmark	0.35%	0.70%	1.04%	1.39%
Estonia	0.57%	1.15%	1.72%	2.30%
Finland	0.37%	0.74%	1.11%	1.48%
France	0.71%	1.43%	2.14%	2.86%
Germany	0.51%	1.02%	1.53%	2.04%
Greece	0.94%	1.87%	2.81%	3.74%
Hungary	0.50%	1.00%	1.50%	2.01%
Ireland	0.40%	0.80%	1.20%	1.60%
Italy	1.24%	2.47%	3.71%	4.95%
Latvia	0.35%	0.69%	1.04%	1.39%
Lithuania	0.62%	1.24%	1.86%	2.48%
Luxembourg	0.48%	0.96%	1.44%	1.91%
Malta	0.84%	1.67%	2.51%	3.34%
Netherlands	0.61%	1.23%	1.84%	2.46%
Poland	0.53%	1.06%	1.59%	2.13%
Portugal	1.23%	2.47%	3.70%	4.93%
Romania	0.84%	1.67%	2.51%	3.34%
Slovak Republic	0.84%	1.68%	2.53%	3.37%
Slovenia	0.67%	1.34%	2.02%	2.69%
Spain	1.28%	2.57%	3.85%	5.13%
Sweden	0.64%	1.29%	1.93%	2.58%

A2.3.2 Increase in asbestos-containing waste generated

As discussed above, the BSO total renovation rates relate to the year 2016. Logically, then, the asbestos waste generated in 2016 in each MS is attributable to that rate of renovation and one can calculate the quantity of waste generated for every unit percent of renovation rate. Using an example, if the total renovation rate for a given MS was 10% in 2016 and the ACW generated in 2016 was 10 000t then, logically, a renovation rate of 1% would generate 1 000t of ACW in that MS.

Using this principle, it is possible to calculate the increase in the quantity of ACW generated by an increase in the energy renovation brought about by the renovation wave in 2030. As the energy renovation rate is included in total renovation rate, an increase in the energy renovation rate will increase the total renovation rate. Continuing the example, if the energy renovation rate in a given MS is 1% and the total renovation rate is 10%, a doubling of the energy renovation rate will increase the energy renovation rate from 1% to 2% - i.e., by 1%. Equally, the total renovation rate will increase from 10% to 11% - i.e., by 1%. If, described above, a 1% increase in renovation rate generates an additional 1 000t of ACW.

Using this method, the additional ACW generated in 2030 has been calculated for each of the 2x, 3x and 4x energy renovation rate scenarios. Values for the additional ACW generated for the years 2024-2029 have been calculated using a linear method with increases beginning in 2024. Values for 2031 onwards are equal to those for 2030 (because the objective is to *maintain post-2030*).

Table A2-11, Table A2-12 and Table A2-13 provide the resulting increases in ACW under the 2x, 3x and 4x energy renovation rate scenarios respectively for each MS for the period 2024-2050. Table A2-10 provides a summary of the totals from the three scenario tables. All tables present the increases in ACW as:

- Cumulative total additional waste generated from 2024-2050 in tonnes;
- Annual average increase in tonnes over the period 2024-2050;
- Cumulative total additional waste generated from 2024-2050 in m^3; and
- Annual average increase in m^3over the period 2024-2050

TableA2-10: Total (EU) increases in ACW under the 2x, 3x and 4x energy renovation rate scenarios for the renovation wave 2024-2050

	Total additional waste generated (t)	Annual average increase (t)	Total additional waste generated (m^3)	Annual average increase (m^3)
2x scenario	7,355,265	272,417	6,693,291	247,900
3x scenario	14,710,531	544,834	13,386,583	495,799
4x scenario	22,065,796	817,252	20,079,874	743,699

Table A2-11: Increases in ACW under the 2x energy renovation rate scenario for the renovation wave 2024-2050				
	Total additional waste generated (t)	**Annual average increase (t)**	**Total additional waste generated (m^3)**	**Annual average increase (m^3)**
Austria	302,359	11,198	275,147	10,191
Belgium	541,829	20,068	493,065	18,262
Bulgaria				
Croatia	11,080	410	10,083	373
Cyprus				
Czech Republic	15,248	565	13,875	514
Denmark	145,478	5,388	132,385	4,903
Estonia	36,108	1 337	32,858	1,217
Finland	94,463	3,499	85,961	3,184
France	1,707,825	63,253	1,554,121	57,560
Germany	1,514,880	56,07	1,378,541	51,057
Greece				
Hungary	9,489	351	8,635	320
Ireland				
Italy	1,712,521	63,427	1,558,394	57,718
Latvia	2,446	91	2,226	82
Lithuania	55,769	2,066	50,750	1,880
Luxembourg	18,698	693	17,015	630
Malta	682	25	621	23
Netherlands	1,036,682	38,396	943,381	34,940
Poland				
Portugal	46,053	1,706	41,909	1,552
Romania	4,282	159	3,896	144
Slovak Republic	336	12	305	11
Slovenia	16,897	626	15,376	569
Spain				
Sweden	82,142	3,042	74,749	2,768
Total	**7,355,265**	**272,417**	**6,693,291**	**247,900**

Table A2-12: Increases in ACW under the 3x energy renovation rate scenario for the renovation wave 2024-2050				
	Total additional waste generated (t)	**Annual average increase (t)**	**Total additional waste generated (m^3)**	**Annual average increase (m^3)**
Austria	604,718	22,397	550,294	20,381
Belgium	1,083,659	40,136	986,130	36,523
Bulgaria				
Croatia	22,160	821	20,166	747
Cyprus				
Czech Republic	30,495	1,129	27,751	1,028
Denmark	290,956	10,776	264,770	9,806
Estonia	72,215	2,675	65,716	2,434
Finland	188,925	6,997	171,922	6,367
France	3,415,650	126,506	3,108,241	115,120
Germany	3,029,760	112,213	2,757,082	102,114
Greece				
Hungary	18,978	703	17,270	640
Ireland				

Table A2-12: Increases in ACW under the 3x energy renovation rate scenario for the renovation wave 2024-2050				
	Total additional waste generated (t)	Annual average increase (t)	Total additional waste generated (m^3)	Annual average increase (m^3)
Italy	3,425,042	126,853	3,116,788	115,437
Latvia	4,891	181	4,451	165
Lithuania	111,538	4,131	101,499	3,759
Luxembourg	37,397	1,385	34,031	1,260
Malta	1,365	51	1,242	46
Netherlands	2,073,364	76,791	1,886,761	69,880
Poland				
Portugal	92,107	3,411	83,817	3,104
Romania	8,563	317	7,793	289
Slovak Republic	671	25	611	23
Slovenia	33,793	1,252	30,752	1,139
Spain				
Sweden	164,283	6,085	149,498	5,537
Total	**14,710,531**	**544,834**	**13,386,583**	**495,799**

Table A2-13: Increases in ACW under the 4x energy renovation rate scenario for the renovation wave 2024-2050				
	Total additional waste generated (t)	Annual average increase (t)	Total additional waste generated (m^3)	Annual average increase (m^3)
Austria	907,078	33,595	825,441	30,572
Belgium	1,625,488	60,203	1,479,194	54,785
Bulgaria				
Croatia	33,241	1,231	30,249	1,120
Cyprus				
Czech Republic	45,743	1,694	41,626	1,542
Denmark	436,433	16,164	397,154	14,709
Estonia	108,323	4,012	98,574	3,651
Finland	283,388	10,496	257,883	9,551
France	5,123,474	189,758	4,662,362	172,680
Germany	4,544,640	168,320	4,135,622	153,171
Greece				
Hungary	28,467	1,054	25,905	959
Ireland				
Italy	5,137,563	190,280	4,675,182	173,155
Latvia	7,337	272	6,677	247
Lithuania	167,307	6,197	152,249	5,639
Luxembourg	56,095	2,078	51,046	1,891
Malta	2,047	76	1,863	69
Netherlands	3,110,046	115,187	2,830,142	104,820
Poland				
Portugal	138,160	5,117	125,726	4,657
Romania	12,845	476	11,689	433
Slovak Republic	1,007	37	916	34
Slovenia	50,690	1,877	46,128	1,708
Spain				
Sweden	246,425	9,127	224,246	8,305
Total	**22,065,796**	**817,252**	**20,079,874**	**743,699**

A2.4 Comparison of asbestos-containing waste generated and landfill capacity

Estimates the volume (m^3) of ACW that would be generated if all currently embedded asbestos in buildings were to be removed completely has been provided in Table for the 3%, 5% and 10% asbestos waste content assumptions.

Increases in the volume (m^3) of ACW under the 2x, 3x and 4x energy renovation rate scenarios reflecting (the renovation wave) for each MS and the EU27 for the period 2024-2050 have been provided in Table A2-11, Table A2-12 and Table A2-13.

All sets of figures can be compared with the most recent (2020) Eurostat data on the landfill disposal volume available in MS and in total in the EU27 set out in Table A2-14 below.

Table A2-14: Landfill disposal volume available in 2020 (rest capacity) in m^3. Source: Eurostat

	Disposal - landfill for hazardous waste	Disposal - landfill for non-hazardous waste	Total
Austria	0	44,827,419	44,827,419
Belgium	8,690,259	25,567,429	34,257,688
Bulgaria	1,055,814	237,091,256	238,147,070
Croatia	0	65,502,629	65,502,629
Cyprus	0	793,635	793,635
Czechia	5,471,872	35,460,342	40,932,214
Denmark	5,319,828	9,295,121	14,614,949
Estonia	372,000,000	4,900,000	376,900,000
Finland			
France	24,325,508	161,000,000	185,325,508
Germany	30,428,056	284,640,743	315,068,799
Greece	16,340	9,122,474	9,138,814
Hungary			
Ireland			
Italy	4,559,165	39,579,014	44,138,179
Latvia	160,000		160,000
Lithuania	259,228	7,531,381	7,790,609
Luxembourg	0	1,186,000	1,186,000
Malta	0	429,140	429,140
Netherlands	59,000	34,200,000	34,259,000
Poland	3,226,842	1,262,344,902	1,265,571,744
Portugal	0	0	0
Romania	338,116	34,167,445	34,505,561
Slovakia	919,801	8,184,344	9,104,145
Slovenia	17	2,912	2,929
Spain	3,780,661	167,349,716	171,130,377
Sweden	6,054,555	9,402,015	15,456,570
European Union - 27 countries (from 2020)	**467,330,000**	**2,502,630,000**	**2,969,960,000**

Table A2-17 provides the implied volume of ACW that would be generated by total removal of remaining asbestos with current methods (m^3 using a conversion factor of 0.91 m^3/t) as a percentage of available landfill volume (m^3) in each MS. This provides data on all three scenarios for asbestos waste content (3%, 5% and 10%) scenarios and shows that a number of MS are likely to lack the capacity in hazardous landfill, in non-hazardous landfill or both for disposal of all remaining building asbestos as asbestos containing waste using current methods However, these figures are only indicative, and do not foresee the increase in landfill capacity. Nevertheless, they show which countries would potentially need substantial increase in their landfill capacity to allow for disposal of the remaining asbestos waste. For convenience of the reader, the total overall EU27 values are also provided as Table A2-15 (below).

Table A2-15: Implied volume of ACW that would be generated by total removal of remaining asbestos with current methods (m^3 using a conversion factor of 0.91 m^3/t) as a percentage of available landfill volume (m^3)

Assumed content of asbestos in construction waste	3%	5%	10%
TOTAL	695,054,998	404,282,091	186,202,411
As a % of hazardous landfill rest capacity in 2020	149%	87%	40%
As a % of non-hazardous landfill rest capacity in 2020	28%	16%	7%
As a % of total hazardous and non-hazardous landfill rest capacity in 2020	23%	14%	6%

Table A2-18 provides increases in ACW under the 2x, 3x and 4x energy renovation rate scenarios for the renovation wave 2024-2050 as a percentage of available landfill volume (m^3) for each MS. This also shows that a number of MS are likely to lack the capacity in hazardous landfill, in non-hazardous landfill or both for disposal. For convenience of the reader, the total overall EU27 values are also provided as Table A2-16 (below).

Table A2-16: Total (EU) increases in ACW under the 2x, 3x and 4x energy renovation rate scenarios for the renovation wave 2024-2050 as a percentage of available landfill volume (m^3)

	Total additional waste generated (m3) to 2030	As a % of hazardous landfill rest capacity in 2020	As a % of non-hazardous landfill rest capacity in 2020	As a % of total hazardous and non-hazardous landfill rest capacity in 2020
2x scenario	6,693,291	1.4%	0.27%	0.23%
3x scenario	13,386,583	2.9%	0.53%	0.45%
4x scenario	20,079,874	4.3%	0.80%	0.68%

Table A2-17: Implied volume of ACW that would be generated by total removal of remaining asbestos with current methods (m^3 using a conversion factor of 0.91 m^3/t) as a percentage of available landfill volume (m^3)									
	Assumed content of asbestos in construction waste = 3%			**Assumed content of asbestos in construction waste = 5%**			**Assumed content of asbestos in construction waste = 10%**		
	Hazardous landfill	**Non-hazardous landfill**	**Total**	**Hazardous landfill**	**Non-hazardous landfill**	**Total**	**Hazardous landfill**	**Non-hazardous landfill**	**Total**
Austria	No listed capacity	44%	44%	No listed capacity	26%	26%	No listed capacity	12%	12%
Belgium and Luxembourg	627%	204%	154%	367%	119%	90%	171%	56%	42%
Bulgaria	0%	0%	0%	0%	0%	0%	0%	0%	0%
Croatia	No listed capacity	16%	16%	No listed capacity	10%	10%	No listed capacity	5%	5%
Cyprus	No listed capacity	1274%	1274%	No listed capacity	764%	764%	No listed capacity	382%	382%
Czech Republic	195%	30%	26%	115%	18%	15%	54%	8%	7%
Denmark	317%	181%	115%	183%	105%	67%	82%	47%	30%
Estonia	0%	21%	0%	0%	12%	0%	0%	5%	0%
Finland	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity
France	448%	68%	59%	257%	39%	34%	115%	17%	15%
Germany	699%	75%	68%	409%	44%	39%	190%	20%	18%
Greece	0%	0%	0%	0%	0%	0%	0%	0%	0%
Hungary	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity
Ireland	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity
Italy	2418%	279%	250%	1399%	161%	145%	635%	73%	66%
Latvia	1652%	No listed capacity	1652%	985%	No listed capacity	985%	485%	No listed capacity	485%
Lithuania	1614%	56%	54%	940%	32%	31%	434%	15%	14%
Netherlands	22096%	38%	38%	10218%	18%	18%	1309%	2%	2%
Poland	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table A2-17: Implied volume of ACW that would be generated by total removal of remaining asbestos with current methods (m^3 using a conversion factor of 0.91 m^3/t) as a percentage of available landfill volume (m^3)									
	Assumed content of asbestos in construction waste = 3%			**Assumed content of asbestos in construction waste = 5%**			**Assumed content of asbestos in construction waste = 10%**		
	Hazardous landfill	**Non-hazardous landfill**	**Total**	**Hazardous landfill**	**Non-hazardous landfill**	**Total**	**Hazardous landfill**	**Non-hazardous landfill**	**Total**
Portugal	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity
Romania	2493%	25%	24%	1491%	15%	15%	740%	7%	7%
Slovakia	3427%	385%	346%	2056%	231%	208%	1028%	115%	104%
Slovenia	83439161%	487110%	484283%	49922612%	291444%	289752%	24785200%	144694%	143854%
Spain	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sweden	201%	129%	79%	118%	76%	46%	56%	36%	22%
TOTAL	149%	28%	23%	87%	16%	14%	40%	7%	6%

Table A2-18: Total (EU) increases in ACW under the 2x, 3x and 4x energy renovation rate scenarios for the renovation wave 2024-2050 as a percentage of available landfill volume (m^3)									
	2x renovation rate by 2030 scenario			**3x renovation rate by 2030 scenario**			**4x renovation rate by 2030 scenario**		
	Hazardous landfill	**Non-hazardous landfill**	**Total**	**Hazardous landfill**	**Non-hazardous landfill**	**Total**	**Hazardous landfill**	**Non-hazardous landfill**	**Total**
Austria	No listed capacity	0.6%	0.6%	No listed capacity	1.2%	1.2%	No listed capacity	1.8%	1.8%
Belgium	5.7%	1.9%	1.4%	11.3%	3.9%	2.9%	17.0%	5.8%	4.3%
Bulgaria	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Croatia	No listed capacity	0.0%	0.0%	No listed capacity	0.0%	0.0%	No listed capacity	0.0%	0.0%
Cyprus	No listed capacity	0.0%	0.0%	No listed capacity	0.0%	0.0%	No listed capacity	0.0%	0.0%
Czechia	0.3%	0.0%	0.0%	0.5%	0.1%	0.1%	0.8%	0.1%	0.1%
Denmark	2.5%	1.4%	0.9%	5.0%	2.8%	1.8%	7.5%	4.3%	2.7%
Estonia	0.0%	0.7%	0.0%	0.0%	1.3%	0.0%	0.0%	2.0%	0.0%

Table A2-18: Total (EU) increases in ACW under the 2x, 3x and 4x energy renovation rate scenarios for the renovation wave 2024-2050 as a percentage of available landfill volume (m^3)									
	2x renovation rate by 2030 scenario			**3x renovation rate by 2030 scenario**			**4x renovation rate by 2030 scenario**		
	Hazardous landfill	**Non-hazardous landfill**	**Total**	**Hazardous landfill**	**Non-hazardous landfill**	**Total**	**Hazardous landfill**	**Non-hazardous landfill**	**Total**
Finland	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity
France	6.4%	1.0%	0.8%	12.8%	1.9%	1.7%	19.2%	2.9%	2.5%
Germany	4.5%	0.5%	0.4%	9.1%	1.0%	0.9%	13.6%	1.5%	1.3%
Greece	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Hungary	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity
Ireland	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity
Italy	34.2%	3.9%	3.5%	68.4%	7.9%	7.1%	102.5%	11.8%	10.6%
Latvia	1.4%	No listed capacity	1.4%	2.8%	No listed capacity	2.8%	4.2%	No listed capacity	4.2%
Lithuania	19.6%	0.7%	0.7%	39.2%	1.3%	1.3%	58.7%	2.0%	2.0%
Luxembourg	No listed capacity	1.4%	1.4%	No listed capacity	2.9%	2.9%	No listed capacity	4.3%	4.3%
Malta	No listed capacity	0.1%	0.1%	No listed capacity	0.3%	0.3%	No listed capacity	0.4%	0.4%
Netherlands	1599.0%	2.8%	2.8%	3197.9%	5.5%	5.5%	4796.9%	8.3%	8.3%
Poland	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Portugal	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity	No listed capacity
Romania	1.2%	0.0%	0.0%	2.3%	0.0%	0.0%	3.5%	0.0%	0.0%
Slovakia	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%
Slovenia	90446.7%	528.0%	525.0%	180893.4%	1056.0%	1049.9%	271340.1%	1584.1%	1574.9%
Spain	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table A2-18: Total (EU) increases in ACW under the 2x, 3x and 4x energy renovation rate scenarios for the renovation wave 2024-2050 as a percentage of available landfill volume (m^3)									
	2x renovation rate by 2030 scenario			3x renovation rate by 2030 scenario			4x renovation rate by 2030 scenario		
	Hazardous landfill	Non-hazardous landfill	Total	Hazardous landfill	Non-hazardous landfill	Total	Hazardous landfill	Non-hazardous landfill	Total
Sweden	1.2%	0.8%	0.5%	2.5%	1.6%	1.0%	3.7%	2.4%	1.5%
EU27	1.43%	0.27%	0.23%	2.86%	0.53%	0.45%	4.30%	0.80%	0.68%

Annex 3 ACW management practices – case studies

A3.1 Czech Republic

A3.1.1 Management of asbestos containing waste

The main treatment for ACW in the Czech Republic is landfilling.

No provisions prohibiting other treatment of ACW, e.g., treatment to remove the asbestos fraction to prepare CDW for recycling have been identified by the study team. However, no asbestos waste treatment technologies have already been implemented or is known to be in research and development in the Czech Republic. ACW is currently only landfilled in the Czech Republic.

The rules and guidance for management of ACW during demolition and renovation are largely organised nationally and the key reference documents include not only legal requirements in the national legislation on waste[206] but also a specific guidance document published in 2018 by the Ministry of Environment that provides advice on construction and demolition and subsequent management of ACW in construction and demolition.[207] The guidance is currently undergoing revision.

The information in this section is primarily sourced from the 2018 Guidance. However, there are indications that the guidance (and the legal requirements) is sometimes not followed, e.g., in a presentation summarising the practical experience of the Czech Environmental Inspectorate.[208] This includes at least one high profile case of construction and demolition waste containing asbestos having been used for the construction of a cycle path.[209]

General principles for asbestos-containing waste in construction and demolition

- In the 2018 Guidance, ACW defined as construction and demolition waste that contains the different asbestos fibres (no concentration threshold)
- ACW should be identified and separated.
- Segregated ACW must enclosed and sent for permitted disposal options.

General principles for landfilling of asbestos-containing construction and demolition waste

- Landfilling of ACW must occur at S-NO and some S-OO landfills.

A3.1.2 Management of demolition and renovation works

Screening and mapping for asbestos before demolition and renovation work (pre-demolition audit)

In the Czech Republic, screening for asbestos is mandatory when there is suspicion that asbestos has been used in the building.

[206] Act. No. 541/2020 Coll., On Waste; Decree No. 273/2021 Coll., On the Details of Waste Management

[207] Ministry of Environment (2018): Metodický návod pro řízení vzniku odpadů s obsahem azbestu při provádění a odstraňování staveb a pro nakládání s nimi, available at http://www.khskv.cz/informace_pro_verejnost/Metodicky_navod_MZP_odpad_s_obsahem_azbestu_leden_2018.pdf

[208] http://www.ekomonitor.cz/sites/default/files/filepath/prezentace/3_hraska.pdf

[209] https://www.cizp.cz/aktuality/azbest-u-milovic-schuzka-zainteresovanych-stran

In cases where asbestos is suspected to be present, a pre-demolition audit is required, and a specific permitting procedure is in place. Demolition work has to be notified to the authorities and in some cases the notification has to include other documentation to enable the authorities to establish further notification requirement, e.g., to labour inspectorates. Employers must notify exposure to asbestos, except sporadic short-term exposure.

For buildings for which demolition documentation has to be elaborated, it is recommended that the audit involves a construction professional, the architect, a hazardous waste professional, and ideally also a representative of the construction contractor.

A screening method is not specified but a list of common construction materials containing asbestos is provided. The guide provides examples of construction materials made in CZ (or Czechoslovakia) that contain asbestos, including the name of the manufacturer and the year in which production of asbestos containing materials was discontinued (list based on information from the relevant companies and The Research Institute for Construction Materials in Brno, CZ). In case of doubt, it is recommended to take samples of building materials that could contain asbestos (future waste) from defined parts of the building during the inspection or subsequently before starting construction work.

It is recommended that pre-demolition audits can involve a review existing documentation and interview the inhabitants/users as to the construction history of the building.

Demolition and renovation work

Demolition can only be carried out by professional demolition providers. For renovation work carried out by the homeowner, surveillance by a professional construction supervisor is required – where asbestos is present in the building, supervision can only be provided by an authorised provider. A specific permitting procedure which involves public health authorities is in place for demolition of buildings that contain asbestos.

Asbestos and materials containing it must be removed before demolition or construction commences, unless a risk assessment indicates that the exposure of workers to asbestos would be higher with this procedure. During asbestos workers carrying out work with asbestos on the construction site, no other activities may be carried out.

General principles for work with asbestos

The principles for work with asbestos include:

- A controlled area must be established.
- Apart from workers carrying out work with asbestos on the construction site, no other activities may be carried out.
- Asbestos or asbestos containing materials must be removed by methods that prevent release of asbestos fibres into the air. The guide includes a list of good removal practices, including wet demolition, do not use electric tools in some instances, specific controls for dry demolition, wrap and cut methods, use of glove-bags, etc. The guide includes some 'DO NOT DO' examples.
- The advice differentiates between high and low risk activities (activities for which notification is required and no notification required).
- Measures against the release of asbestos into the air include, among other things, proper wetting of materials with water and spraying of materials with polymer encapsulation preparations.
- ACW must be packed in airtight containers or stored in sealed vessels or containers immediately after generation and marked with an inscription warning of the asbestos content.

- A hazardous waste identification sheet must be completed.
- Waste secured in this way must subsequently be handed over to a company authorised to accept such waste.

Since 2021, waste collection centres have been accepting ACW only in bags and loose ACW is no longer accepted.[210]

Measures during indoors asbestos-remediation work

A controlled area must be established. Apart from workers carrying out work with asbestos in a controlled area on the construction site, no other activities are allowed to be carried out at the same time.

OSH requirements apply, including choosing technical measures to prevent minimise the release of asbestos fibres into the air.

[210] https://tepvos.cz/odpad-obsahujici-azbest-musi-byt-ulozen-v-neprodysnych-obalech/, https://www.cistaplzen.cz/azbest-na-sberny-dvur-pouze-zabaleny/

A3.2 Denmark

A3.2.1 Management of asbestos containing waste

The main treatment for ACW in Denmark is landfilling, and in some cases export for special treatment. Landfilling of ACW must occur at approved facilities. Recycling hazardous ACW is not allowed in Denmark, and the same holds for preparation for reuse. Incineration of ACW is also not practiced.

Management of ACW during demolition and renovation projects is organised and monitored by individual municipalities. Some variations can hence be seen across different municipalities in Denmark, but the general principles are described in the following.

General principles for asbestos-containing waste (Boldrin et al., 2022)

- Waste must be landfilled and cannot be recycled.
- Incineration is typically not considered as an option for treatment of ACW.
- Asbestos containing materials which are not dusty are classified as "non-hazardous", whereas asbestos containing materials which are dusty are classified as "hazardous".

General principles for landfilling (Statutory order on Landfilling, 2019[211])

- Waste can be deposited in a landfill for mixed waste or mineral waste if certain requirements are fulfilled, among which that the waste must not contain hazardous substances other than bound asbestos and asbestos fibres bound by a binder or wrapped in plastic.
- Both for mineral and mixed waste landfills, ACW must be disposed of in a separate cell or a separate disposal unit.
- To avoid the spreading of fibres, on the same day that ACW has been deposited, asbestos waste must be covered with an appropriate material, e.g., soil. The cover must have a layer thickness of at least 0.2 meters.
- If the asbestos waste is not wrapped in plastic, it must be moistened regularly, during the summer period and in dry periods it is daily.
- It is not permitted to carry out compaction of landfilled ACW, as well as all unnecessary vehicle traffic in the area where asbestos waste has been deposited must be avoided.
- To avoid the risk of spreading of asbestos fibres, as soon as possible after the deposit of asbestos waste has ceased, a final cover is established on the disposal unit.
- After the final covering of a disposal unit where ACW has been landfilled, the operator of the disposal facility must submit an overview to the supervisory authority stating where the asbestos waste is located.
- After the closure of a disposal unit where ACW has been deposited, measures must be taken to ensure that no construction work or drilling of holes is carried out in the area, which may give rise to the release of asbestos fibres.
- After the closure of a disposal unit where ACW has been deposited, there must be taken appropriate measures, e.g., fences, to limit possible exploitation of or access to the area, in order to avoid people or animals coming into contact with the waste.

Waste containing a combination of asbestos and other pollutants

Currently in Denmark there is an issue with the management of ACW which also contains other environmentally problematic substances.

[211] Bekendtgørelse om deponeringsanlæg, 2019. Danish Ministry of Environment. https://www.retsinformation.dk/eli/lta/2019/1253.

ACW is separately collected, handled, and landfilled. Waste contaminated with environmentally problematic substances such as PCBs, PAHs, and heavy metals is also separately collected.

In some cases, waste contains both asbestos and other environmentally problematic substances (e.g., PCBs, PAH, heavy metals) in concentrations exceeding the limit values for hazardous waste. In these cases, the waste is likely to be classified as hazardous. However, the combined presence of asbestos and other environmentally problematic substances makes managing this type of waste challenging. While incineration of ACW is currently not done in Denmark, the presence of organic substances and heavy metals may limit the possibilities for landfilling. At present, there is no possible solution for this waste. Currently, this type of waste is stored at waste management facilities, while awaiting a solution (e.g., exporting the waste to an underground storage mine in Germany, which is however a very expensive solution).

A3.2.2 Management of demolition and renovation works

Screening and mapping for asbestos before demolition and renovation work (pre-demolition audit)

In Denmark, the building owner/developer/client has an obligation to screen, map and notify the authorities about the materials containing asbestos and other environmentally problematic substances, so the waste can be sorted and handled accordingly.

- Screening: determines to what extent a more detailed mapping of the building is needed. The screening can be a desktop study or/and a visual inspection of the building/site. The screening determines the risk of presence of materials containing environmentally problematic substances, including asbestos.
- Mapping (miljøkortlægning): When the screening indicates that environmentally problematic substances may be present, a more thorough investigation needs to be carried out. This mapping includes sampling and analysis to determine whether and to what extent the building or parts of it are contaminated with environmentally problematic substances.
- Reporting: an environmental mapping report is needed so the municipality can classify the waste. The mapping report is also used by demolition company to plan the demolition.

Demolition and renovation work

The demolition company must separate and remove asbestos and other environmentally problematic substances and hazardous waste from the building before the actual demolition work begins.

It is the responsibility of the demolition company that the waste is transported in a safely manner and according to the regulations for transport of waste to the designated destination.

General principles for work with asbestos

Following are the rules for any work with asbestos, including the repair, maintenance, and removal of asbestos-containing materials in Denmark.

Today, it is prohibited to manufacture, import, use or work with asbestos or asbestos-containing materials. However, buildings, facilities, technical machinery etc. that contain asbestos or asbestos-containing material can still be legally marketed in Denmark in their entirety. This applies if the asbestos or asbestos-containing material has been legally installed, and the building, facility, technical aid, etc. is put into use before 1 January 2005.

However, as reuse of asbestos-containing material is not permitted, it is forbidden to e.g., install a removed asbestos-cement board.

Registration of asbestos waste

Anyone who carries out demolition or maintenance work must identify the materials which may possibly contain asbestos before the work is started. This information can e.g., be obtained from the building owners through the pre-demolition audit.

Any employer who owns or uses a building for professional work, including public business, must register asbestos-containing materials that are damaged or that otherwise involve a risk of exposure to asbestos. Based on the registration, the employer must initiate the necessary encapsulation, sealing or removal of asbestos-containing materials.

In buildings built before 1990, the employer must register where asbestos or asbestos-containing materials have been used, before repair, maintenance, installation etc. is started. The registration must relate to the parts of the workplace where the work is to be carried out. Registration does not apply to asbestos-containing material used externally and to private buildings. It is therefore recommended to carry out further investigations into the possible presence of asbestos before the work begins. In case of doubt, materials can be sent for analysis for asbestos content.

- Corrugated asbestos cement sheets are provided with a number system which makes it possible to determine whether a sheet contains asbestos.
- If there is the slightest suspicion that there is asbestos in a material or in a building, asbestos regulations must be followed.

If the asbestos is not completely removed, the remaining and possibly encapsulated asbestos must be registered in the records that the building owner's occupational health and safety coordinator must prepare, so that future work in the building is safeguarded against the accidental spread of asbestos.

Work with demolition of asbestos-containing material inside buildings and in ships, trains, machines, etc. must in some cases be notified to the Danish Working Environment Authority before the work begins. Work that does not require a notification to the Danish Working Environment Authority is e.g., work that only entails a risk of short-term and low exposure to asbestos. If it is assessed that the work may involve long-term and high exposure to asbestos, it must be reported to the Danish Working Environment Authority.

Work that does not require a notification to the Danish Working Environment Authority is, if the work only entails a risk of short-term and low exposure to asbestos, and if the exposure is low.

Education, training, and instruction for works with asbestos

Employers must ensure that the persons involved in the internal demolition of asbestos-containing material in buildings, ships, etc., have undergone special asbestos training and have a training certificate.

Any company that must carry out demolition or removal of asbestos must be able to demonstrate to the Danish Working Environment Authority that the company is qualified to undertake the work. This can be done by documenting either that the employees have gone through a specific training process, covering e.g., asbestos' properties and effects on health, materials that may be suspected of containing asbestos, safe working methods and personal protective equipment, cleaning procedures, waste disposal.

Measures during indoors asbestos-remediation work

The work must be organised and carried out in such a way that it is ensured to the greatest extent possible that people at the workplace and in the surroundings are not exposed to dust from asbestos and asbestos-containing materials. The number of people who are exposed or may be exposed to dust must be limited as much as possible, and personal protective equipment is mandatory.

Working methods and tools should produce the least amount of dust possible. Asbestos-containing material that is demolished can be moistened to prevent dust formation. In indoors spaces, if it is not possible to choose working methods that prevent the generation of asbestos-containing dust, the dust must be removed through ventilation and extraction followed by a filter designed to retain asbestos dust. To prevent the spreading of asbestos fibres during the work, negative pressure is established by means of air cleaners with filters (microfilters or HEPA filters), which also serve the purpose of filtering the air in the area for suspended dust and thus facilitate the cleaning work.

After the major decontamination work has been carried out, a final cleaning has to be carried out by vacuuming and wet wiping all surfaces. After cleaning, a visual inspection of the area is carried out. Negative pressure is maintained in the remediation area until final inspection and final approval is available.

The cleaning standard is approved by a visual inspection to check the absence of dust, which can be supplemented with an air sample test (collecting an air sample through an air pump) or a gel tape test (where a piece of rectangular plastic film with an adhesive gel is used to collect surface dust to then be analysed with a microscope.

For outdoors remediation works, it may be necessary to moisten the asbestos-containing materials. After the remediation has been completed, the substrate and covering materials are cleaned through vacuuming (with filters) and wet wiping - if possible.

A3.3 Germany

A3.3.1 Management of asbestos containing waste

The main treatment for ACW in Germany is landfilling and in some cases in underground storage facilities. Landfilling of ACW must occur at approved facilities. Recycling hazardous ACW is not allowed in Germany, and the same holds for preparation for reuse. Incineration of ACW is also not practiced.

Management of ACW during demolition and renovation projects is organised and monitored by individual municipalities. Some variations can hence be seen across different municipalities in Germany, but the general principles are described in the following.

General principles for asbestos-containing waste

- Waste must be landfilled and cannot be recycled.
- Incineration is not considered as an option for treatment of ACW due to bad experience made in different treatment plants in Germany in the past. While there is an indication that high temperature thermal treatment (i.e., 1100 °C) may be effective in destroying asbestos fibres, no incineration plant in Germany (including incineration plant for hazardous waste) is willing to accept waste with asbestos.
- Asbestos containing materials are considered as hazardous waste in case of 0.1% asbestos content or more and as non-hazardous waste in case of contents below 0,1 % (but still asbestos containing, see regulations in LAGA M23). Even low contents of asbestos have to be removed out of the recycle material circle.

The following tables contain the most commonly used waste codes in Germany from the Waste Catalogue Directory for ACW in practice. Additionally, other waste codes may be applicable that do not explicitly refer to asbestos (e.g., for soil contaminated with asbestos fibers, waste codes 17 05 03* and 17 05 04, see also the "technical guidance on the classification of waste" of the European Commission (2018/C, Section 1.4.3. Asbestos).

Table A3-1: Waste codes for frequently occurring ACWs	
Waste code	**Waste designation according to AVV**
15 01 11*	Metallic packaging containing a hazardous solid porous matrix (for example asbestos), including empty pressure containers
16 02 12*	discarded equipment containing free asbestos
16 02 15*	hazardous components removed from discarded equipment[1]
17 06 01*	Insulation materials containing asbestos
17 06 05*	construction materials containing asbestos
[1] with remark "containing asbestos"	

Table A3-2: Wastes, that may occur during asbestos removal or treatment of ACWs	
Waste code	**Waste designation according to AVV**
15 02 02*	absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by hazardous substances
15 02 03	absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02 [1]
[1] with remark "containing asbestos"	

General principles for landfilling

The following general principles are valid for the landfilling of ACW (Deponieverordnung), which are in line with the prescriptions in Council Decision 2003/33/EC:

- Waste can be deposited in a landfill for mineral waste if certain requirements are fulfilled, among which that the waste must not contain hazardous substances other than bound asbestos and asbestos fibres bound by a binder or wrapped in plastic.
- For mineral waste landfills, ACW must be disposed of in a separate cell or a separate disposal unit.
- To avoid the spreading of fibres, on the same day that ACW has been deposited, asbestos waste must be covered with an appropriate material, e.g., soil. The cover must have a layer thickness of at least 0.25 meters.
- There are special regulations for low asbestos content waste; e. g. this waste must not be wrapped in plastic but has to be moistened regularly and can be deposited outside of mono areas.
- To avoid the risk of spreading of asbestos fibres, as soon as possible after the deposit of asbestos waste has ceased, a final cover is established on the disposal unit.
- After the final covering of a disposal unit where ACW has been landfilled, the operator of the disposal facility must submit an overview to the supervisory authority stating where the asbestos waste is located (different regulations in the federal states).
- After the closure of a disposal unit where ACW has been deposited, measures must be taken to ensure that no construction work or drilling of holes is carried out in the area, which may give rise to the release of asbestos fibres.

Waste containing a combination of asbestos and other pollutants

ACW which also contains other environmentally problematic substances is separately collected, handled, and landfilled. Waste contaminated with environmentally problematic substances such as PCBs, PAHs, and metals are also separately collected.

In some cases, waste contains both asbestos and other environmentally problematic substances (e.g., PCBs, PAH, metals) in concentrations exceeding the German limit values according to the regulations of the DepV. Exceptions are possible on a case-by-case basis (see §6 DepV and LAGA M23), e.g., if TOC / loss on ignition is exceeded.

The combined presence of asbestos and other environmentally problematic substances makes managing this type of waste a challenge. While incineration of ACW is not practiced in Germany, the presence of organic substances and metals in asbestos waste may limit the possibilities for landfilling. This waste is stored at underground storage facilities, which is however a very expensive solution (e.g., underground storage facilities in Zielitz and Herfa-Neurode).

Unsuccessful asbestos waste treatments – experience from former research projects

In the 1990s some research projects took place in Germany to avoid deposition of asbestos containing materials. The following different treatment methods and combination of them were tested:

- Mechanical shredding processes
- Thermal processes and vitrification (glazing)
- Tempering
- Chemical processes

A study of the *Kernforschungszentrum Karlruhe* from September 1994 ("Stand der Behandlung und Entsorgung asbesthaltiger Reststoffe 1994, I. Jovanovic, Projekt Schadstoff- und Abfallarme Verfahren") summarises the status of techniques as follows:

"*At present none of the treatments fulfil the demands of being low in energy consumption, reducing waste volume and permitting a total destruction of the asbestos structures with the possibility of reusing the products.*"

All above mentioned treatment methods are categorised until today as not suitable in Germany due to drawbacks like no efficient destruction of the asbestos fibres, high costs and uncertainties regarding the full destruction of the fibres.

A3.3.2 Management of demolition and renovation works

A good practice of all asbestos regulations can be found on the "BAuA Informationsplattform Asbest"[212] because of the national asbestos dialogue in Germany taken place in the period 2017-2019. It offers valuable resources and guidance regarding asbestos-related topics. Additionally, the German Working Group on Waste (LAGA) has issued a notification titled "LAGA M23[213]", which specifically addresses the handling and disposal of ACW. These resources serve as important references for

[212] https://www.baua.de/DE/Themen/Arbeitsgestaltung-im-Betrieb/Gefahrstoffe/Arbeiten-mit-Gefahrstoffen/Stoffinformationen/Informationsportal-Asbest/Asbest_node.html

[213] https://www.laga-online.de/documents/laga-m23-vollzugshilfe-zur-entsorgung-asbesthaltiger-abfaelle-2022-11-29_1683724418.pdf

individuals and organizations seeking detailed information and guidelines pertaining to asbestos in Germany.

General principles for work with asbestos

Following are the rules for any work with asbestos, including the repair, maintenance, and removal of asbestos-containing materials in Germany. Today, it is prohibited by Chemical Law resp. the ordinance (Gefahrstoffverordnung) to manufacture, import, use or work with asbestos or asbestos-containing materials. One exception is referring to § 17 GefStoffV at a facility in Stade, where a Chlor-alkali electrolysis is still using asbestos containing diaphragms. The use of Asbestos was banned in Germany on 10/31/1993, with some exceptions until 12/31/1994. However, buildings, facilities, technical machinery etc. that contain asbestos or asbestos-containing material can still be legally marketed in Germany (as in the rest of EU) in their entirety. This applies if the asbestos or asbestos-containing materials has been legally installed, and the building, facility, technical aid, etc. is put into use before 1 January 2005. This is based on REACH restrictions, Annex XVII, entry 6.[214] However, as reuse of asbestos-containing material is not permitted, it is forbidden to e.g., install a removed asbestos-cement board. Since the Act on the Implementation of Measures of Occupational Safety and Health to Encourage Improvements in the Safety and Health Protection of Workers at Work (Arbeitsschutzgesetz - ArbSchG) prescribes an assessment of working conditions prior to the commencement of activities and the Ordinance on Hazardous Substances (Gefahrstoffverordnung - GefStoffV) prescribes a determination of hazards and a risk assessment, the exploration for asbestos is definitely anchored. A draft amendment to the Ordinance on Hazardous Substances contains a strengthening of the obligations of the initiator of measures. According to building law, no danger may emanate from a building and in particular from asbestos. The Asbestos Guideline (Annex 16 of the Model Administrative Regulation on Technical Building Regulations – Musterverwaltungsvorschrift Technische Baubestimmungen) as a part of the building law includes specific regulations only applicable to weakly bound asbestos products.

Asbestos surveys / Screening and mapping for asbestos before demolition and renovation work (pre-demolition-audit)

A binding duty to investigate asbestos in structural and technical installations was discussed in the context of the national asbestos dialogue in Germany. As a compromise, incident-related investigations (surveys) prior to activities or construction measures are established. This means that in the event of occurring damages (e.g., fire and water damage), no asbestos survey results are available on a recurring basis. So far, no state register of asbestos-containing materials in buildings is kept in Germany. Since the Asbestos Directive (Asbestrichtlinie) requires the building owner to at least check for a possible user hazard from weakly bound asbestos products in older buildings, a systematic survey was usually carried out in the 1990s, especially for public buildings. Screening and mapping for asbestos before demolition and renovation work is particularly critical for buildings in Germany with construction dates before 10/31/1993 or in some special cases before 12/31/1994. These dates are significant as they represent the implementation of stricter asbestos regulations in Germany. The "Guideline for Asbestos Surveys" (*Leitlinie Asbesterkundung*) and the "VDI Guideline 6202 Part 3" provide specific guidance on assessing and identifying asbestos-containing materials in buildings constructed prior to these dates.

These guidelines are non-obligatory, but it is essential to follow these guidelines to ensure a comprehensive evaluation of asbestos risks and to implement appropriate safety measures when

[214] EC Regulation 1907/2006, REACH. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02006R1907-20221217&qid=1679406726981&from=EN

working on older buildings. By adhering to the regulations and guidelines, the health and well-being of workers and occupants is safeguarded during demolition and renovation projects in Germany.

The exploration process according to VDI 6202 Sheet 3 involves several steps:

- Firstly, information about the building is collected, including its history and potential asbestos presence.
- Subsequently, a visual inspection is conducted to identify potentially asbestos-containing materials.
- In a third step, samples are taken and sent to an accredited laboratory for analysis to accurately determine the presence of asbestos.
- The results of the analysis are then evaluated and documented to make informed decisions. The type of documentation is not specified in any legal regulations.

The necessary interaction between owner and dismantling company is shown in Figure A10-1 for an incident-related asbestos investigation / survey, according to the *Leitlinie Asbesterkundung*.

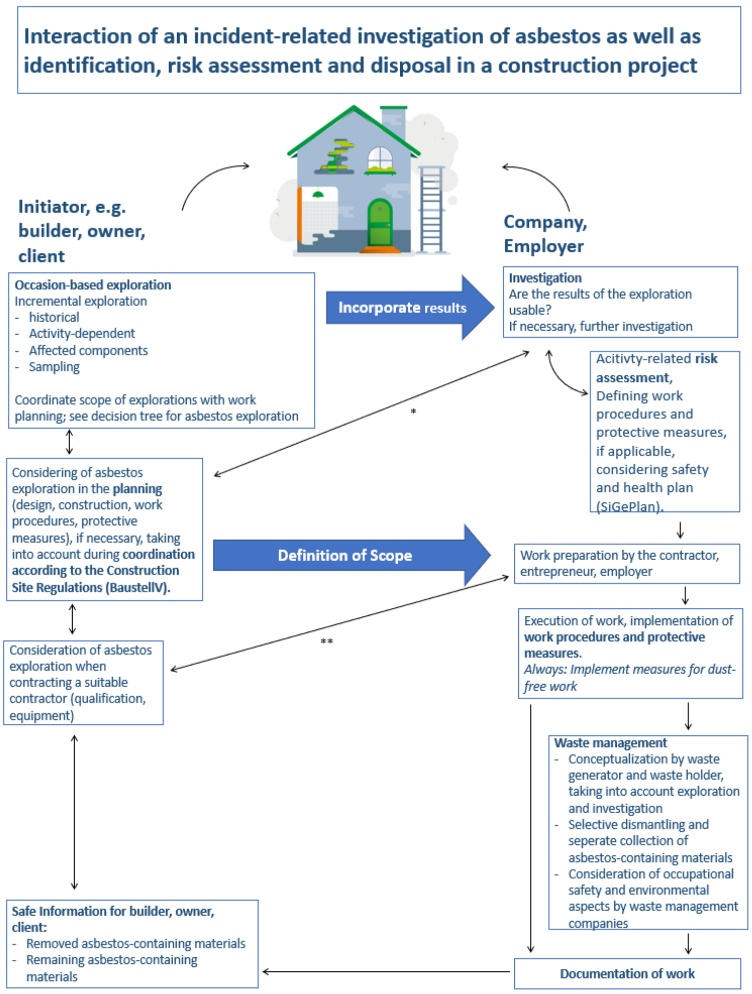


Figure A3-1: Interaction of an incident-related investigation of asbestos as well as identification, risk assessment and disposal in a construction project (from *Leitlinie für die Asbesterkundung zur Vorbereitung von Arbeiten in und an älteren Gebäuden, BAuA, translated*[215])

215 https://www.baua.de/DE/Angebote/Publikationen/Kooperation/Asbesterkundung.pdf?__blob=publicationFile&v=2

Planning Process

The planning of asbestos removal is legally anchored only to a limited extent in Germany. While there are guidelines and recommendations in place, there is no comprehensive legal framework specifically governing the planning process. As a result, the development of a remediation concept often relies on industry best practices, expert knowledge, and adherence to relevant safety standards.

In the planning of asbestos-related activities, the following key components should be considered:

- Remediation concept (asbestos-specific qualifications, permissibility, ban on covering, asbestos exposure and protective measures, need for low-emission processes).
- Disposal concept in accordance with the Closed Substance Cycle Waste Management Act (KrWG) and state recycling laws (e.g., in Baden-Württemberg and North Rhine-Westphalia).
- Tendering / contract design (selection of suitable companies / determination of qualifications / asbestos permit etc.)

Remediation concepts are mandatory under building law (Asbestrichtlinie) for weakly bound asbestos products, but not for all firmly bound products.

The planning steps for contaminant remediation are described in detail in the AHO booklet No 43 (Specialist planning services for pollutants in buildings - structural and technical installations / Heft 43 - Fachplanungsleistungen zu Schadstoffen in Objekten – bauliche und technische Anlagen).

Demolition, remediation and maintenance work

The execution of asbestos remediation projects in Germany has to be conducted in accordance with the German Hazardous Substances Ordinance (GefStoffV) and Technical Rules for Hazardous Substances 519 (TRGS 519). It involves a systematic approach. The asbestos survey before starting work, the risk assessment and handling of asbestos-containing materials are regulated to ensure the protection of workers and the environment. The TRGS 519 provides detailed guidelines and procedures for the safe removal, disposal, and clearance testing of asbestos.

According to TRGS 519, asbestos remediation activities must be performed by companies who possess the requisite qualifications, expertise, and knowledge in asbestos handling. Specialist companies must hold official recognition for high-risk work from the relevant authorities, demonstrating their capability to implement the prescribed technical and organizational measures outlined in TRGS 519. If the specifications are met, the company is entitled to receive the asbestos permit for high-risk work on the basis of the submitted documents. Site inspections are not part of the approval process.

Based on the asbestos survey (chapter 3.2), a remediation plan should be developed in accordance with the TRGS 519 and in case of weakly bound asbestos in accordance with the Asbestrichtlinie, outlining the necessary procedures, equipment, and control measures for the safe removal of asbestos.

During the remediation process, strict control measures are implemented to minimize asbestos exposure, as outlined in the TRGS 519. This includes:

- the establishment of containment areas with negative pressure systems,
- the use of appropriate personal protective equipment (PPE) conforming to TRGS 519,
- and the implementation of decontamination procedures.

The removal of asbestos-containing materials follows the procedures specified in the TRGS 519, ensuring proper dismantling, encapsulation or enclosure techniques to minimize fiber release.

Clearance testing, as specified in the TRGS 519, is conducted to verify the success of the remediation before dismantling the asbestos work areas (black areas). This involves air monitoring to ensure that the area meets the required clearance criteria and is free from asbestos fibers. Depending on the type and extent of asbestos removal and the locations of the material and personnel lock, the additional success control measurements prior to reuse must also be observed in accordance with the specifications of the asbestos guideline. The possibility of additional surface sampling can be used as well but is not implemented in the regulations of the TRGS 519 or Asbestrichtlinie.

Throughout the entire process, comprehensive documentation, as required by the GefStoffV and TRGS 519, is maintained, providing a record of site assessments, remediation plans, work permits and air monitoring results.

In case of full demolition of buildings, the demolition company must separate and remove asbestos and other environmentally problematic substances and hazardous waste from the building *before* the actual demolition work begins. Building decontamination consists in removing all environmentally problematic substances before demolition, e.g., by dismantling, by milling work, by water jet high pressure method etc. to remove ACM and plaster / paint / putty from surfaces, by physically removing PCB-containing soft joints and removing secondary PCB-load due to evaporation. This is done to make sure that the problematic substances are removed, so that waste can be better sorted and reused/recycled. Since removing problematic substances poses strict requirements on the working environment (e.g., ventilation, shorter shifts, use of personal protections), it is easier to demolish the building afterwards, when the problematic substances have been removed. While it often can be the same company performing both tasks, it is also common to have a specialised company performing the decontamination first (e.g., removing all the asbestos) and then a demolition company takes over the building. The boundary between the two processes can however often overlap.

Spacers containing asbestos in concrete building components have emerged as a new problem, which may be asbestos containing in the 1960s to 1990s. For buildings, solutions are visible here both in the exploration and in the removal before demolition. In the case of large bridge structures, the spacers containing asbestos currently still pose an unsolved problem in terms of detection, but especially in terms of disposal.

The "new" asbestos findings plasters / putties / tile adhesives are currently proving to be problematic for many activities in existing buildings, as low-emission procedures are not yet available for the treatment of small areas during maintenance work. In many cases tests for asbestos are not yet adequately carried out before small-area interventions. An attempt is being made to counter this with a more comprehensive information campaign, as agreed in the national asbestos dialogue, see also the following section.

Education, training, and instruction for works with asbestos

Employers must ensure that the persons involved in the internal demolition of asbestos-containing material in buildings, ships, etc., have undergone special asbestos training and have a training certificate according to the regulations of the TRGS 519.

Any company that must carry out demolition or removal of asbestos must be able to demonstrate to the local authorities that the employees have gone through a specific training process (TRGS 519), covering e.g., asbestos' properties and effects on health, materials that may be suspected of containing asbestos, safe working methods and personal protective equipment, cleaning procedures, waste disposal. As mentioned above, only in case of asbestos removal work with high risks a formal asbestos permit is necessary.

Since in Germany, among other things, the "new" asbestos findings in plasters / fillers / tile adhesives have caused a new sensitivity, efforts are being made to provide all employees working in old buildings with basic training in asbestos. The Employer's Liability Insurance Association for the Construction Industry (BG Bau) has launched a special training campaign (basic knowledge of asbestos, e-learning course with or without test and certificate[216]) for this purpose on a digital way including an asbestos house showing a lot of asbestos findings.

Measures during indoors asbestos-remediation work

The work must be organised and carried out in such a way that it is ensured to the greatest extent possible that people at the workplace and in the surroundings are not exposed to dust from asbestos and asbestos-containing materials. The number of people who are exposed or may be exposed to dust must be limited as much as possible, and personal protective equipment is mandatory.

Working methods and tools should produce the least amount of dust possible. Asbestos-containing material that is demolished can be moistened to prevent dust formation. In indoors spaces, if it is not possible to choose working methods that prevent the generation of asbestos-containing dust, the dust must be removed through ventilation and extraction followed by a filter designed to retain asbestos dust. To prevent the spreading of asbestos fibres during the work, negative pressure is established by means of air cleaners with filters (microfilters or HEPA filters), which also serve the purpose of filtering the air in the area for suspended dust and thus facilitate the cleaning work. Indoor security measures should always be two-tiered. On the one hand, asbestos dusts should be collected as close as possible to the source. On the other hand, asbestos fibres released into the room should be professionally extracted with high air exchange rates and appropriate filter stages.

After the major decontamination work has been carried out, a final cleaning has to be carried out by vacuuming and wet wiping all surfaces. After cleaning, a visual inspection of the area is carried out. Negative pressure is maintained in the remediation area until final inspection and final approval is available.

The cleaning standard is approved by a visual inspection to check the absence of dust, which can / must be supplemented with an air sample test (collecting an air sample through an air pump). Dust samples are usually not taken additionally.

In Germany, an extension of the exposure-risk matrix established within the TRGS 519 with an adapted protective measures and training programme is currently being developed. The exposure-risk matrix is intended to provide practical assistance in assessing exposures on the basis of measurement results.

216 https://lernportal.bgbau.de/ilias.php?ref_id=62625&cmd=view&cmdClass=ilobjcontentpagegui&cmdNode=xr:mj&baseClass=ilrepositorygui

A3.3.3 Asbestos Waste Disposal

Handling of asbestos waste in Germany involves the participation of different stakeholders, including the property owner/client, the waste holder, which is typically a licensed waste management company and in lot of cases the consultant. The consultant, in collaboration with the property owner / client, develops a waste management plan. This plan outlines the proper packaging, labelling, transportation, and disposal procedures for the asbestos waste. The waste holder receives the waste management plan and obtains the necessary signatures from the property owner/client, the consultant and the waste holder themselves. These signatures confirm their acknowledgment and agreement with the designated handling methods.

The disposal of asbestos in Germany involves a comprehensive monitoring process that incorporates the use of the electronic waste management system (eANV). This system facilitates a two-step monitoring approach. Firstly, a disposal proof or waste disposal certificate has to be obtained prior to the disposal, serving as evidence that the waste will be managed and disposed appropriately ("Entsorgungsnachweis"). Secondly, an acceptance document, such as a transfer/consignment note, is utilized as a control measure to track the remaining of the waste ("Übernahmeschein / Begleitschein"). This ensures proper documentation and serves as a register obligation, enabling authorities to monitor the movement and final destination of the asbestos waste in Germany. The eANV system plays a crucial role in streamlining these monitoring processes, enhancing transparency, and promoting the responsible disposal of asbestos in compliance with regulatory requirements.

Asbestos waste has to be collected properly during demolition, remediation and maintenance works. The asbestos containing waste has to be sealed, labelled, and disposed of in accordance with the requirements of the TRGS 519 and the new LAGA M23.

The objective of the new LAGA M 23 is to ensure that as much of the construction and demolition waste as possible is recycled as RC building material. To this end, the new LAGA M 23 introduces an assessment value (Beurteilungswert 0.010 %) similar to those in the Netherlands and Belgium, which links recyclability to a concrete value with the help of a clear definition of "asbestos-free" as a convention.

What is remarkable is that a new assessment value between > 0.010 M-% < 0.1 M-% is classified as "non-hazardous waste" (e.g., waste code 17 01 01 according to AVV), but it must still be disposed of if it is a man made asbestos contamination ("on purpose"), since geogenic material containing asbestos may be placed on the market up to < 0.1 M-%.

The following figure summarises the procedure for dealing with the material stream "construction waste" when dismantling older buildings that may contain asbestos-containing construction materials. The standard procedure is the investigation, removal and high-quality recycling of the remaining decontaminated building materials. The illustration shows the corresponding allocation to the waste types according to the Waste Catalogue Ordinance (AVV / European Waste Types Catalogue).

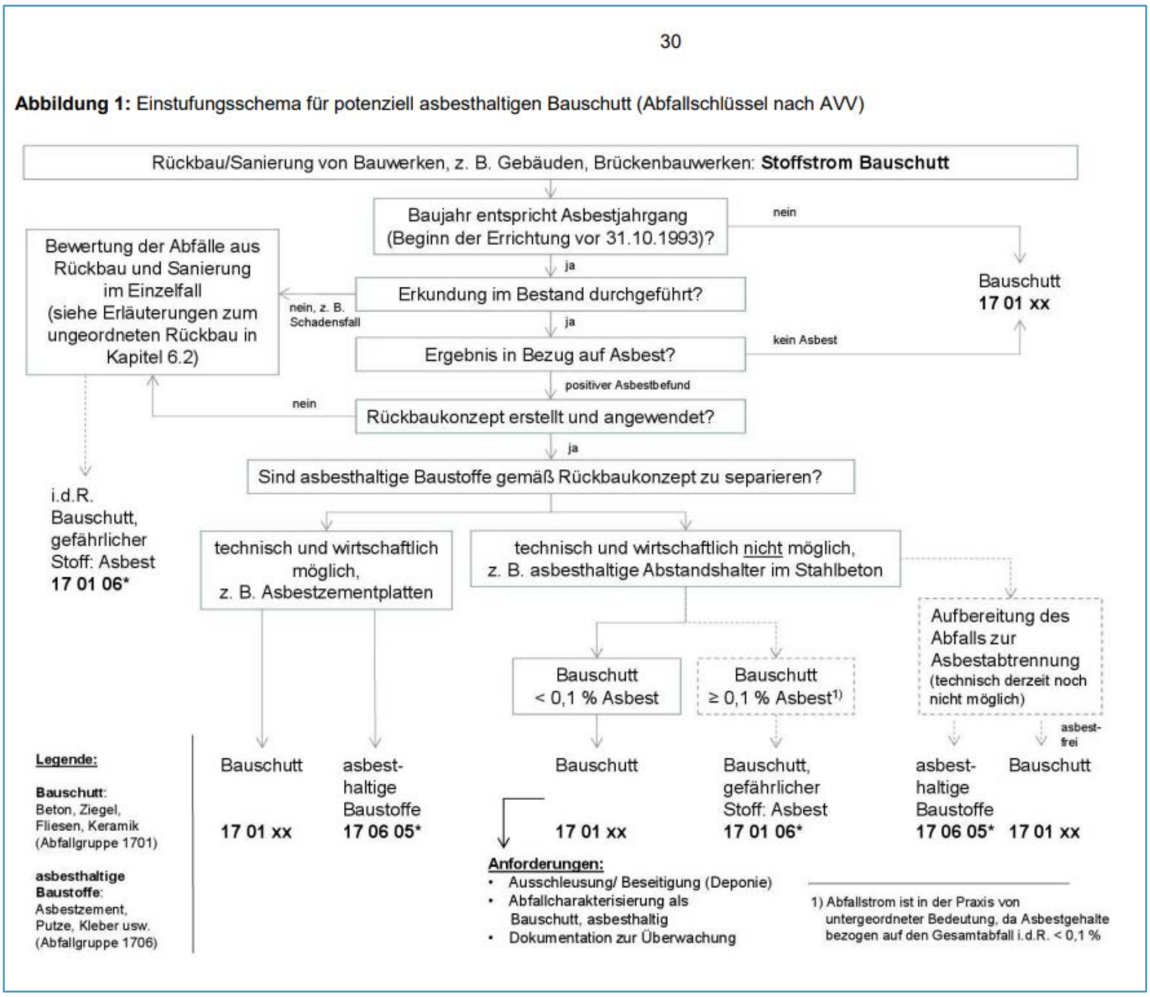


Figure A3-2: Classification scheme for construction waste potentially containing asbestos (waste conclusions according to AVV / European Waste Catalogue) (from *LAGA M23 -Implementation Guide for the Disposal of Waste Containing Asbestos, Communication of the Federal / State Working Group on Waste (LAGA) 23, as of November 2022)*[217]

[217] https://www.laga-online.de/documents/laga-m23-vollzugshilfe-zur-entsorgung-asbesthaltiger-abfaelle-2022-11-29_1683724418.pdf

Annex 4 Treatment technologies from peer-reviewed publications

Table A4-1: Thermal treatment technologies identified through literature search on Dimensions.

Process	Process details	Waste stream	Outcome	Maturity level	Advantages	Disadvantages	Source
Vitrification	Thermal plasma	Asbestos-containing waste	Road construction material (Cofalit)	Industrial - Inertam plant designed by Europlasma	• Thermal plasma treatment provides complete destruction. • A potentially sustainable and environmentally friendly technology. • The product gas formed in the plasma process is cleaner in nature on account of the very high temperatures compared with the conventional gasification processes and there is no need for product gas cleaning. • Final emissions to the atmosphere is a function of the extent of cleaning of the fuel gas with an exception of NO x which is not formed during gasification, though NO x can be formed during the combustion of the producer gas. • The prevention of the formation of dioxins and furans. • Comparatively reduced exit gases, higher volume reduction, installations with smaller footprints, faster start-up and shut-down times and, lower costs for a specified throughput.	• The lack of understanding of the process. • High installation and operation costs. • The utilisation of the most useful form of energy (electricity) as input.	Sikarwar et al., 2020
	Thermal plasma	Asbestos-containing waste	Cofalit as a solid filler in a pilot-scale thermocline thermal energy storage (TES)	Pilot	• Helps to reduce the environmental impact of ACW and increases the potential of sustainable energy solutions such as concentrated solar power and energy recovery system. • It has suitable thermo-physical properties as well as good thermal behaviour inside the TES, which makes it economically competitive. • Cofalit® exhibits outstanding thermal performance in this experimental setup when compared to reference materials.	• Volumetric heat capacity is usually desired to be as high as possible for a bigger thermal storage capacity, smaller tank size, and longer operation time. Hence, higher operational cost, lower efficiency and higher thermocline thickness are often underestimated, which is emphasized by the comparison	Keilany et al., 2020

Table A4-1: Thermal treatment technologies identified through literature search on Dimensions.							
Process	**Process details**	**Waste stream**	**Outcome**	**Maturity level**	**Advantages**	**Disadvantages**	**Source**
					• It can be produced with any required size or shape, which allows broader applications and different designs.	between Cofalit® and alumina spheres.	
	Thermal plasma	Asbestos cement, fly ash	Glassy slag	Laboratory	• The transformation of a glassy slag, which is an inert waste after processing without any subsequent use, results in a product with an added value. • It is possible to consider the application of this product in the field of thermal insulation materials. • Production uses asbestos waste and fly ash.		Lázár et al., 2018
	50% by mass asbestos containing waste and 50% by mass waste glass cullet	Asbestos cement, waste glass cullet	Amorphous, hard and harmless product	Laboratory	• An effective method of neutralising asbestos-cement materials. • The use of cathode ray tube (CRT) cullet provides economic and environmental benefits, namely through the management of CRT waste, the pollution of the environment with electronic waste is reduced. • CRT cullet also acts as a flux that reduces the glass transition temperature, thus lowering the disposal costs of asbestos-containing waste. • The products resulting from the decomposition of asbestos are effectively immobilised in the glass structure. • The product can find practical application in many industries, e.g. in the building materials industry or road construction industries as aggregate or as an additive to concrete.		Iwaszko et al., 2021
	50% by mass asbestos containing waste and 50% by mass waste glass cullet	Asbestos cement, glass cullet	Harmless vitrified product	Laboratory	• Vitrification is a highly effective method of neutralising hazardous waste containing asbestos. • The vitrification process effectively binds the components of asbestos-cement waste in		Iwaszko et al., 2018

Table A4-1: Thermal treatment technologies identified through literature search on Dimensions.							
Process	**Process details**	**Waste stream**	**Outcome**	**Maturity level**	**Advantages**	**Disadvantages**	**Source**
					the glass structure and converts ACW into a harmless product. • Vitrification leads to complete disappearance of the asbestos fibres in the vitrified material and significantly reduces the vitrified composition volume. • The vitrified material was characterized by higher resistance to ion leaching in an aquatic environment than ACW and a smaller volume of nearly 72% in relation to the apparent volume of the substrates.		
	Vitrifying KRY·AS together with glass waste	Asbestos cement, glass waste	Foam glass	Laboratory	• The obtained product presented values of apparent density (0.55–0.68 g/cm3) and compressive strength (0.56 MPa) comparable with those reported in the literature for foam glasses obtained from wastes and close to commercial foam glasses.	• The technical and economic limitations of the process	Ligabue et al., 2022
	Vitrifying KRY·AS together with recycled glass	Asbestos cement, recycled glass	Glass-ceramic frits for manufacturing porcelain stoneware slabs	Laboratory	• The novel products can be classified as BIa-type. • A technically viable recycling option. • Geographically advantageous considering the short distance between major Italian ceramic industries and potential waste sources. • The frit can be obtained only from a mixture of thermally treated asbestos and glass processing waste without any addition of natural raw materials.		Ligabue et al., 2020
	Alkali activation, gel-casting and sintering of partially crystallized residues	Asbestos-containing wastes	Highly porous glass-ceramics	Laboratory	• Optimised conditions led to foams with high strength-to-density ratio. • The process minimises the use of additives.		Monich et al., 2021

Table A4-1: Thermal treatment technologies identified through literature search on Dimensions.							
Process	**Process details**	**Waste stream**	**Outcome**	**Maturity level**	**Advantages**	**Disadvantages**	**Source**
Thermal treatment	Short-time thermal processing, heating up to 1100°C, keeping temperature for 15 min and cooling quickly	Asbestos-containing wastes	Secondary raw material in ceramic industries	Pilot	• An exceptionally short processing time. • A substantial drop in the inertisation cost. • The deactivated wastes revealed chemical, mineralogical and micro/nanostructural characteristics that appear to be very promising for their recycling in several industrial sectors as secondary raw materials, in a perspective that is fully compatible with the principles of sustainability, natural resources protection and circular economy.		Marian et al., 2021
	Melted for 100 minutes in an electric arc-resistance furnace with mineral additives	Asbestos cement	Artificial aggregate	Laboratory	• The process of melting with appropriate additives allowed a new material to be obtained, which can be successfully used for the production of artificial aggregates. • The investigated aggregates fulfil the requirements for different levels of categories, as defined in PN-EN 12620 Aggregates for concrete and PN-EN 13043 Aggregates for bituminous mixtures and surface treatments for roads, airfields, and other trafficked areas.		Witek et al., 2019
	Deactivated cement asbestos powder as individual substitution (5 wt%) of quartz and feldspar	Asbestos cement	Ceramic sanitary wares	Laboratory	• Important technological properties such as the water absorption are as good as (or even better than) they are in normal production.	• The presence of sulphate salts that increase the dispersant demand and the colour of the fired ceramic body.	Bernasconi et al., 2023
	Heated for 1 h in a furnace at 800°C	Asbestos cement	Alkali-activated binders	Laboratory	• It was possible to replace metakaolin with 27.4 % of thermally treated asbestos waste without compromising the mechanical properties of the paste.		Santana et al., 2023
	With and without	Asbestos cement	Hydraulic binder	Laboratory	• It has been found that the burning of asbestos cement materials alone or with the addition of limestone at the temperature		Staněk et al., 2018

Table A4-1: Thermal treatment technologies identified through literature search on Dimensions.							
Process	**Process details**	**Waste stream**	**Outcome**	**Maturity level**	**Advantages**	**Disadvantages**	**Source**
	addition of bulk limestone				above 1100 °C leads to the decomposition of hazardous asbestos and, with or without the addition of a setting regulator, hydraulic binder is formed. • This material has quality technological parameters appropriate for various applications in building industry. • The material can be used as supplementary cementitious material. It could be used in the production of blended cements, dry plaster mixtures or as an admixture in concrete.		
	Heated for 1 h in a furnace at 800°C	Asbestos cement	Alkali-activated binder	Laboratory	• The proper heat treatment of asbestos-cement waste eliminates the health risks inherent in the presence of chrysotile, in addition to adding value through the production of the precursor for the alkali-activated binder. • The application of alkali-activated cements proved to be very promising as an alternative binder to Portland cement.		Carneiro et al., 2022
	Heated for 1 h in a furnace at 800°C	Asbestos cement	Binder	Laboratory	• The optimisation of treatments resulted in residue sinterin aimed at the maximum belite formation, higher calcite contents, amorphous phases with minimum mass loss, and total elimination of chrysotile.		Carneiro et al., 2021
	Heated for 3.5 h (asbestos cement with polymers) and 7.5 h (asbestos cement) in a muffle furnace at up to 1200°C	Asbestos cement, asbestos cement with polymers	Asbestos-free solid by-product	Laboratory	• The product of transformation can be recycled in further industrial processes (ceramics, clay brocks, concrete), thus avoiding the consumption of renewable resources and promoting circular economy.	• Its main drawback is the relatively high energy consumption.	Tomassetti et al., 2020
	Heated for 1 h in an electric	Asbestos cement	Decomposition of chrysotile	Laboratory	• Products harmless to humans are created, which can be used in the building materials industry, or in road construction	• Only the treatment at 1300°C completely eliminates asbestos fibres. Processing at	Iwaszko, 2019

Table A4-1: Thermal treatment technologies identified through literature search on Dimensions.							
Process	**Process details**	**Waste stream**	**Outcome**	**Maturity level**	**Advantages**	**Disadvantages**	**Source**
	furnace at 1300°C					1300°C is associated with higher costs. • The consequence of changes in the morphology and properties of the fibrous phase induced by heat treatment is a very explicit decrease in the strength properties of the asbestos-cement composite.	
	Heat treatment in air at 1100°C in Nabertherm static furnace	Asbestos cement	Secondary raw material (SRM)	Laboratory	• During the recycling process, a small amount of the SRM is admixed to the primary raw materials and becomes tightly bonded within a cement or ceramic matrix, preventing leaching of contaminants.	• A significant fraction of nanoparticles is produced, which may pose environment and human health concern. • Leaching test results on the powdered SRM evidenced some critical release of SO4 2–, F– and Cr6+. • Sulphates may have adverse effects on potential applications of the SRM in the ceramic and cement industries. • Hexavalent Cr is highly toxic, and caution must be paid to impede the arrival of any SRM leachate to drinking water supplies. • Fluorine may cause dental and skeletal fluorosis, and sulphate may cause salty taste and gastrointestinal problems.	Vergani et al., 2021
	Not known	Asbestos cement	Epoxy resins for flooring applications	Laboratory	• Waste asbestos cement can be detoxified by a sustainable thermal treatment, powdered and successfully mixed, potentially in large amounts, to commercial resin formulations of different compositions without any further surface treatment.	• Some decrease in the relevant mechanical properties.	Campanale et al., 2023

Table A4-1: Thermal treatment technologies identified through literature search on Dimensions.

Process	Process details	Waste stream	Outcome	Maturity level	Advantages	Disadvantages	Source
					• Deactivated cement asbestos powder (DCAP) can be advantageously used as a filler in substitution for commercial barite. • Sample with 20 wt% of DCAP is the best performing in terms of compressive, tensile, and flexural strengths, whereas the sample with 30 wt% of DCAP shows the highest Shore hardness, which is an important property to be considered in flooring applications.		
	Calcination in a Nabertherm furnace with electronically programmable temperature regulator, increasing the temperature at 10°C/min to 1000-1500°C, for 30 and 120 minutes	Asbestos cement	Neutral mineral with potential uses for cement production	Laboratory	• At 1400-1500°C, the structure of asbestos was permanently changed, and it became a mineral neutral to human health. • The material obtained gives potential uses for cement production.	• In samples sintered in the temperature of 1250°C for 120 minutes trace amounts of chrysotile were found. • Destruction only achieved at 1400°C or higher, which would require a lot of energy.	Poniatowska et al., 2019
	Keeping granulated mass obtained from ACMs mixed with additives in appropriate proportions at high temperatures in rotary kilns	Asbestos cement	Clinker	Laboratory	• The process is exothermic and is carried out in rotary kilns used in the production of cement. • Destruction of asbestos fibres. • The resulting product is a kind of clinker which does not contain asbestos fibres. • The product obtained may be used in a number of industries, which reduces the cost of the processing of asbestos and its derivatives into an asbestos-free product.	•	Pawlikowski et al., 2018
Microwave thermal treatment		Asbestos-containing waste	Neutralised asbestos waste	Pilot (Aton in Poland)	• This process is economically optimal, as it allows a temperature reduction to 700–1100 ◦C.	• The efficiency of asbestos destruction was proved to be insufficient.	Obminski, 2021

Table A4-1: Thermal treatment technologies identified through literature search on Dimensions.							
Process	**Process details**	**Waste stream**	**Outcome**	**Maturity level**	**Advantages**	**Disadvantages**	**Source**
						• The process is awaiting further research on its recyclability.	
	Using silicon carbide balls as an inorganic heating element	Asbestos-containing waste	Detoxified asbestos	Laboratory	• Asbestos was completely removed from the crystal structure and microstructure when the microwave thermal treatment was performed at 1200 °C for over 60 min and at 1300 °C for over 30 min. • Asbestos is expected to be economically detoxified and recycled through the use of this method, which enables fast heating to the target temperature and reduction of energy consumption.		Hong et al., 2020
	Using silicon carbide balls as an inorganic heating element	Asbestos-containing waste	Detoxified asbestos, recovery of valuable metals	Laboratory	• Complete asbestos detoxification was confirmed when the microwave thermal treatment was performed at 1200°C for over 60 min and at 1300°C for over 10 min.		Hong et al., 2021
Hydrothermal synthesis	Synthesising a mixture of KRY·AS and a fine glass powder	Asbestos cement	Tobermorite-rich material	Laboratory	• The environmental benefits of replacing natural raw materials (NRM) with waste-derived materials outweigh the overall impact of the collection, sorting, transport, and recycling of waste, and the cost of these operations can be recovered by the sale of the synthesised materials.	• The chemical composition of the waste which may vary depending on the source. • The occurrence of natural raw materials with similar properties available at lower costs.	Malferrari et al., 2022

Table A4-2: Other treatment technologies identified through literature search on Dimensions							
Process	**Technology**	**Waste stream**	**Outcome**	**Maturity level**	**Advantages**	**Disadvantages**	**Source**
Chemical	Treatment with acids, fluoride or sodium hydroxide	Asbestos cement roof tile, asbestos rope, asbestos waste	Decomposition / dissolution of asbestos, pure silica powder, layered double hydroxide	Laboratory	• Process takes place at room temperature. • The best results were provided by oxalic acid, hydrochloric acid and the acid mixture. • Decomposition can be accomplished both with the use of pure chemicals and waste		Necasova & Buchta, 2019; Necasova et al., 2021; Talbi et al., 2019; Li, 2019

Table A4-2: Other treatment technologies identified through literature search on Dimensions							
Process	**Technology**	**Waste stream**	**Outcome**	**Maturity level**	**Advantages**	**Disadvantages**	**Source**
					chemicals from production technologies. • Nitric acid treatment was able to destroy the structure of the serpentine-type asbestos (chrysotile), pure silica powder with fibres and aggregates is obtained, which was used as silicon precursor to synthesize a zeolite. • The fibres of amphibole are completely dissolved by an alkaline treatment. The alkaline resulting solution is also usable for synthetizing a zeolite. • The layered double hydroxides have the similar physical and chemical properties as the one synthesized by traditional method.		
	Hydrothermal treatment in supercritical water	Asbestos-containing waste, chrysotile, crocidolite	Riebeckite and magnetite (crocidolite), forsterite and enstatite (chrysotile), and calcite, spurrite and gehlenite (asbestos-containing waste)	Laboratory	• The lower energy consumption than thermal processes, which are realized for T ≥ 1200°C, especially torch plasma vitrification. • No additive chemical solution is used for conversion chrysotile, crocidolite and ACW in non-hazardous waste. • The ability to convert simultaneous asbestos and organics waste by using supercritical water oxidation.	• Elongated structures persist after treatment.	Nzogo Metoule et al., 2019
Mechanical	Milling	Asbestos cement, raw tremolite and anthophyllite	Powder without fibrous asbestos construction	Laboratory	• High-energy milling is a highly efficient technology which converts asbestos containing waste into a fine powder with a great specific surface. • It leads to disappearance of the fibrous asbestos construction.		Iwaszko et al., 2018a; Bloise et al., 2018

Table A4-2: Other treatment technologies identified through literature search on Dimensions							
Process	**Technology**	**Waste stream**	**Outcome**	**Maturity level**	**Advantages**	**Disadvantages**	**Source**
					• High-energy milling may be an alternative to other asbestos cement waste disposal techniques such as thermal or microwave treatment.		
Biological	Biodeterioration of asbestos by bacteria and fungi	Asbestos cement, asbestos-containing waste, raw asbestos, asbestos contaminated soil	Biodegradation / weathering of asbestos	Laboratory	• The eco-friendly management of asbestos waste. • Resembles composting systems, which could be implemented by the asbestos materials storage companies, and an applicable method to in situ decontamination of areas with asbestos. • Efficient method.	• Long process	David et al., 2020a; David et al., 2020b; David et al., 2021; Bhattacharya et al., 2021; Borges et al., 2022a
	Dark fermentation and anaerobic digestion	Asbestos-containing waste	The whole process could lead to the production of both biohydrogen and biomethane.	Laboratory	• Productions of H2 and CH4. • Adoption of mild operative temperature (35 ÷ 55 ◦C) and pressure (~1 atm) conditions. • No requirement for non-renewable reagents, such as inorganic acids. • Very promising process in a context of circular economy if waste biodegradable substrates, less valuable than glucose, are used.		Trancone et al., 2022
Thermochemical	Thermal treatment in the presence of special clays	Corrugated asbestos roof	Complete mineralogical conversion of ACM waste into non-asbestos materials	Laboratory	• An innovative geo-polymerisation route to achieve the declassification of ACM as a hazardous waste and provide secondary raw recovered materials.		Ruiz et al., 2018
	Microwave thermal treatment using chemical additives	Asbestos cement sheets	Detoxification of asbestos: chrysotile, calcite, calcium silicate, and tricalcium silicate converted to Ca, Mg, and Si oxides	Laboratory	• The optimal temperatures associated with ACW mixed with additives in the microwave treatment involving SiC plates enables detoxification at lower temperatures.		Hong et al., 2022

Table A4-2: Other treatment technologies identified through literature search on Dimensions							
Process	**Technology**	**Waste stream**	**Outcome**	**Maturity level**	**Advantages**	**Disadvantages**	**Source**
					• This approach reduces energy consumption and can promote complete asbestos removal from ACW and cheaper recycling.		
Mechanochemical	Binding of hazardous asbestos fibres in a polymer matrix formed from waste cooking oil	Asbestos roof tiles (corrugates and flat), used cooking oil	Oil blocks can be used in the road and construction industry	Laboratory	• The resulting asbestos-oil blocks are safe for the environment because the waste asbestos fibres are permanently bound in the oil matrix. • The proposed method enables new material to be obtained by managing two types of waste. • Due to their high mechanical strength these blocks can be used in the road and construction industry.		Staroń et al., 2020
	Mechanochemical process using citric acid as a reactant	Asbestos cement tiles	Magnesium/calcium Citrate as agricultural input	Laboratory	• The final material can be used as an acid soil pH corrector. • The treated materials have a positive effect on microbial soil activity. • The negative impact observed for arylsulfatase, related to the sulphur cycle in the soil, does not differ from an equivalent treatment with commercial limestone. • The process is easily adjustable for alternative sources rich in citric acid, such as fungal biomass. • The citric acid used as a reagent in the process can be easily obtained from the cultivation of microorganisms, such as Aspergillus niger C, even in solid state cultivation.		Borges et al., 2022

Table A4-2: Other treatment technologies identified through literature search on Dimensions							
Process	**Technology**	**Waste stream**	**Outcome**	**Maturity level**	**Advantages**	**Disadvantages**	**Source**
Biothermal	Dark fermentation (DF) process followed by a hydrothermal phase (and anaerobic digestion)	Asbestos cement waste	Methane, hydrogen, crystallization of struvite - an eco-friendly phosphorous-based fertilizer, complete asbestos denaturation	Laboratory	• The proper management of the anaerobic digestion sludge may lead to the production of phosphorous-based fertilizers. • These, together with the reagent saving and the productions of H2 and CH4, could make the present ACW treatment extremely competitive.	• The best acid type and load for hydrothermal phase can only be derived at a pilot scale reactor	Spasiano, 2018; Spasiano et al., 2018

Annex 5 EU funded projects

Table A5-1: EU Cordis and EU Life projects.					
Source	**Acronym**	**Project title**	**Start date**	**End date**	**Status**
EU Cordis	MAGRAM	MAGNESIUM METAL RECOVERY FROM ASBESTOS AND RELATED WASTE MATERIALS[218]	1992-11-01	1995-10-31	No information found.
EU Cordis		Use of methods and programmes developed in nuclear field for treatment and disposal of toxic and hazardous waste[219]	1992-01-01	1993-09-30	No information found.
EU Cordis	KRAKER	The Asbestos Cruncher - 'ABC/ABK'- breakthrough in asbestos disposal[220]	1999-02-01	2001-01-31	No information found.
EU Cordis	IRCOW	Final Report Summary - IRCOW (Innovative Strategies for High-Grade Material Recovery from Construction and Demolition Waste)[221]	2011-01-17	2014-01-16	The microwave thermal treatment by Aton was selected as the most promising technology to transform fibrous structures into inert compounds.
EU Cordis	OPTS	Final Report Summary - OPTS (OPtimization of a Thermal energy Storage system with integrated Steam Generator)[222]	2011-12-01	2014-11-30	The project was not finalised. Despite the premature project termination, it was possible to provide some useful data for possible future exploitation of the proposed TES technology.
EU Cordis	AMIANTE	THE DEVELOPMENT OF SELECTED HAZARDOUS WASTES UTILIZATION TECHNOLOGIES, BASED ON MICROWAVE THERMAL TREATMENT (MTT) METHOD[223]	2008-10-01	2010-09-30	The company Aton that coordinated the project is still active.[224]
EU Cordis	REACMIN	RECYCLING ASBESTOS CONTAINING MATERIALS INTO NEW ECO-FRIENDLY SECONDARY RAW MATERIALS FOR FURTHER INDUSTRIAL PROCESSES[225]	2015-08-01	2015-10-31	Company Tiessepi SRL that developed the technology has been discontinued.

218 https://cordis.europa.eu/project/id/BRE20212
219 https://cordis.europa.eu/project/id/FI2W0110
220 https://cordis.europa.eu/project/id/BRST985472
221 https://cordis.europa.eu/project/id/265212/reporting
222 https://cordis.europa.eu/project/id/283138/reporting
223 https://cordis.europa.eu/project/id/222142
224 https://aton.com.pl/en/home/
225 https://cordis.europa.eu/project/id/697256

Table A5-1: EU Cordis and EU Life projects.					
Source	**Acronym**	**Project title**	**Start date**	**End date**	**Status**
EU Life	AFCE-DEP	Asbestos Fibre Cement - Denaturing Plant[226]	2003-12-01	2006-12-01	No information found.
EU Life	ADIOS	Asbestos denaturing with innovative oven systems[227]	2010-09-01	2013-02-28	Currently, all attention is focused on the design and preparations for the realisation of the installation.[228]
EU Life	LIFE FIBERS	Fibres innovative burning and reuse by SHS[229]	2013-07-01	2016-07-01	It is not clear if the prototype developed during the project is currently being applied to treat asbestos waste. The project website is still active.[230]

226 https://webgate.ec.europa.eu/life/publicWebsite/project/details/2362
227 https://webgate.ec.europa.eu/life/publicWebsite/project/details/3100
228 https://www.dnature.nl/
229 https://webgate.ec.europa.eu/life/publicWebsite/project/details/3705
230 https://fibers-life.eu/en-home.html

Annex 6 Patents

Table A6-1: Patents on asbestos waste treatment. ***Source: Espacenet & Lens.***				
Process	**Title**	**Publication date**	**URL**	**Source**
Biochemical	Process for biochemical denaturation of an asbestos-containing material	2019-08-27	Link	Lens
Chemical	INERTIZATION METHOD FOR MATERIALS CONTAINING ASBESTOS	2020-05-07	Link	Espacenet
Chemical	PROCESS FOR THE DESTRUCTION OF CEMENT, ASBESTOS-CONTAINING MATERIAL AND/OR OTHER MATRIX MATERIAL BY SIMULTANEOUSLY SUBJECTING THE MATERIAL TO CAVITATION AND ACID-BASED CHEMICAL REACTION	2019-01-24 2020-09-22	Link	Espacenet
Chemical	PROCESS FOR THE DISPOSAL OF ACID WASTES COMBINING THEM WITH ASBESTOS CONTAINING MATERIALS AND/OR CONCRETE USING SYNERGISTIC PHYSICAL, BIOLOGICAL AND CHEMICAL TREATMENTS	2018-03-29 2019-08-20	Link	Espacenet
Chemical	Detoxification of asbestos by mechano-chemical treating method	2021-02-15 2021-06-10	Link	Espacenet
Chemical	Asbestos treatment method using an asbestos pre-treatment agent for pre-treating an object containing asbestos and an asbestos detoxifying agent for detoxifying the pre-treated object	2023-01-18	Link	Espacenet
Chemical	METHOD FOR UTILIZING ASBESTOS	2021-02-18	Link	Espacenet
Chemical	METHOD FOR DETOXIFYING ASBESTOS, AND TREATMENT AGENT USED IN THE METHOD	2019-12-12 2020-07-28	Link	Espacenet
Chemical	DETOXIFYING AGENT FOR ASBESTOS-CONTAINING SLATE WASTE AND DETOXIFYING METHOD FOR ASBESTOS-CONTAINING SLATE WASTE	2020-08-31 2021-02-24	Link	Espacenet
Chemical	APPARATUS OF MINERALCARBONATION USING WASTE ASBESTOS SLATE	2021-05-10 2021-06-03	Link	Espacenet
Chemical	METHOD OF MINERALCARBONATION USING WASTE ASBESTOS SLATE	2021-05-10 2021-06-03	Link	Espacenet
Chemical	Asbestos waste destruction and valorisation method	2023-02-14	Link	Lens
Chemical	Method and stationary or movable device for neutralizing and recycling asbestos waste	2022-05-17	Link	Lens
Chemical	Method and system for neutralizing asbestos	2022-12-27	Link	Lens
Chemical	Method and system for neutralizing asbestos	2019-05-14	Link	Lens
Chemical	Process for the destruction of matrix material by cavitation and acid-based chemical reaction	2020-09-22	Link	Lens
Chemical	METHOD AND DEVICE FOR NEUTRALIZING AND RECYCLING ASBESTOS WASTE	2022-11-09	Link	Lens

Table A6-1: Patents on asbestos waste treatment. *Source: Espacenet & Lens.*				
Process	**Title**	**Publication date**	**URL**	**Source**
Mechanical	Method for stabilization of unbonded granular and/or fibrous asbestos and/or asbestos-containing materials, in particular construction waste	2020-07-01 2020-12-02	Link	Espacenet
Mechanochemical	Detoxification treatment method of asbestos construction materials	2020-05-26 2020-11-03	Link	Espacenet
Mechanochemical	ASBESTOS-CONTAINING SEWAGE DISPOSAL APPARATUS	2019-01-31 2021-04-21	Link	Espacenet
Thermal	DIGITIZED INERTING PROCESS IN A PROTECTIVE ATMOSPHERE IN A CONTINUOUS LINE INDUSTRIAL PLANT FOR THE INERTIZATION OF SILICATES AND ASBESTOS MATERIALS, FOR RECYCLING IN THE POWDER METALLURGY INDUSTRY, IN THE AEROSPACE, ARMS AND DEFENSE INDUSTRY FOR TECHNOLOGIES AND MILITARY EQUIPMENT, FROM INDUSTRIAL ELECTRONICS TO THE GOLDSMITH INDUSTRY AS WELL AS FOR THE PRODUCTION OF REFRACTORY MATERIAL	2022-06-15	Link	Espacenet
Thermal	Innocent treatment system for asbestos-containing waste	2021-12-17	Link	Espacenet
Thermal	Harmless treatment method of asbestos waste, asbestos-free material and application of asbestos-free material	2021-12-28	Link	Espacenet
Thermal	PROCESS FOR RECYCLING ASBESTOS-CONTAINING STEEL SCRAP	2019-10-31	Link	Espacenet
Thermal	Manufacturing method of waste asbestos slate cement and waste asbestos slate cement manufactured thereby	2022-06-08 2022-07-21	Link	Espacenet
Thermal	Harmless method of asbestos products using cement kiln and construction material manufacturing method using harmless asbestos products	2020-07-23	Link	Espacenet
Thermal	Continuous asbestos slat detoxification method using kiln and cement admixture manufactured using the method	2020-07-08	Link	Espacenet
Thermal	Waste asbestos processing	2022-01-12	Link	Espacenet
Thermal	ASBESTOS DISPOSAL METHOD AND DISPOSAL DEVICE	2019-07-11	Link	Espacenet
Thermal	Waste asbestos resource utilization process cooperating with steelmaking production	2021-01-05 2022-06-21	Link	Espacenet
Thermal	APPARATUS AND METHOD FOR DENATURING ASBESTOS	2020-12-10	Link	Espacenet
Thermal	Asbestos processing	2019-09-03	Link	Lens
Thermal	A method for converting an asbestos-containing waste product into a safe asbestos-free product	2018-11-07	Link	Lens

Table A6-1: Patents on asbestos waste treatment. *Source: Espacenet & Lens.*				
Process	**Title**	**Publication date**	**URL**	**Source**
Thermal	Method for heating an asbestos-containing waste product and apparatus for removing the resulting safe product	2018-01-31	Link	Lens
Thermal	Disposal system and disposal apparatus	2018-01-30	Link	Lens
Thermal	DISPOSAL SYSTEM	2018-02-28	Link	Lens
Thermal (microwave)	METHOD FOR DECOMPOSING ASBESTOS-CONTAINING MATERIALS USING ILMENITE OR CARBON-BASED MATERIALS	2019-08-05 2019-11-20	Link	Espacenet
Thermal (microwave)	A DEVICE FOR ASBESTOS DETOXIFICATION AND METHOD OF ASBESTOS DETOXIFICATION USING THEREOF	2020-04-08	Link	Espacenet
Thermal (microwave)	A METHOD FOR DISPOSING OF ASBESTOS-CONTAINING WASTE AND A SYSTEM FOR DISPOSING OF ASBESTOS-CONTAINING WASTE	2020-09-30	Link	Lens
Thermal or chemical	Manufacturing Method of Extruded Concrete Using Recycled Harmless Asbestos Fibre	2020-12-07	Link	Espacenet
Thermo-chemical	METHOD FOR DETOXIFYING ASBESTOS-CONTAINING WASTE MATERIAL	2021-05-06	Link	Espacenet
Thermo-chemical	Detoxification method of asbestos by mineral transition	2021-05-11	Link	Espacenet
Thermo-chemical	Method of removing asbestos from asbestos-containing materials by 99% through low temperature heat treatment	2018-07-04	Link	Lens
Thermo-chemical	Method of Asbestos Detoxification	2020-09-23	Link	Lens

Annex 7 Asbestos waste treatment technologies – key parameters

A7.1 General parameters

Table A7-1: General parameters

	Inertam	D-Nature	Thermal Recycling	Purified Metal Company	ARI	VALAME	BlackAsbestos / De Dietrich / Neutraval	Somez	Colas	Asbeter	ABCOV®	MID-MIX®
Source of information	OVAM (2016)	Interview, supporting material and company's website	Interview and company's website	No data	Interview and company's website	Interview	Interview and laboratory report	General Council for the Environment (2021)	General Council for the Environment (2021)	Interview, workshop and company's website	Interview, supporting material and company's website	Zoraja et al., 2021
Key elements of the process	Melting with plasma torch (1,400-1,600°C) for destruction of the fibre structure	Unopened bags of ACW are put into a tunnel oven and subjected to a maximum temperature of 1,000 °C in order to destroy all type of asbestos. The material is not broken before the treatment.	ACW is delivered in specially designed bags which are put in the kiln at 1,250-1,300°C.		ACW is shredded to smaller particles, fluxing agents are added to the waste which is then heated in a rotary furnace to asbestos melting point (1,200°C). By-product is cooled off, analysed and recycled	Asbestos-containing waste is sorted, milled to 2-3 mm particles and submitted to a 2-phase acid attack with HCl at low temperature (<100°C) and ambient pressure	The ACW is sorted, milled to sub 1 mm, and submitted to a water diluted chemical attack with H_2SO_4 acid. After a filtration step, solid and liquid by-products are produced. Temperature is initially set to sub-100°C and then the reaction is self-sustaining (exothermic)	Two-stage process that treats chrysotile at the first stage and amphiboles at the second phase with the help of acids.	Asbestos cement waste is attacked by an acid cocktail under vapour pressure.	The process is a combination of mechanical impact, temperature, chemical conversion in an alkaline environment. pH of approximately 12.5 is achieved without adding any chemicals	Asbestos-containing waste is shredded with water spray nozzles and then subjected to acid attack at low temperatures (65°C). Solids are settled and ABCOV® chemicals are recycled and regenerated for further treatments. A proprietary solid is added to the solids to neutralise acidity	Asbestos waste is crushed, shredded and milled with the addition of water. The waste mixture is introduced into the mixer, which homogenises the waste mixture with process additives, after which it enters the MID-MIX® reactor.
Type of process	Thermal	Thermal	Thermal	Thermal	Thermochemical	Chemical	Chemical	Chemical	Chemical	Mechanochemical	Mechanochemical	Mechanochemical
Process time		> 3 days			20 min	30-60min	6 hours	10-20 hours	24 hours	480-600 min	±120 min	
Process temperature	1,400-1,600°C	1,000°C	1,250-1,300°C		1,200°C	<100°C	Sub 100°C	80°C (first stage), higher for the second stage if required	100-200°C	25-90°C	65°C	
Type of asbestos	All	All	Chrysotile		All	Chrysotile	All	All	Chrysotile	Chrysotile, crocidolite, amosite	All	

Table A7-1: General parameters												
	Inertam	**D-Nature**	**Thermal Recycling**	**Purified Metal Company**	**ARI**	**VALAME**	**BlackAsbestos / De Dietrich / Neutraval**	**Somez**	**Colas**	**Asbeter**	**ABCOV®**	**MID-MIX®**
Type of ACW		Only asbestos cement (at this time)	Cement bound chrysotile		All	Asbestos cement – plaster – asbestos primer – slates – floor tiles/ mineral or not / flexible or rigid – Thermal insulation – Glass wool – asbestos flocking	All types of asbestos waste except asbestos waste mixed with metals or tar.	Free or bound in an inorganic matrix	Favours treatment of asbestos-cement	Serpentine and amphibole asbestos unbonded and cement bonded asbestos	All	
Friable / non-friable	Both	Both	Non-friable		Both	Both				Both	All	
Packaging			Yes		Yes (Potentially Hazibag)	Big Bag – container bag				Airtight	All	
Pre-treatment		No pre-treatment	No pre-treatment		Shredded to a uniform size, addition of a fluxing agent (sodium borate)	Milling to <2-3 mm granulometry	Milling to sub 1 mm granulometry	Sorting in order to separate the flocking-type waste from that of the fibrocement type	No pre-treatment	Safe intermediate packaging and storage, dry pre-treatment to 12 mm particles, next steps in wet process	Wetting, there can be a sorting step depending on the waste	Shredding waste for easy insertion into a grinding mill
Use of additives or other chemicals (and their function)		No	No use of additives or other chemicals		Sodium borate as fluxing agent, shredded plastic to improve the thermal reaction	Anti-foaming agents, if necessary (to prevent foam formation), lime (to correct the acidity)	H_2SO_4 for the acid attack to destroy the fibers	Acid (unclear what)	Acid cocktail (unclear what acids)	No chemicals needed for high pH. Dispersants for higher dry solid content in the end product slurry. Option for carbonization (by using carbon dioxide) of the end product.	Surfactant for wetting ACW, chemicals to regenerate the acids	Additives: sand, calcium hydroxide and calcium oxide
Rate of fibre destruction	100%	100%	No asbestos can be detected after successful completion of the process. NOTE that in the UK it is not possible to say that no asbestos is present because of limits of detection		100%	100%		100%		100% - verified by Det Norske Veritas. End of waste declaration by Environmental Protection Agency DCMR	100%	

Table A7-1: General parameters												
	Inertam	**D-Nature**	**Thermal Recycling**	**Purified Metal Company**	**ARI**	**VALAME**	**BlackAsbestos / De Dietrich / Neutraval**	**Somez**	**Colas**	**Asbeter**	**ABCOV®**	**MID-MIX®**
			related to analytical equipment and also to use of any sampling process.									
Mass/volume reduction	Mass - 40% Volume - 60%	25%			50-90% - depends on the type of ACW	Mass reduction: various – Depending on asbestos waste type (from some precents (primer) to almost 50% (Mineral floor tiles)				0%	Up to 80%	
End-product(s) / by-product(s)	Cofalit	Bestof® (Cement-like material)	CALMAG (mixture of calcium, aluminium and magnesium, silicate, sulphates, oxides, and other)		Volcanic-type aggregate (olivine, wollastonite, diopsides), depending on ACW chemistry.	Calcium chloride, Magnesium chloride, Amorphous silica, Hydroxides (Iron & Aluminium)	Silicates, anhydrites, gypsum, magnesium sulphate	Silica, metal oxides and tobermorite (hydrated calcium silicate)	Amorphous silica, hydroxyapatites (heavy metal sponges that can replace activated carbon), metals (magnesium, etc.)	Zero carbon Calcium Silicate Hydrate (CSH) slurry Negative carbon Calcium Silicate Carbonate slurry	Dependent on the ACW, e.g., cement like materials, steel, copper	NEUTRAL - a mixture of organocalcium water-soluble salts
Use of end-product(s)/by-product(s)	Road foundations and as a substitute of quartz and basalt in building materials	Filler, co-formulation with cement, aggregate for road construction granulate	Cement replacement or in the production of concrete		Filler, additive	Additive and filling for road construction, concrete formulation, de-icing agent; chemical industry for chlorides + gas desulphurisation and industrial water treatment	Anhydrites and gypsum – components of cement, silicates are used to manufacture zeolites used for depollution, magnesium sulphate to extract magnesium as metal			Raw materials like fillers for cement and hybrid cement, precursor in geopolymer concrete, paints additive for better dividing pigments and avoiding biocides.	Additive and filling for asphalt or concrete, metals	In concrete blocks, additive for solid fuels, additive for industrial fuel, asphalt production
Markets for of end-product(s) / by-product(s)	Construction industry	Construction industry	Construction sector		Construction sector (roads and buildings)	Construction sector (buildings and roads); chemical industry	Construction, cement and chemical industry, agriculture, electronics,			Cement and concrete industry, paint industry	Construction sector (buildings and roads), metallurgic sector	Construction sector, process industry, cement industry

Table A7-1: General parameters												
	Inertam	**D-Nature**	**Thermal Recycling**	**Purified Metal Company**	**ARI**	**VALAME**	**BlackAsbestos / De Dietrich / Neutraval**	**Somez**	**Colas**	**Asbeter**	**ABCOV®**	**MID-MIX®**
							automotive, metallurgy					
Residues		None			N/A	None	None if no-blended materials are treated, otherwise low value, non-polluted residues are disposed of in landfills			Zero	None	
Control (e.g., sampling, testing)		Specific check is performed before the transportation to the site and at the site, to avoid the presence of hazardous material or contaminants that could hinder the process. The check is performed both visually and by sampling the ACW. After control, the big bags will go into the storage. After this, it is determined which big bags can go into the oven and when. Control of temperature, process time, gas emission and asbestos	By-product sampling and testing at the end of the process to check complete destroy of fibres		By-product sampling at the end of the process to check complete destruction of fibres (TEM), emission control system, off-gases are routed through a secondary thermal oxidising unit for the destruction of residual organic compounds that may be present in the gas	Asbestos: COFRAC accreditation in progress	Sorting of materials at the beginning of the process prior to grinding, the process is highly automated with continuous monitoring built-in, sampling and testing is done at multiple stages. Asbestos destruction is confirmed post process by laboratory analysis in line with regulatory requirements			Sampling and analysing asbestos destruction at relevant process steps by Scanning Electron Microscope (SEM) Release end-product only with zero fibres, based on SEM results.	Polarized Light Microscopy (PLM)/ Transmission Electron Microscopy (TEM), and if necessary, Toxic Characteristic Leaching Procedure (TCLP) Samples are taken every 15 minutes from the reactor to validate the progress of asbestos destruction	

Table A7-1: General parameters												
	Inertam	**D-Nature**	**Thermal Recycling**	**Purified Metal Company**	**ARI**	**VALAME**	**BlackAsbestos / De Dietrich / Neutraval**	**Somez**	**Colas**	**Asbeter**	**ABCOV®**	**MID-MIX®**
		presence in the by-product										
Precautions and safety measures		Adequate PPE when moving ACW from the trucks to the tunnel oven trays	Comply with all Environmental Agency and Health and Safety Requirements for operating a full-scale plant. Have registered with REACH		Negative pressure while handling the ACW, emissions control system	Gas scrubbing tower to prevent release acid vapours. Hydrochloric acid is stored in a safe place. The process is carried out in high performance vacuum.	Negative pressure containment in all areas where ACW is manipulated by operators. This is done in accordance with the French strict requirements regarding ACW handling.			Industrial design is based on automated process from control room and minimal human presence in the asbestos-contaminated environment. Environment is kept clean by closed installation, negative pressure and dust extraction. Air emission to the outside goes through several lines of HEPA 14 filters. Filters are continuously monitored for proper operation. Alarms and automatic interlocking ensure that the areas are monitored and secured. Personal protection measurements (e.g. suits, breathing air) are available in case people have to be in polluted areas for maintenance.	Negative air pressure containment	The wetting prevents the asbestos particles from floating in the air
Occupational risk			All risks properly assessed and mitigated. Have produced COSHH and		N/A	Asbestos trained workers	The entire process is under environment control. After opening of the bags, the			Contact with asbestos fibres avoided by remote process control in central control room. Maintenance and	Chemical mishandling	

Table A7-1: General parameters												
	Inertam	**D-Nature**	**Thermal Recycling**	**Purified Metal Company**	**ARI**	**VALAME**	**BlackAsbestos / De Dietrich / Neutraval**	**Somez**	**Colas**	**Asbeter**	**ABCOV®**	**MID-MIX®**
			Safety Data Sheet.				content is going into the grinders that are in a closed and contained area. The manipulations are therefore minimal, and the process is designed to be automated. No in process manipulation.			inspection with PPE's		
RMMs/PPE			PPE is used for certain stages of the process.		Yes	Man-machine interface at each step of the process Remote monitoring & management – Conform to asbestos regulation	PPE is standard.			Yes, present	HEPA filter and carbon filter; chemical resistant aprons or laboratory coats; safety shower with eyewash; safety glasses; full face powered air respirator with organic vapor/ acid gas high-efficiency cartridge; tyvek chemical resistant full body and head protective clothing; chemical and slip-resistant steel-toed 16" high boots; neoprene/chemical resistant gloves	
Installation type	Fixed	Fixed	Fixed		Fixed or mobile	Fixed	Fixed/mobile			Fixed	Fixed/mobile	Fixed/mobile
Installation size			Demonstration plant is 700 m2 but the full-scale plant will need c.4,000 m2 to treat 29.5 thousand tonnes (50 tonnes a day)			30,000 m^2 - depending on land's requirement	10,000 m^2			3 ha - factory including logistic space. Industrial scale foreseen in Moerdijk, the Netherlands, from 2025 onwards.	189.271 litters to any size the end user requires	

Table A7-1: General parameters												
	Inertam	**D-Nature**	**Thermal Recycling**	**Purified Metal Company**	**ARI**	**VALAME**	**BlackAsbestos / De Dietrich / Neutraval**	**Somez**	**Colas**	**Asbeter**	**ABCOV®**	**MID-MIX®**
Current capacity	8,000 tonnes/year at 1 site in France		c.1,000 tonnes/year			1 tonne per day or approximately 200 tonnes per year – pilot plant that ran in 2022 for six months	60 tonnes/year at 1 site (industrial scale pilot with one reactor)			15-50 tonnes/year demonstration scale at 1 site	9 tonnes a day	
Potential future capacity		100,000-120,000 tonnes/year per site	29,500 tonnes/year		Is scalable	15,000 tonnes/year, at least 1 plant per country	15,000 tonnes/year (10 reactors in parallel), 20 sites in the EU for a total capacity of 300,000 tonnes/year, 45 sites worldwide	10 to 20,000 tonnes/year	Tens of thousands of tonnes/year	75,000 tonnes/year, 10-20 sites by licencing, total tonnes/year – 1 mil/year	40 Tonnes a day or more to meet the user's needs	
Amounts of ACW left for disposal after treatment and the associated cost (% waste entering treatment that needs to be disposed of after treatment (by weight; method and cost of disposal of this waste (€/tonne))			0%		None, 100% destruction	None or less than 1% (undesirable)	0%. If, however, any waste is produced (rubble), it is being disposed of at 20 €/tonne			Packaging waste will be asbestos contaminated, max 1-3% incoming materials. Used for their calorific value in cement or waste processing >1200 °C alternative is landfilling; estimated costs €100/ton.	None	

A7.2 Environmental parameters

Table A7-2: Environmental parameters												
	Inertam	**D-Nature**	**Thermal Recycling**	**Purified Metal Company**	**ARI**	**VALAME**	**BlackAsbestos / De Dietrich / Neutraval**	**Somez**	**Colas**	**Asbeter**	**ABCOV**	**MID-MIX®**
Transport intensity (average		125 km	The plan would be to have a network of sites		Specific on the individual opportunity	Regional is preferable but will depend on	200 km or less			We developed together with the asbestos	All ABCOV process equipment is	

Table A7-2: Environmental parameters												
	Inertam	**D-Nature**	**Thermal Recycling**	**Purified Metal Company**	**ARI**	**VALAME**	**BlackAsbestos / De Dietrich / Neutraval**	**Somez**	**Colas**	**Asbeter**	**ABCOV**	**MID-MIX®**
distance travelled to treatment site)			to reduce distance travelled – probably 4 in the UK – and more internationally			VALAME's treatment sites localisation				sector a concept for the Dutch authorities about intermediate storage in airtight packing from the demolition site to the storage facilities at landfill sites. Asbeter will pick up the packed materials there and transport them in closed ISO-containers to the treatment site. Expected distances for Asbeter in total 500,000 km/year.	built modular, mobile, and transportable	
Energy requirements (electricity consumption)	500 to 1,300 kWh/tonne, with an average of consumption of 1,000 and 1,300 kWh/tonne	2,640,000 KWh & 6,650,000 m^3 gas a year for 120,000 tonnes/year or ~500 kWh/tonne			Commercially sensitive	Less than 1,000 kWh/tonne	Very low energy intensity. Energy is used mostly to kick start the process which is exothermic.			10 MW installed power for asbestos destruction, carbonization and partly drying of end product, including internal heat recovery.	Because the ABCOV process is built modular and the end users required capacity, electrical costs will vary	
Emissions to air (GHG, other pollutants)		GHG – 101 kg CO2 eq/tonne Other pollutants - NOx, PM10 in traces or below the legal limits			Commercially sensitive	GHG - depending on asbestos waste treated. Between 0 and 130 kgCO2 eq/tonne. CO2 capture under study	Low GHG expected - this will be quantified with the pre-plant			GHG - 0, process is based on electricity from renewable energy	GHG – none; Other pollutants – reduced	

Table A7-2: Environmental parameters												
	Inertam	**D-Nature**	**Thermal Recycling**	**Purified Metal Company**	**ARI**	**VALAME**	**BlackAsbestos / De Dietrich / Neutraval**	**Somez**	**Colas**	**Asbeter**	**ABCOV**	**MID-MIX®**
Emissions to water					Commercially sensitive	Limited - Material & operators decontamination needs – Offices installations				0, because rinse water will be re-used as process water	None	
Emissions of asbestos fibres		0			None	Exterior: 0 Inside the plant: to be measured	None			Below natural background value of 28 fibres/m^3, based on design with different air pressure regimes and internal dust treatment within containment.	None. No asbestos fibres are found after treatment.	
Emissions of other hazardous substances					None	None	None			0	Emissions are scrubbed by negative air machines with HEPA filters backed by activated carbon filters.	
Waste generation		0			Commercially sensitive	Limited - Plant operators personal & collective protection equipment	None or asbestos free rubbles			750-2,250 tonne/year		
Water consumption		0			Commercially sensitive	Limited - Mainly to wash solid residues (to be determined)	limited thanks to water recycling step post process			1,000 liters/tonne to deliver CSH-slurry with 50% dry solids	Depending on the size of the ABCOV plant.	
Total carbon footprint (taking into account transport and energy intensity)		We have never calculated this. It also very much depends on what you are going to use the end material for. The saving of CO2 in the cement is			Commercially sensitive	Under study (life cycle analysis planned)	This will be ultimately determined with the pre-plant results.			Asbeter's AC Minerals calcium silicate slurry is carbon-neutral: *European Waste Framework Directive: energy used for*	Reduced product and carbon footprint.	

Table A7-2: Environmental parameters

	Inertam	D-Nature	Thermal Recycling	Purified Metal Company	ARI	VALAME	BlackAsbestos / De Dietrich / Neutraval	Somez	Colas	Asbeter	ABCOV	MID-MIX®
		higher than if we mix the dust with our own material.								*destructing of a so-called 'substance of very high concern', will not be counted for the remaining non-hazardous by-product.* Asbeter's yearly production of 124,000 tons CSH-slurry will result in avoiding of >56,000 tons CO_2. Transport not included, because we didn't decide yet how transport will take place.		

A7.3 Techno-economic parameters

Table A7-3: Techno-economic parameters

	Inertam	D-Nature	Thermal Recycling	Purified Metal Company	ARI	VALAME	BlackAsbestos / De Dietrich / Neutraval	Somez	Colas	Asbeter	ABCOV	MID-MIX®
Cost of treatment	1,000-2,500 €/tonne	175 €/tonne			Specific to the individual opportunity	900 €/tonne	Forecasted commercial price 1,000-1,500 €/tonne	600-800 €/tonne		400 €/tonne	€250 to €350 per tonne excluding recyclable end-product sales of sand and metals and the amount of ABCOV® chemicals	

Table A7-3: Techno-economic parameters												
	Inertam	**D-Nature**	**Thermal Recycling**	**Purified Metal Company**	**ARI**	**VALAME**	**BlackAsbestos / De Dietrich / Neutraval**	**Somez**	**Colas**	**Asbeter**	**ABCOV**	**MID-MIX®**
											that can be recycled back into the process.	
Included in the cost					Commercially sensitive	Everything		The valuation of the by products		Processing + utilities, transport, team, office, sales, depreciation (capex+opex)	All	
Excluded from the cost					Commercially sensitive	ACW transport	The revenue from the by-products. The company provides a certificate of destruction made by external independent laboratories. Several such certificates were already provided during their test trials.			Licensing to other countries	Sales of end products	
CAPEX		€38,000,000			Commercially sensitive	€20 to €25 million/plant of 15,000 tonnes	Over €9 million invested so far in research and pilot plant development. Industrial scale plant CAPEX not disclosed			€70 million - excluded process development costs	Because the ABCOV® process is built modular all costs will vary.	
OPEX		€6,600,000			Commercially sensitive	Various – Depending on	Not disclosed			€21 million: direct process	These costs are	

Table A7-3: Techno-economic parameters												
	Inertam	**D-Nature**	**Thermal Recycling**	**Purified Metal Company**	**ARI**	**VALAME**	**BlackAsbestos / De Dietrich / Neutraval**	**Somez**	**Colas**	**Asbeter**	**ABCOV**	**MID-MIX®**
						plant's location				costs - €15 million; organisational costs - €6 million	dependent on local laws that govern tax deductions, rent, utilities, and salaries	
Return on investment		Earn back the investments in about 4 or 5 years.			Commercially sensitive	7 years payback	Not disclosed			IRR flagship plant 12%; IRR incl. licenses 23%	Depends on the end user's purpose, and size of treatment capacity, i.e. on-site examples: military base, utility, commercial, and landfill, mobile use, i.e. example: abatement contractor	
Revenue streams					Commercially sensitive	Various – Depending on plant's location	Not disclosed			Asbestos cement treatment fee; Sales of the end-product CSH; Licencing technology to partners outside the Netherlands	All ACW treatment and end product sales i.e. sand, metals, and any other material after processing them asbestos fee.	
Depreciation and amortisation		€2,400,000			Commercially sensitive	10 years amortisation	Not disclosed			€3 million/year, factory depreciation in 25 years	Dictated by local tax laws	

Table A7-3: Techno-economic parameters												
	Inertam	**D-Nature**	**Thermal Recycling**	**Purified Metal Company**	**ARI**	**VALAME**	**BlackAsbestos / De Dietrich / Neutraval**	**Somez**	**Colas**	**Asbeter**	**ABCOV**	**MID-MIX®**
Market value of end-product	Cofalit sold for €10/tonne (transportation costs excluded)	Do not yet know exactly what the value of the Bestof is. Expects between €25 and €75			Commercially sensitive	Estimation in progress – Depending on product treated & plant environment needs	Magnesium: > 2,200$/tonne			Average 73.5 €/tonne. Slurry 50% dry solids, average price based on different values in concrete (>€50,-) or paint applications (€>150,-)	Depending on the materials treated dictate the end product ABCOV®'s end products are sand that can be used in a concrete or asphalt kiln and metals are cleaned to asbestos-free and can be sold at market value.	

Annex 8 Stakeholder consultation overview

The targeted stakeholder survey (TSS) was open from 1 March to 7 April 2023.

Analysis was undertaken using Microsoft Excel. Complete and partial responses of survey participants were considered valid and included in the analysis if they met the following criteria:

- Respondent answered at least one question, and
- Respondent provided their name or the name of the organisation.

Exported data also underwent a cleaning process prior to analysis to remove duplicate or malicious responses which could affect the validity of the survey results. Duplicate responses were identified by reviewing respondent names and IP addresses.

A8.1 Asbestos waste statistics

The survey received 108 responses in total, with 29 complete responses and 79 partial responses. A total of 36 were valid responses that were included in the analysis. The majority of respondents were operating in Belgium (5 respondents) and were from national authorities (Figure A8-1 and Figure A8-2).

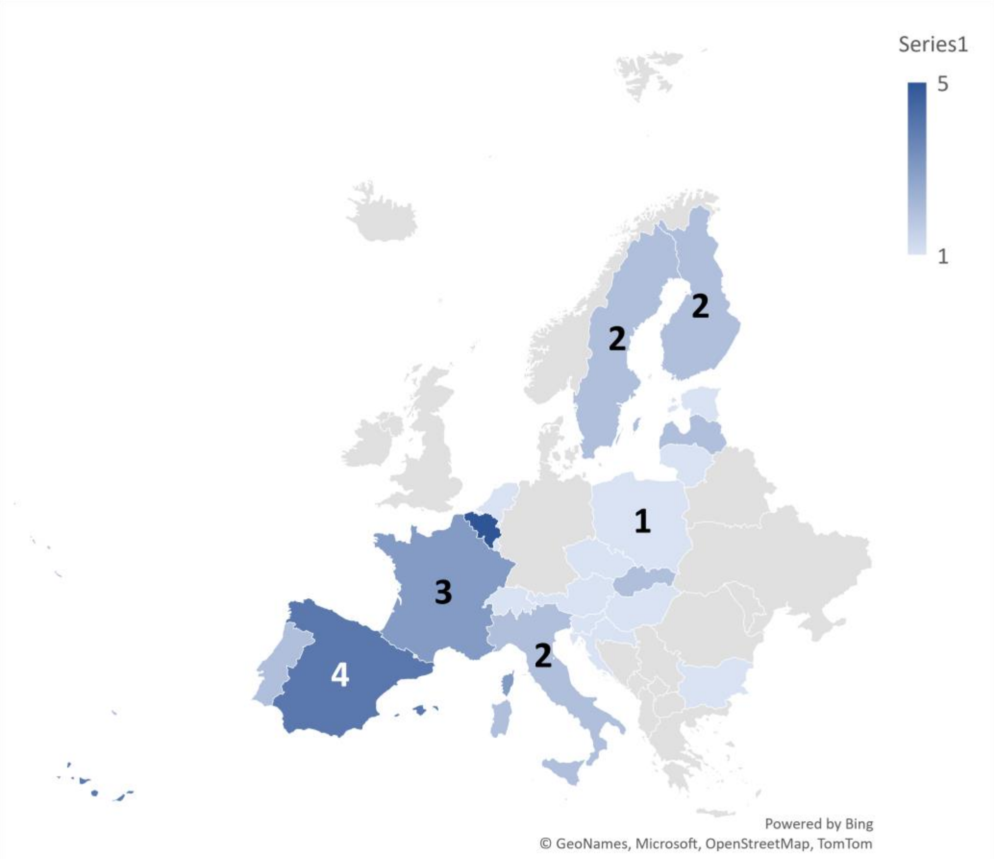


Figure A8-1: Responses by country of operation – Number of respondents: 36

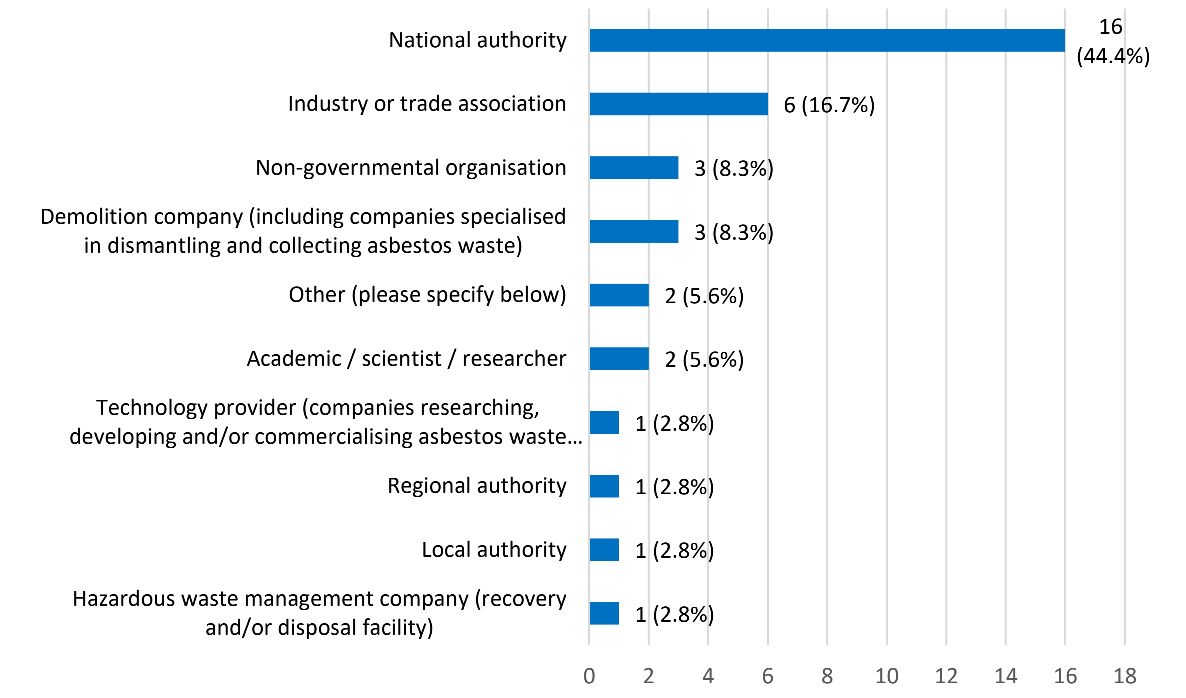


Figure A8-2: Responses by stakeholder type – Number of respondents: 36

Most of the respondents indicated their availability to be contacted for clarification and/or a follow-up interview (Figure A8-3).

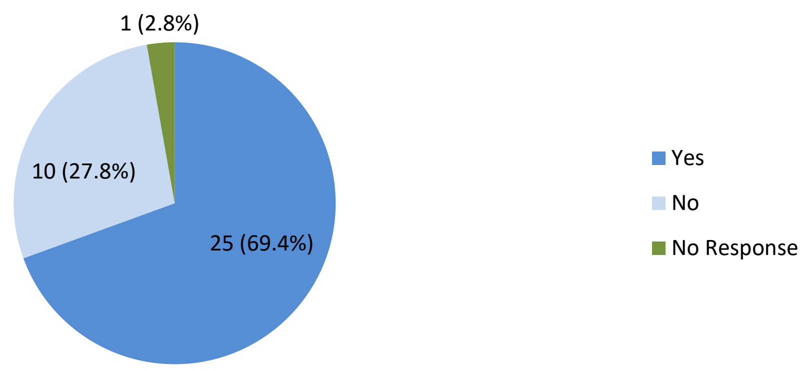


Figure A8-3: After completing this survey, are you willing to be contacted for any clarification and/or a follow-up interview to further discuss asbestos waste treatment technologies? - Number of respondents: 36

There was a total of five responses from industry-related stakeholder types, most of which were microenterprises or small enterprises (Figure A8-4). Industry-related stakeholder types included:

- Technology provider (companies that are currently trialling new technologies for asbestos waste inertisation and recycling, companies that have patented technologies, industry plants that are using these technologies, providers of equipment to analyse and detect asbestos),

- Hazardous waste management company (recovery and/or disposal facility), and
- Demolition company (including companies specialised in dismantling and collecting asbestos waste).

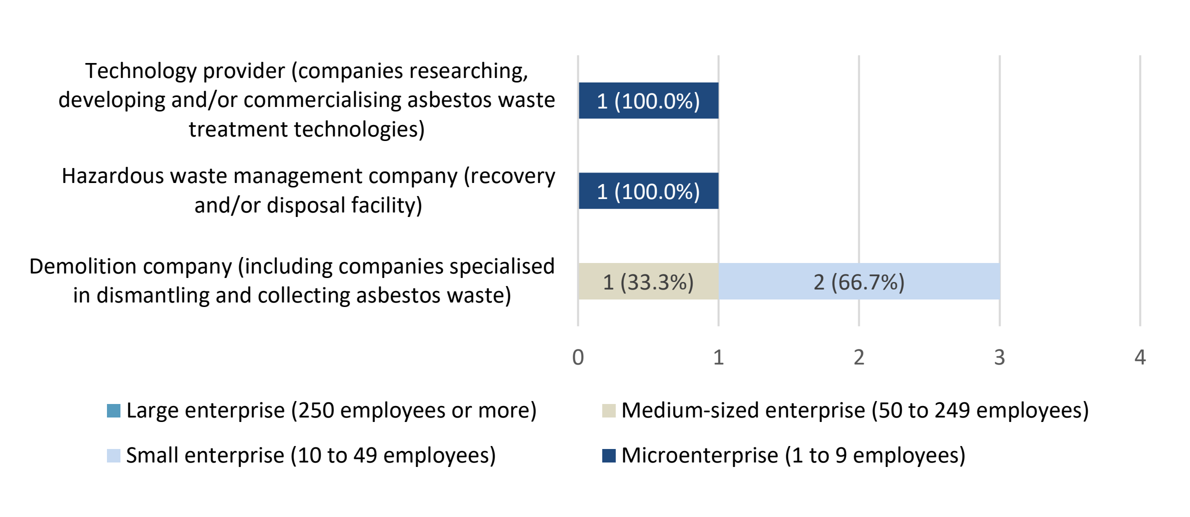


Figure A8-4: Organisation size of technology providers, hazardous waste management companies and demolition companies – Number of respondents: 5

In response to Q3, majority of respondents indicated that statistics on the quantity of asbestos-containing waste landfilled are available, followed by quantity of ACW collected. Most respondents indicated that statistics on projections of quantities of ACW generated/collected/treated/recycled/landfilled in the short, medium and/or long term are not available (Figure A8-5).

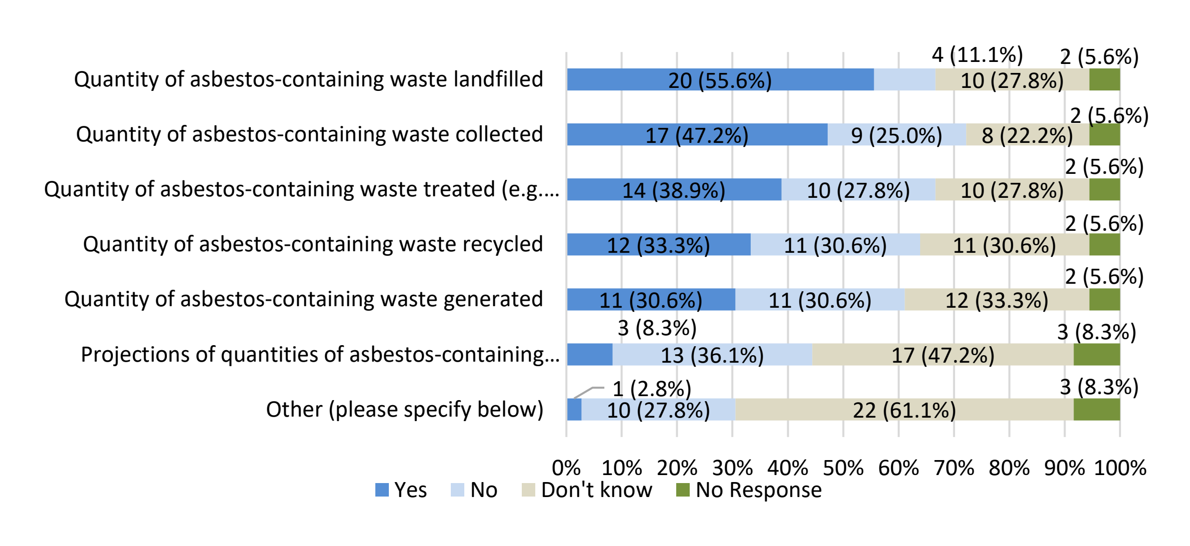


Figure A8-5: Q3: Are statistics on ACW available in your country/region? – Number of respondents: 36

Majority of respondents thought that in the short term (2023-2032), the quantity of ACW generated per year would increase, whereas most thought it would stay the same in the medium term (2033-2042) and decrease in the long term (2043-2052) (Figure A8-6).

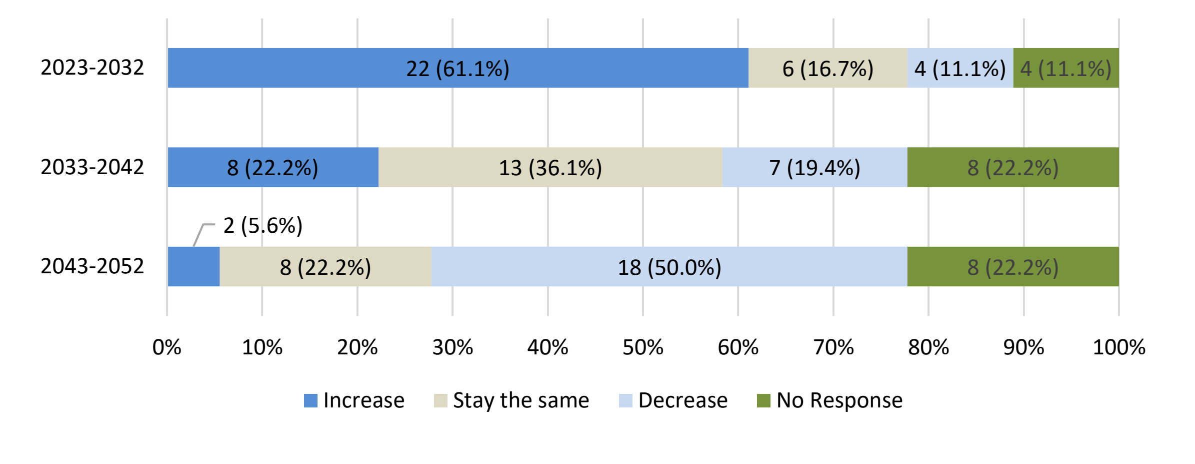


Figure A8-6: Q4: In your opinion, the quantity of ACW generated per year in your country is likely to increase, decrease or stay the same over the short, medium and long terms? – Number of respondents: 36

Most respondents were aware of the main pieces of legislation regulating asbestos waste, of guidance documents, standards or best practices on asbestos waste management and of ongoing or past initiatives supporting the removal of asbestos waste in their country/region (Figure A8-7).

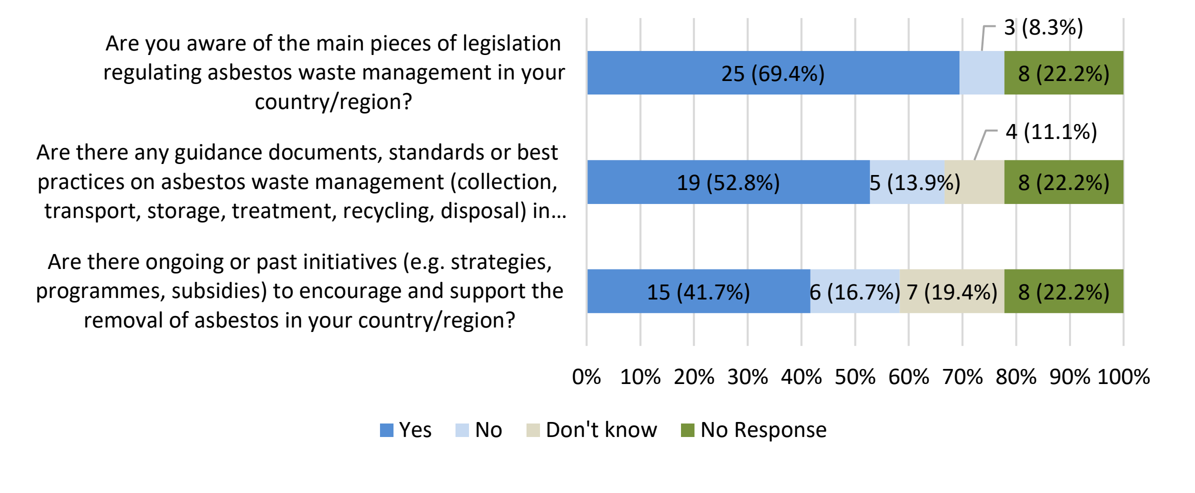


Figure A8-7: Q6, and 8. Q6: Are you aware of the main pieces of legislation regulating asbestos waste management in your country/region? Q7: Are there ongoing or past initiatives (e.g. strategies, programmes, subsidies) to encourage and support the removal of asbestos in your country/region? and Q8: Are there any guidance documents, standards or best practices on asbestos waste management (collection, transport, storage, treatment, recycling, disposal) in your country/region? – Number of respondents: 36

A8.2 Asbestos waste treatment technologies

The survey on asbestos waste treatment technologies received 196 responses in total; 42 complete responses and 154 partial responses. A total of 51 valid responses were analysed.

The majority of responses were operating in Belgium and were from national authorities (Figure A8-8 and Figure A8-9).

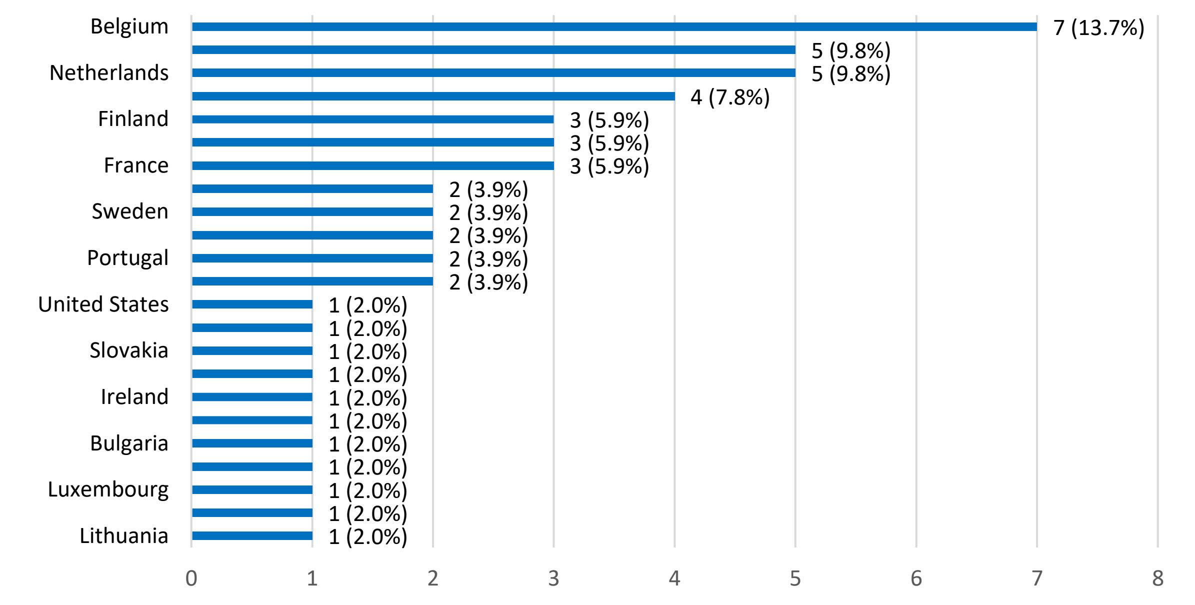


Figure A8-8: Responses by country of operation – Number of respondents: 51

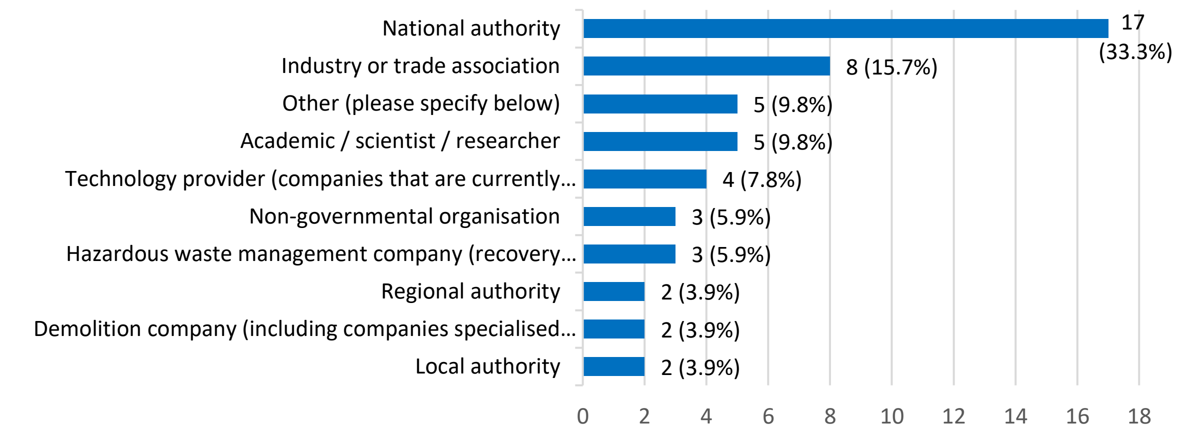


Figure A8-9: Responses by stakeholder type – Number of respondents: 51

There was a total of eight responses from industry-related stakeholder types and among these, the majority were microenterprises (Figure A8-10). Industry-related stakeholder types included:

- Technology provider (companies that are currently trialling new technologies for asbestos waste inertisation and recycling, companies that have patented technologies, industry plants that are using these technologies, providers of equipment to analyse and detect asbestos),
- Hazardous waste management company (recovery and/or disposal facility), and
- Demolition company (including companies specialised in dismantling and collecting asbestos waste).

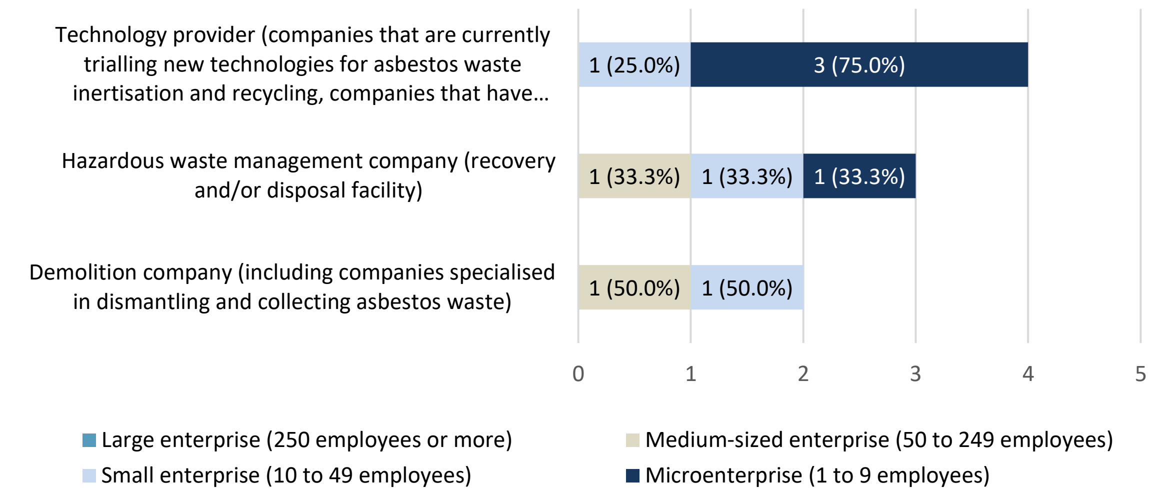


Figure A8-10: Organisation size of technology providers, hazardous waste management companies and demolition companies – Number of respondents: 9

Most of the respondents indicated their availability to be contacted for clarification and/or a follow-up interview (Figure A8-11).

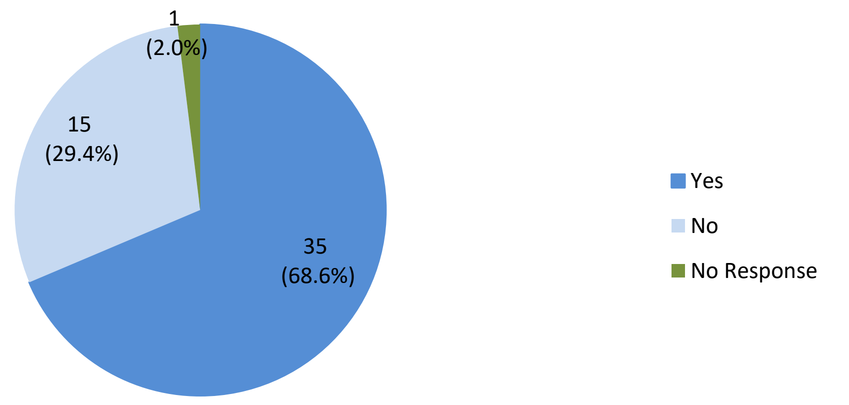


Figure A8-11: After completing this survey, are you willing to be contacted for any clarification and/or a follow-up interview to further discuss asbestos waste treatment technologies? - Number of respondents: 51

In response to Q10, the majority of respondents indicated that information on the location of ACW recovery and/or disposal facilities is available, followed by information on the number of facilities. Most respondents indicated that information on the average cost of recovery for ACW is not available (Figure A8-12).

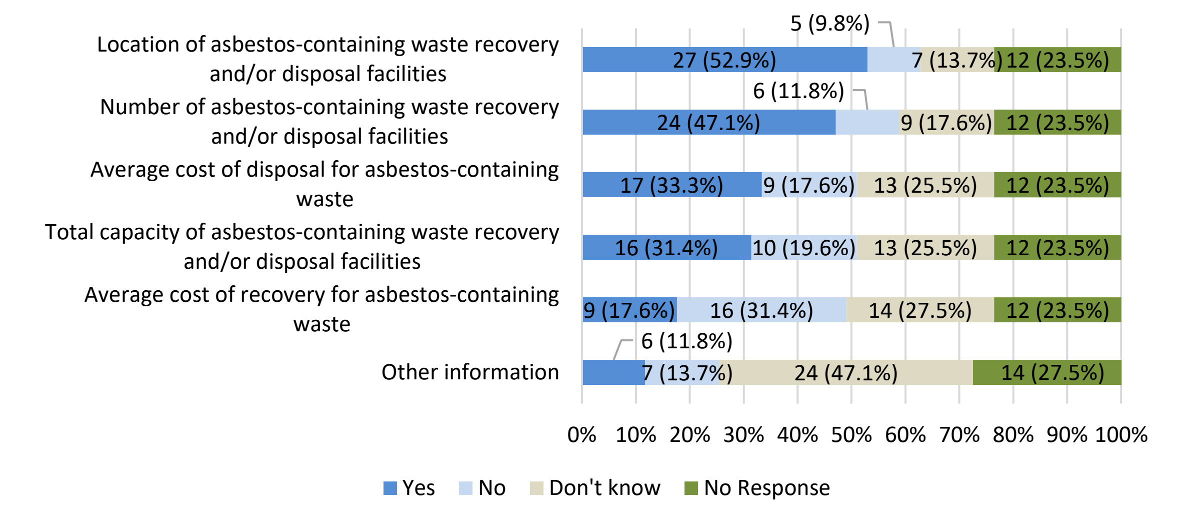


Figure A8-12: Q10: Is information on asbestos waste treatment facilities available in your country/region? – Number of respondents: 51

In response to Q17, the majority of respondents indicated that it would not be feasible to introduce restrictions to the landfill of asbestos waste (Figure A8-13).

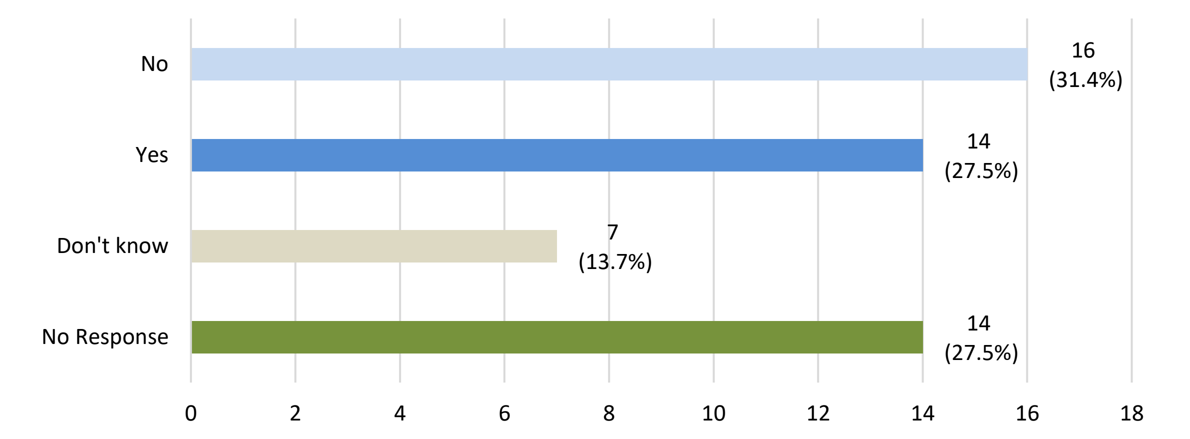


Figure A8-13: Q17: Would it be feasible to introduce restrictions to the landfill of asbestos waste? – Number of respondents: 51

Q3-Q9 were for industry-related stakeholder types and available only to respondents that selected either demolition company, hazardous waste management company or technology provider under stakeholder type. Of the nine respondents from an industry-related stakeholder type, two respondents answered the additional questions. Only the questions that had responses are included in Table A8-1.

Table A8-1: Responses to Q3-Q9 – Number of respondents: 2

Question	Sub-question	Responses	
		Response ID: 110	Response ID: 157

Table A8-1: Responses to Q3-Q9 – Number of respondents: 2			
Question	**Sub-question**	**Responses**	
Q3: Do you treat asbestos-containing waste?		Yes	
Q4: Can you estimate the proportion of asbestos-containing waste treated at your facility by waste stream?			
	Plastic packaging waste	30%	
	Building and construction waste	70%	
Q5: Can you provide the following information in relation to your facility?			
	Location (address, city, country)	Lichtstraat, Mol, Belgium	
	Asbestos-containing waste treatment capacity in tonnes per year	3500	
	Quantity of asbestos-containing waste received in tonnes per year (average of the last five years)	2000	
	Quantity of asbestos-containing waste recovered in tonnes per year (average of the last five years):	0	
	Quantity of asbestos-containing waste disposed of in tonnes per year:	3800	
	Cost of asbestos-containing waste treatment per tonne	1100	
	Comments:	Treatment consists of 'cementation' ie we ad water & cement to asbestos-containing waste to immobilise the dangerous 'free'-asbestos fibres	
Q6: Do you apply any of the following treatment techniques to asbestos-containing waste?			
	Mechanical treatment	Mechanical treatment	
	Mechano-chemical treatment		Mechano-chemical treatment
	Comments:	Treatment consists of 'cementation' i.e. we add water & cement to asbestos-containing waste to immobilise the dangerous 'free'-asbestos fibres	
Q7: Can you describe the treatment process of asbestos-		Incoming construction and	

Table A8-1: Responses to Q3-Q9 – Number of respondents: 2			
Question	**Sub-question**	**Responses**	
containing waste at your facility? Please include information on the preparation prior to recovery or disposal, the recovery and/or the disposal operations. Please also include information on the specific technology applied for the treatment of asbestos-containing waste.		demolition waste containing asbestos is processed on the basis of two processes: - lightly contaminated compressible waste (such as plastic film, filters, clothing, etc.) is compacted into bales to reduce landfill volume - construction and demolition waste containing free asbestos fibres is crushed and, after adding water and cement, moulded into concrete blocks which, after curing, are deposited in a class I landfill site	
Q8: What are the pros and cons of the asbestos waste treatment process applied at your facility?		pros: - landfill volume is significantly reduced - harmful free fibres are bound before entering landfill cons: - no final destruction of the fibres - considerable amounts of cement are required to immobilise fibres - still requires landfill capacity	
Q9: Is all treated asbestos-containing waste landfilled or is there any end-use for the treatment process output? Please provide information.		all treated asbestos-containing waste is landfilled	

Annex 9 Workshop report

A9.1 Introduction

As of 1 January 2005, Directive 1999/77/EC, amending Directive 76/769/EEC, banned the use of any asbestos fibres throughout the EU. Furthermore, the REACH Regulation specifies that the manufacture, sale and use of asbestos fibres and products containing these fibres are prohibited, and Commission Regulation 2016/1005 amending Annex XVII to REACH aims to ensure the complete phase-out of asbestos products in Member States by 1 July 2025. However, the use of articles containing asbestos fibres which were already installed and/or in service before 1 January 2005 remains permitted until they are disposed of or reach the end of their service life. While asbestos may not be actively used and marketed, built-in asbestos still exists in pipes, insulation, stoves, heating devices, asbestos sheeting, and roofing.

In October 2021, the European Parliament adopted a resolution calling for a 'European strategy for the removal of all asbestos'. In the resolution, the Parliament called for further EU action to protect workers and citizens from the health risks related to exposure to asbestos, especially in the context of the energy transition. The European Economic and Social Committee also called for the removal of all asbestos, underlining that works in energy renovations create synergies with the removal of harmful substances.[6] The European Parliament highlighted that asbestos waste treatment should fully apply the precautionary principle and called on the Commission to propose a corresponding revision of relevant Union waste legislation. The Commission is committed to follow up on the resolution from the European Parliament. Therefore, evidence is in demand for the European Commission to accompany one or more possible new legislative or non-legislative initiative(s) on the matter.

In 2022, the European Commission launched the 'Study on asbestos waste management practices and treatment technologies'. The purpose of this study is to investigate asbestos waste management practices and technologies in Europe and beyond. The ultimate aim is to ensure that the waste hierarchy (Article 4 of the Waste Framework Directive) is applied to asbestos waste properly and consistently across the EU, i.e., that efforts are put in place to reduce the landfilling of asbestos waste and promote its recycling into a non-hazardous mineral fraction. The study is carried out by RPA Europe, RPA Prague, the Danish Technological Institute and ARCADIS.

The **workshop 'Asbestos waste management practices and treatment technologies'** is a part of the study on asbestos waste management practices and treatment technologies. It enabled the study team to consult with and get feedback from the stakeholders that perform different roles in the management and treatment of asbestos waste and to identify the participants for further consultation activities (semi-structured interviews).

The **report on the workshop** "Asbestos waste management practices and treatment technologies" aims to describe the organisation of the workshop and the stakeholder participation in the event, as well as to outline the main topics discussed during the workshop and the conclusions drawn from it.

For analysing the content of the workshop discussions, thematic analysis – a qualitative method for distinguishing major patterns and themes in textual information was used.

The **report is structured** as follows:

- Section A9.2 describes the workshop objectives and agenda;
- Section A9.3 gives an overview of the workshop target audience, dissemination of information about the event and participation patterns (the list of participants is available in A9.6);

- Section A9.4 summarises the main themes that emerged in the workshop discussions; and
- Section A9.5 provides conclusions and next steps.

A9.2 Workshop objectives and agenda

The workshop "Asbestos waste management practices and treatment technologies" took place online on Webex on 15 June 2023, starting at 9:30 CET and concluding at 16:00 CET. It aimed to exchange knowledge and ideas about the current policies and legislative landscape, practices and treatment technologies in the field of asbestos waste management. It brought together stakeholders from Member State competent authorities, waste management companies, C&D businesses, waste treatment technology providers, non-governmental organisations, and research institutions with knowledge and practical experience on asbestos waste management practices and asbestos waste treatment technologies in the EU.

The workshop commenced with an introductory session, followed by two topic-specific sessions (see the agenda below)

Timing		Agenda item
	Introduction to the study and preliminary findings (130 mins)	
09:00 – 09:30	30 mins	Registration
09:30 – 09:35	5 mins	Welcome and housekeeping rules (Marco Camboni, RPA Europe)
09:35 – 09:40	5 mins	Welcome message from the Commission and introduction to the aims of the study (Enrique García John, DG Environment)
09:40 – 09:50	10 mins	Research questions and study methodology (Marco Camboni, RPA Europe)
09:50 – 10:05	15 mins	Quantities and sources of asbestos waste (Francesca Chiabrando, RPA Europe)
10:05 – 10:20	15 mins	Asbestos waste management legislation and practices in the EU (Daniel Vencovsky, RPA Prague)
10:20 – 10:35	15 mins	The current and emerging asbestos waste treatment technologies in the EU (Rūta Akelytė, RPA Europe)
10:35 – 10:50	15 mins	Q&A
10:50 – 11:00	10 mins	Break
Topic-specific sessions and wrap-up		
11:00 – 12:30	90 mins	Morning session: Management of asbestos waste in the EU: policies and practices (moderators: Daniel Vencovsky, RPA Prague) Keynote speakers: Stefania Butera (Danish Technological Institute) Olaf Dünger (ARCADIS)
12:30 – 13:30	60 mins	Lunch break
13:30 – 15:00	90 mins	Afternoon session: Current and emerging technologies for the treatment of asbestos waste (Zinaida Manžuch, RPA Europe) Keynote speakers: Nicolas Humez (Chairman of Hazardous Waste Europe) Jos Hofs (Chief Financial Officer at Asbeter Holding B.V.)
15:00 – 15:30	30 mins	Break
15:30 – 16:00	30 mins	Presentation of discussion outcomes and wrap-up

In the introductory session, the study team introduced the research questions and methodology of the study and provided an overview of the initial findings, including the outcomes concerning asbestos waste statistics, management practices, and treatment technologies. The participants had the opportunity to provide their feedback on these preliminary findings during a Q&A session.

Two topic-specific sessions then dived deeper into two areas:

- Management of asbestos waste in the EU: policies and practices; and
- Current and emerging technologies for the treatment of asbestos waste

The morning session 'Management of asbestos waste in the EU' **aimed** to get rich feedback (opinions and examples) from the participants on what elements (strategic directions, and practical actions) are crucial for designing and implementing effective asbestos waste management programmes in the EU Member States and how the EU-level action support these initiatives. In particular, **the discussion focused on**:

- Identification of best practices in asbestos waste management.
- Identification of any gaps in EU waste legislation as regards asbestos waste management.

The discussion session consisted of two keynote speeches and a moderated discussion with the participants. During this session, two keynote speakers – Stefania Butera (DTI) and Olaf Dünger (Arcadis Germany GmbH) from the study team presented case studies of asbestos waste management in Europe in two countries, Denmark and Germany.

The afternoon session 'Current and emerging technologies for the treatment of asbestos waste' **aimed** to get rich feedback (opinions and examples) from the participants on the most promising asbestos treatment technologies and the current state-of-the-art in their development. It consisted of two keynote speeches and a moderated discussion with the participants. The session was opened by two external speakers, Nicolas Humez (Chairman of Hazardous Waste Europe) who presented his views on asbestos waste treatment technologies, and Jos Hofs (Chief Financial Officer at Asbeter Holding B.V), who delivered an overview of the technology developed at Asbeter.

At the end of the presentations in each session, the discussion was opened with the participants, who were able to exchange their views, share knowledge and provide feedback on these specific topics by taking the floor and intervening in the discussion or by writing in the event chat.

Finally, the study team wrapped up the workshop by presenting the discussion outcomes.

A9.3 Target audience

A9.3.1 Event dissemination activities

Invitations to participate in the workshop were sent by email to 519 contacts representing Member State competent authorities, waste management companies, C&D businesses, waste treatment technology providers, non-governmental organisations, and research institutions with knowledge and practical experience on asbestos waste management practices and asbestos waste treatment technologies in the EU.

The workshop was promoted through a post on RPA Europe's Linkedin webpage 10 days prior to the event and reposted by members of the study team and by attendees.

A9.3.2 Participation in the event

A total of 95 participants joined the event (including participants from the study team) representing competent authorities, EU institutions, industry and trade associations, non-governmental organisations, researchers and business entities.

The detailed list of participants is provided in A9.6. Originally, 115 people registered for the event, meaning that 82.6% of the people who registered attended the workshop.

Representatives of all target audience groups attended the event (see Figure A9-1).

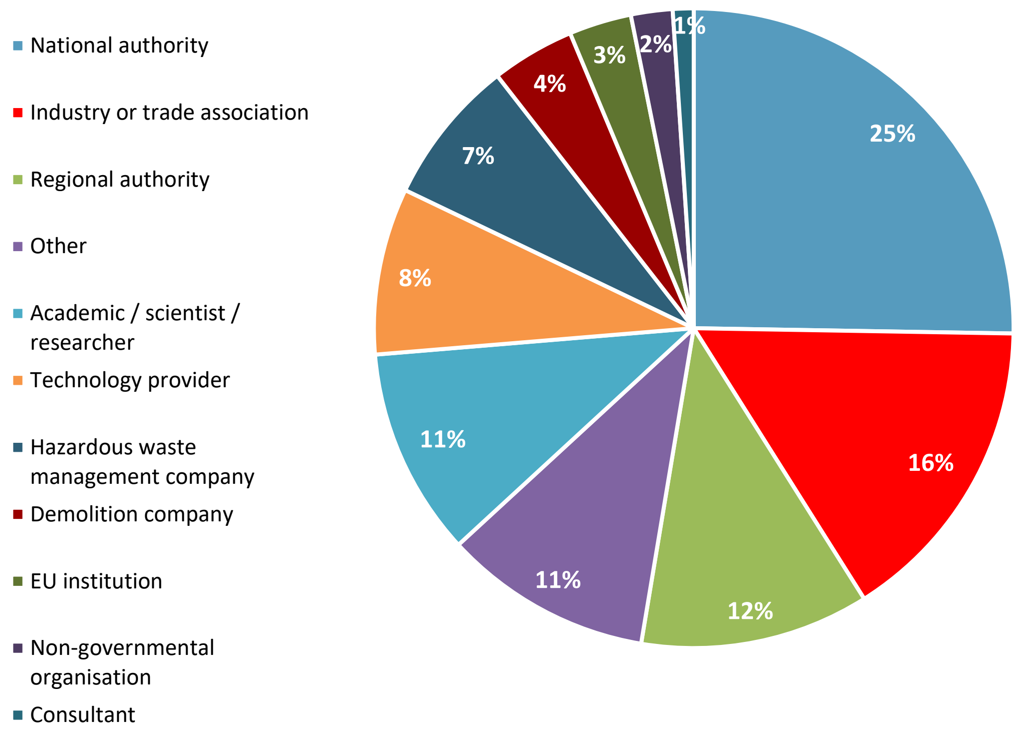


Figure A9-1: Attendees according to their affiliation

Figure A9-1 shows that the participants represented diverse target audiences of the study. The attendees representing competent authorities (including national and regional authorities) prevailed (37% of the total attendees, 35 participants). However, a large participant group representing industry or trade associations category was also well represented, with 15 representatives attending the event.

A total of 28 countries were represented during the workshop. This number included twenty-three EU Member States, and 5 non-EU countries: Brazil, Serbia, USA, UK and North Macedonia. Figure A9-2 shows the number of participants attending the event based in Europe.

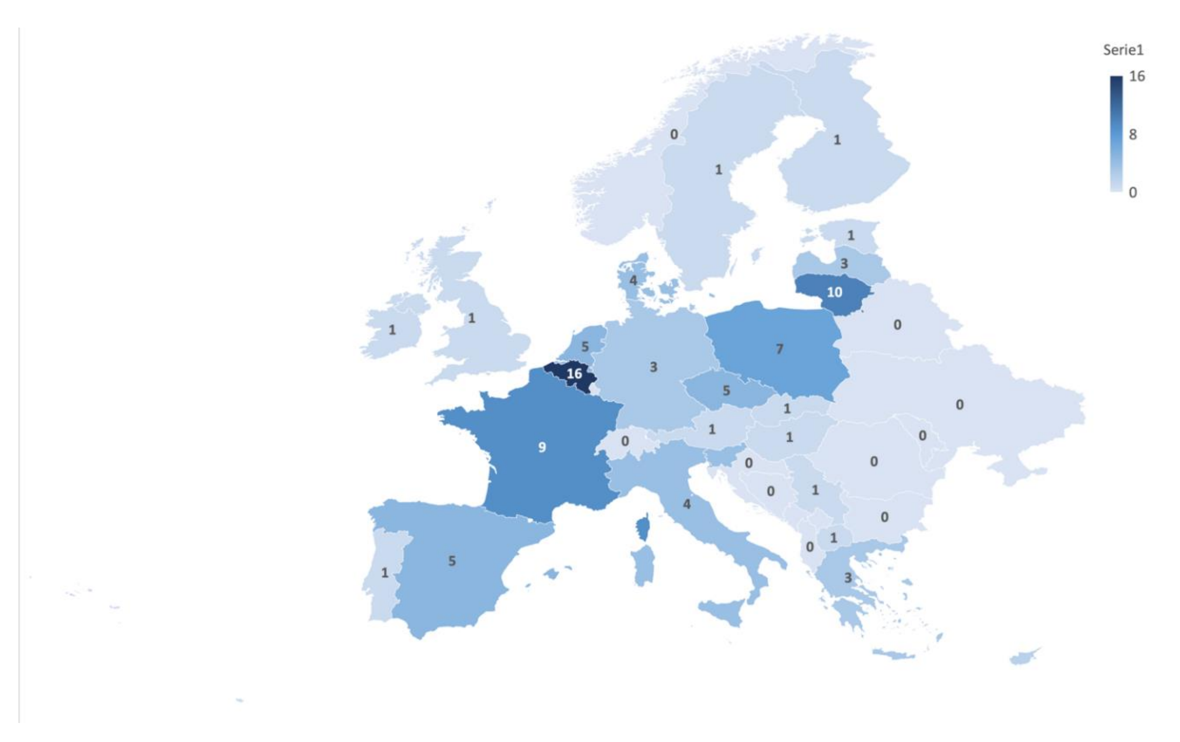


Figure A9-2: Attendees according to their countries of residence (operation)

Belgium registered the highest number of participants, with 16 people joining the workshop from this country. This number includes, in addition to Belgian authorities, companies or associations, also EU level associations and EU institutions representatives.

A9.4 Workshop discussions

This section describes the main themes that emerged in the two topic-specific discussions organised at the workshop:

- Management of asbestos waste in the EU: policies and practices, and
- Current and emerging technologies for the treatment of asbestos waste.

A9.4.1 Management of asbestos waste in the EU: policies and practices

During the first discussion session on policies and practices of asbestos waste management in the EU, two keynote speakers from the study team presented the study findings on management practices in two Members States: Germany and Denmark.

Stefania Butera (DTI) presented asbestos waste management practices in Denmark, focusing on the asbestos containing waste generated by C&D works and outlining the major requirements building owners, demolition companies and landfill operators have to comply with.

Olaf Dünger (Arcadis Germany GmbH) described asbestos waste management practices in Germany, presenting the provisions outlined in the new German Regulation concerning asbestos-containing waste (ACW) and the requirements to comply with before demolition and during remediation and maintenance work, as well as education and training provided to the workers.

To open up the discussion with the participants, four general questions were posed by the study team:

- What are the **most important elements of a national asbestos management strategy** in your opinion? Why are these elements important?
- What are the measures or actions in the existing national strategies or other initiatives on asbestos waste management that can be considered **best practice**? What can we learn from their implementation?
- What **challenges are currently faced** by EU Member States that have developed (are developing or want to develop) programmes and initiatives to support the implementation of their national strategies?
- Which elements should be part of a strategy at the **EU level**? Why do you think the EU action is needed?

Attendees participated lively in the discussion, both by intervening in the chat and by taking the floor. The points raised are summarised in the sections below.

A9.4.2 Main elements of a national asbestos management strategy

During the discussion on the elements that are important for designing a successful asbestos waste management strategy, some participants focused on actions that should be taken to improve asbestos waste management at national level, while other participants emphasised the need to take into consideration a number of relevant factors when taking decisions. Figure A9-3 summarises the main topics that emerged in the discussion.

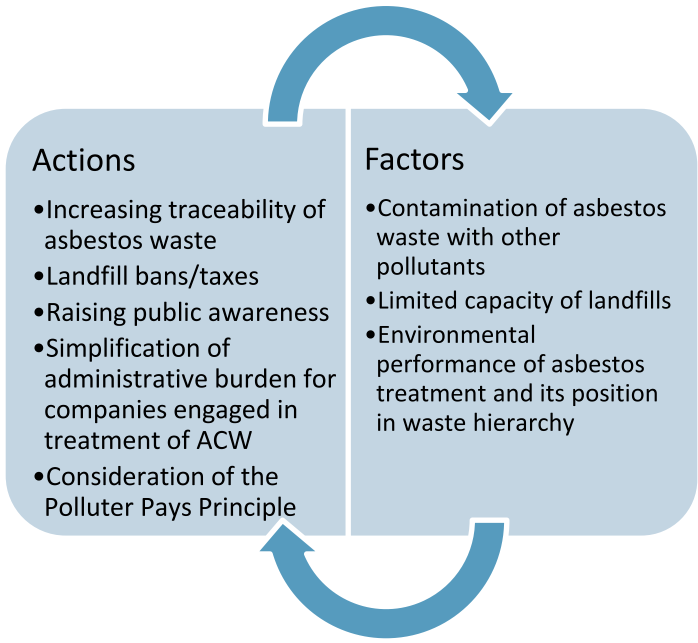


Figure A9-3: Overview of the main discussion themes

Participants identified five relevant actions that should be taken at the EU and national level.

- **Increasing traceability of asbestos waste**. A comprehensive mapping of asbestos waste (i.e. an asbestos cadastre) at EU and national level was identified as a very important element to increase the traceability of the waste. Better and more specific data should be collected, and there should be training and harmonisation at Member States level on the use of the List of Waste codes.

- Potential **introduction of landfill bans or landfill taxes**. The issue was raised and debated among participants, with some attendees arguing that such bans or taxes could be useful tools, stating that "a landfill tax that is high enough to penalise landfill, will make any treatment option more commercially attractive". However, others believed that such measures can be too radical and may lead to unintended consequences. The participants emphasised that landfill taxes or bans can only be put in place once "there is a sufficient network of alternative treatments at reasonable prices", otherwise decontamination works would be penalised and improper management or inaction to remove asbestos would be encouraged. Some of the participants expressed the opinion that landfilling of asbestos waste will remain relevant even in the presence of operational asbestos waste treatment technologies and maintained that in some cases landfilling is the only waste management option.
- **Increasing awareness at the household/private citizens level**. The lack of awareness among citizens often causes a significant problem of illegal dumping around urban centers, so raising public awareness is key. In relation to this, the availability and affordability of collection sites should be increased.
- **Administrative ease** should be granted to companies dealing with asbestos waste disposal, who often have to deal with bureaucratic burdens which hinder the handling and management of the waste.
- **Consideration of the Polluter Pays Principle.** When considering the economic aspects of waste treatment and disposal, the discussion highlighted that, due to the prevailing economic conditions that govern waste management practices, a lot of the ACW ends up in landfills. In this context, participants emphasised the vital importance of considering and applying the Polluter Pays Principle, which asserts that those responsible for creating pollution or generating waste should bear the associated costs and responsibility for its proper management and disposal.

Several attendees focused on key factors to be taken into account when making decisions on asbestos waste management.

The **impact of the presence of other pollutants** in asbestos waste should be taken into account, and a case-by-case impact assessment of ACW should be carried out. The presence of other hazardous substances might determine the options for waste processing and treatment. One participant drew a parallel between disposing ACW and the provisions of Part II of Annex V of the POPs Regulation that contains a list of inorganic or mineral waste in which there can be POP substances above the limits set out in Annex IV.

The **capacity for disposal and treatment** in each Member State should be considered when implementing new policies such as asbestos removal plans at the EU or national level to ensure the capacity to receive the waste is sufficient, taking into account that in many countries, the capacity for landfilling is reducing and new permits for landfilling are very limited and difficult to obtain.

A point was made that the **waste hierarchy** is also important. The whole Life Cycle Approach should be taken into account because some of the relevant treatment options might be very energy intensive. When studying the technologies for the destruction of asbestos, it is important to understand what their externalities are and how they compare with landfilling.

A9.4.3 Best practices

During the discussion on what existing national strategies or other initiatives can be considered best practice, participants provided ideas and suggestions on how some of the major issues related to asbestos waste management could be tackled, while others gave examples of a number of good practices that some Member States are already implementing. Figure A9-4 summarises the main points that emerged in the discussion.

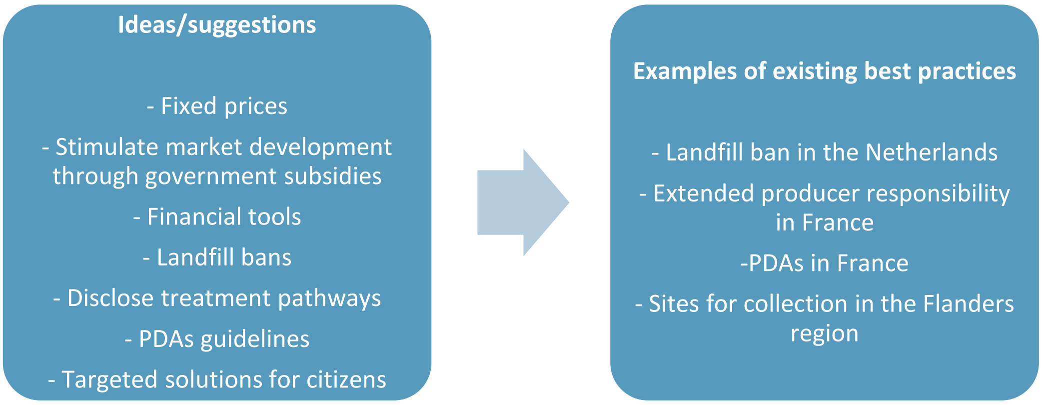


Figure A9-4: Overview of the main discussion themes

Participants underlined the need for a **pricing system** that does not encourage landfilling, as cheap landfilling may hinder the development of new technologies. In this context, the idea of having a **fixed price for landfilling and treatment options** was proposed, with a participant stating that "the gap between low landfill prices and higher treatment costs needs to be bridged, to enable commercial operators to de-risk the investment for building a facility".

The need to **stimulate market development** in terms of alternative solutions was discussed. A potential way to do this could be to get the traction going through government subsidies for the capital cost of building facilities, as a first step. Then the facilities could be scaled up and replicated until they reach the capacity to treat all the waste generated.

The introduction of new **financial tools** (e.g., taxes) or **landfill bans** may also be needed to achieve the transition towards new technologies and divert from landfilling.

Good practice example

In the Netherlands there is already a landfill ban that will become effective when 75% of the asbestos containing waste generated can be recycled, with the objective of having capacity to recycle 100% of the waste stream within a couple of years.

Good practice example

France has implemented an Extended Producer Responsibility (EPR) for construction waste, which ensures that producers pay for or contribute to waste management. This includes asbestos waste from households; however the specific implementation details are yet to be clarified.

Pre-demolition audits (PDAs) were identified as an important element; however, participants stated it is not clear whether the rules are always rightly implemented. **Clear guidelines** on how the PDA should be carried out are needed, such as on the number of samples that need to be taken to be sure of the presence of asbestos.

Good practice example

In France, the assessment of asbestos presence in buildings is mandatory when selling a house or before any kind of demolition or renovation work.

Participants proposed the idea of having an obligation for companies to **disclose the treatment pathway** of the ACW they generate, as this may promote best practice and improve the waste traceability.

Participants suggested the introduction of more **targeted solutions for private citizens**. Incentive plans for the removal and disposal of asbestos waste are already implemented in some Member States (e.g., Italy), however these plans are usually reserved to companies. According to participants, it would be important to include **incentives for private citizens** in the national plans considering the high costs for removal and disposal that scare privates away from correct management. Another solution that was mentioned was that private citizens could bring household waste to demolition companies that have the storage space to keep the ACW until they can bring it to the landfill location.

The Commission underlined that the **separate collection obligation** set out in Article 20(1) of the Waste Framework Directive[231], which in some Member States or some regions has already been in place for some time, will be applicable in all EU Member States starting on 1 January 2025, and that includes asbestos waste.

Good practice example

The Flanders region in Belgium implemented a policy allowing households to dispose of non-friable (bound) asbestos resulting from Do-It-Yourself renovation work. This can be done by either taking the asbestos to a designated location or requesting a pick-up service from the municipality.

A9.4.4 Challenges

Participants identified the major challenges related to asbestos waste management in the Member States, and some attendees described examples of issues occurring in their own countries. Figure A9-5 summarises the main topics raised in the discussion.

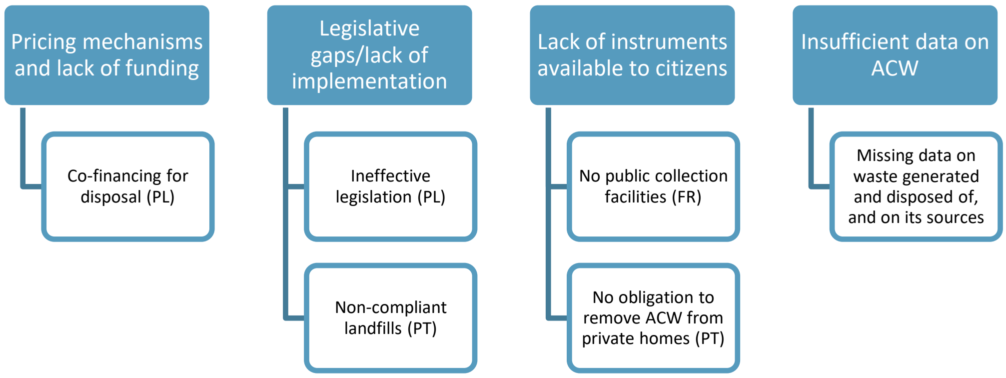


Figure A9-5: Overview of the main discussion themes

[231] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098

Participants highlighted four major challenges across the Member States:

- The current **pricing mechanisms** might encourage landfilling rather than the alternatives.
- The presence of **legislative gaps and the inadequate implementation** of existing regulations hinders the development and adoption of robust asbestos waste management practices.
- The **lack of viable instruments available to private citizens**, such as adequate waste collection facilities or pick-up programs specifically designed to cater to private sources of asbestos waste, complicates the proper handling and disposal of the ACW. This lack of accessible solutions places an additional burden on private individuals and raises concerns about the potential mishandling or improper disposal of asbestos waste originating from residential or small-scale sources.
- At both EU and Member State level the **data gathered on asbestos waste generation, disposal and sources remains insufficient.** This knowledge gap limits the effectiveness of policymaking, planning, and resource allocation efforts, as well as the ability to evaluate the success of implemented initiatives or track progress in addressing the challenges associated with asbestos waste management.

A number of examples were presented to outline specific issues and challenges in different Member States.

- The primary challenges faced in Poland regarding asbestos management stem from **insufficient funding and ineffective legislation**. As per the current regulations, during renovation projects the state budget's co-financing program only covers the costs associated with dismantling and disposing of asbestos products. However, the burden of procuring new materials, such as a new roof, falls entirely on the building owner, necessitating additional financial resources.
- The **closure of a significant number of landfills** in Portugal stemmed from their failure to adhere to the applicable EU legislation. The landfills were found to be mixing non-friable asbestos waste with organic waste within the same landfill cells. Currently, Portugal only has three remaining landfills authorised to accept asbestos waste, leading to an escalation in prices for proper disposal and to an increase in illegal dumping activities.
- In Portugal, an additional concern arises from the disparity in regulations pertaining to asbestos removal between companies and public building owners on one hand, and private citizens on the other. The legislation mandates that companies and public building owners must be aware of the presence of asbestos in their structures and take appropriate measures for its removal. However, there is **no corresponding obligation for private citizens to remove asbestos from their homes**. This discrepancy becomes significant as a substantial portion of C&D activities occurs at the household level. As a result, ACW generated from private residences often goes unnoticed and is susceptible to being illegally dumped. To address this issue, non-governmental organizations (NGOs) in Portugal have taken on the task of collaborating with local Chambers to promote awareness among individuals.
- In France, households and small enterprises face a significant challenge when it comes to the proper disposal of waste. The issue arises from the **closure or non-operation of public collection facilities**, primarily due to the difficulties encountered in adhering to the stringent regulations imposed.

A9.4.5 Current and emerging technologies for the treatment of asbestos waste

During the second discussion session on current and emerging technologies for the treatment of asbestos waste, two keynote speakers presented their perspectives on asbestos waste treatment technologies.

Nicolas Humez, Chairman of Hazardous Waste Europe, underlined that the diversity of ACW must be considered to ensure adequate disposal. In the presentation, several aspects of asbestos waste management were emphasised:

- Complementarity of different management solutions, including landfilling;
- The importance of certifying the recovered materials to ensure they are free from asbestos fibres;
- Monitoring the pollutants produced in the waste treatment installations; and
- Safety and appropriate training of the treatment facility staff.

Jos Hofs, Chief Financial Officer at Asbeter Holding B.V., presented the work his company is currently doing in treating ACW. Asbeter Holding B.V. developed the patented AC Minerals process that completely dissolves asbestos fibres from asbestos cement and recovers carbon-neutral raw materials.

To open the discussion with the participants, four general questions were posed by the study team:

- What are the **key characteristics of the technologies** that make them the most promising? Are there data (e.g., from pilots) to back up these advantages?
- What are the main **barriers to the commercialisation** of the technologies? Can you provide examples?
- What can be done to **overcome these barriers**? Can we draw any parallels with other technologies/sectors from which we could learn and get inspired?
- What are the output **materials** obtained by the different treatment technologies? What are their safety profiles and potential uses? And do they have a market?

Attendees participated lively in the discussion, both by intervening in the chat and by taking the floor. The points raised are summarised in the sections below.

The discussion mainly focused on the **key characteristics of technologies** and **barriers to commercialisation**. Participants identified several characteristics that make treatment technologies viable and promising, as well as major issues that currently hinder the development and spreading of such technologies across Member States on the industrial scale. Figure A9-6 summarises the main topics that emerged in the discussion.

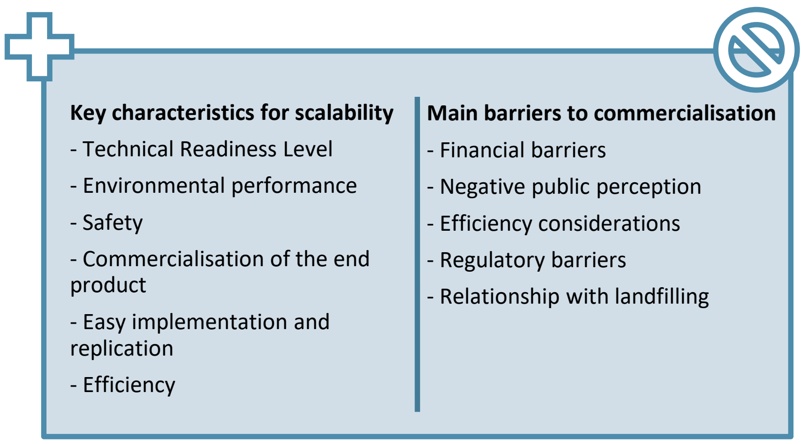


Figure A9-6: Overview of the main discussion themes

The participants highlighted six key characteristics of the promising asbestos waste treatment technologies. The **Technical Readiness Level** of the technology was mentioned as one of the key characteristics by several participants, as well as the **environmental performance** of the process. In particular, technologies should have a low energy consumption, low environmental footprint, and be eco-friendly.

Participants underlined the importance of **safety of the final product and the treatment process.** According to the participants, the treatment process must ensure that the end product is 100% fiber-free, and also that fibers are not released into the environment during the operations. Similarly, safety of the treatment process for workers and citizens living around the plants is critical. The participants emphasized the importance of transparency in regard to how and where the end products will be used.

Among the key characteristics of the promising treatment technology is a **market for the end product** of the treatment process. In turn, to enter the market successfully, output materials should be sold at a reasonable price and be attractive to consumers. Some underlined this might prove especially difficult in some sectors, e.g., construction.

Asbestos treatment technologies should be **easy to implement** and as easy to work with as landfills. According to some participants, the technology can be given priority (over traditional methods, such as landfilling) if it provides a simple workflow for the players in the asbestos waste processing chain. The international spread of technology is influenced by the simplicity of its replication in different countries.

Several participants highlighted various aspects related to the **efficiency** of asbestos waste treatment. These aspects covered the **capacity** of plants to handle streams of asbestos waste, the maintenance cost of the technology, and its reliability. It was stressed that technologies should be able to handle the different types of asbestos waste.

A benchmark study "International Benchmark of Research and Development on the treatment of asbestos"[232] carried out in France was suggested during the discussion and will be further analysed.

The participants distinguished four **barriers** to the commercialisation of treatment technologies and how these barriers could be overcome:

- **Financial barriers** included the needs for substantial funding for the treatment technologies to reach the industrial scale. Drawing investments and incentives to fund the scalability of existing solutions and research on new ones is therefore fundamental. Here the collaboration between the governments, investors and the developers of asbestos treatment technologies is crucial. To ensure funds and investments, government support at the beginning of technology development project is important at Member State level. Government subsidies and funding can create the initial capital to build the installations and stimulate the market for these technologies. Government support is also important to show private investors that the technology is viable and scalable and that it can generate a return on investment.
- **Public perception** was identified as another major barrier to the commercialisation of asbestos waste treatment technologies and the introduction of recycled asbestos-free materials or products to the market. Similarly, as in other sensitive areas (e.g., nuclear energy), asbestos waste is often a source of public concern and negative perceptions. Materials or products developed as outcomes of asbestos waste treatment are considered with caution and raise safety concerns in society. It is therefore very important to work on changing the public perception by raising awareness of these technologies.

[232] http://www.plateforme-prda.fr/IMG/pdf/bi_rd_amiante.pdf

- Efficiency considerations, such as high **energy consumption** can become a potential barrier.
- **Regulatory barriers** play an important role. The participants highlighted current uncertainties and the lack of clarity associated with the definition of the End of Waste (EoW) status in Article 6 of Directive 2008/98/EC. In different Member States, the practices of assigning the EOW status vary. EOW status granted in one country may not be recognised in another Member State which can pose barriers for selling the end product on the international market. According to one participant, the lack of regulatory harmonisation and different standards in the EU are barriers to asbestos waste treatment companies to reach the industrial scale at the EU level.

The **relationship between landfilling and waste treatment technologies** was mentioned. Some participants believed that asbestos waste treatment technologies should offer competitive prices (as compared to landfilling) and regulatory measures to encourage circular solutions are necessary. However, there was no general agreement between the participants on the relationships between the treatment technologies and landfilling. Suggestions on how to overcome these barriers included the **harmonisation and standardisation** of how waste is managed in each Member State through EU level legislation, and the **involvement of all stakeholders**.

Other topics emerged in the discussion related to the potential **market use of the outputs** of the asbestos treatment process.

Participants identified the **recovery of raw materials** for which Europe is dependent on third countries as a potential market for output materials generated by the treatment of asbestos waste. In particular, one attendee outlined how asbestos can be a source of magnesium, which is a very valuable material for many industries including automotive and aircraft, and iron, which is valuable in the agriculture sector.

Through the **up-cycling of products**, recycled asbestos waste can be reused in the cement industry, but it could also reach new industries, such as the paint industry.

A9.5 Conclusions and next steps

The workshop generated substantial interest among stakeholders. Over eighty percent of registered stakeholder attended the event resulting in nearly 100 participants from twenty-three EU Member States and five non-EU countries. The participants represented eleven stakeholder groups concerned with the issue of asbestos waste and taking part in asbestos waste management and treatment.

The views of stakeholders provided in this report may reflect the opinions of competent authorities and/or waste treatment technology companies. These two stakeholder groups prevailed among the participants. Furthermore, the topics of the workshop addressed issues that are most relevant to these stakeholders and reflect their role in the management and treatment of asbestos waste.

Several themes were vivid in both thematic discussions:

- The **composition of asbestos waste**, especially the contamination with pollutants and the presence of other components then asbestos, was mentioned in both discussions. This feature of asbestos waste has implications for both choosing the appropriate treatment method and the overall organisation of asbestos waste management. The mixed composition of asbestos waste may have implications for the market use of the outputs of the asbestos treatment process.
- **The transition from landfilling to asbestos waste treatment technologies**. A number of participants highlighted various issues related to shifting from landfilling asbestos waste to sustainable treatment options. For instance, the participants discussed the market or

regulatory measures to encourage using the asbestos treatment technologies instead of landfilling when such technologies are in place. It should be noted that the participants had different opinions concerning the role of landfilling in tackling the issue of asbestos waste and this topic generated debates and lively discussion.

- **Raising public awareness and working with public perceptions and behaviours**. This discussion related to the important role of the public in increasing the efficiency of asbestos collection (especially from households) and in accepting asbestos-free products resulting from the treatment processes.

Based on the workshop discussions, the study team collected information and examples to complement the literature review and legislation analysis. The next step of the study involves continuing stakeholder consultation activities. Semi-structured interviews will be arranged with different stakeholders. The workshop contributed to identification of the interviewees.

A9.6 Workshop participants

List of participants	
Organisation name	**Country of residence**
ABCOV® Companies, LLC	United States of America
Amsterdam University of Applied Sciences	Netherlands
ARATC	Lithuania
Arcadis	Germany
ARI Global Technologies	United Kingdom
ARSO	Slovenia
Asbeter Holding B.V.	Netherlands
Asbeter Holding B.V.	Netherlands
ASEGRE	Spain
Assoambiente	Italy
Black Asbestos	France
BMAW	Austria
BRB Bundesvereinigung Recycling-Baustoffe e.V.	Germany
Brussels Environment	Belgium
Brussels Environment	Belgium
CCOO del Hábitat	Spain
Confederation of Danish industry	Denmark
D-nature B.V.	Netherlands
Danish Technological Institute	Denmark
Danish Technological Institute	Denmark
Danish Working Environment Authority	Denmark
Department of Environment	Cyprus
Embrapa Instrumentation	Brasil
Environmental Protection Agency	Lithuania
European Commission	Belgium
European Commission	Belgium
European Commission	Belgium

List of participants	
Organisation name	**Country of residence**
European Construction Industry Federation (FIEC)	Belgium
European Construction Industry Federation (FIEC)	Belgium
European Waste Management Association (FEAD)	Belgium
Federación de Industria, Construcción y Agro de la Unión General de Trabajadoras y Trabajadores (UGT FICA)	Spain
Fédération Française du Bâtiment (FFB)	France
Fédération Nationale des Travaux Publics (FNTP)	France
General Office of Building Supervision	Poland
Hazardous Waste Europe (HWE)	Belgium
Institute of Plasma Physics	Czech Republic
Istituto Nazionale Assicurazione Infortuni sul Lavoro (INAIL)	Italy
Latvian Association of Waste Management Companies	Latvia
Leefmilieu Brussels	Belgium
Leefmilieu Brussels	Belgium
Ministerio para la Transición Ecológica y el Reto Demográfico	Spain
Ministry for the Ecological Transition and the Demographic Challenge	Spain
Ministry of Economic Development and Technology	Poland
Ministry of Energy	Hungary
Ministry of Environment	Lithuania
Ministry of Environment	Lithuania
Ministry of Environmental Protection and Regional Development	Latvia
Ministry of Environmental Protection and Regional Development	Latvia
Ministry of Finance	North Macedonia
Ministry of the Environment	Czech Republic
Ministry of the Environment of Estonia	Estonia
Ministry of The Environment, Climate and Energy	Slovenia
National Labour Inspectorate	Poland
National Public Works Federation	France
Oosten Project Management	Netherlands
Organisme Professionnel de Prévention du Bâtiment et des Travaux Publics (OPPBTP)	France
Polyeco Group	Cyprus
Polyeco Group	Greece
Polyeco Group	Greece
Polyeco Group	Greece
Public Health Authorithy of the Slovak republic	Slovakia
PWW DOO	Serbia
Rematt	Belgium
Rematt	Belgium
Remontes Soluções Ambientais Ltda	Brasil
Remontes Soluções Ambientais Ltda	Brasil

List of participants	
Organisation name	**Country of residence**
Research Institute for Buildings Materials	Czech Republic
RPA Europe	Italy
RPA Europe	Italy
RPA Europe	Lithuania
RPA Europe	Lithuania
RPA Europe	Lithuania
RPA Europe	Lithuania
RPA Europe Prague s.r.o.	Czech Republic
Scientific Intitute of Public Service (ISSeP)	Belgium
Scientific Intitute of Public Service (ISSeP)	Belgium
Silesian Voivodeship	Poland
SIPTU	Ireland
Slovenian Environment Agency	Slovenia
Slovenian Environment Agency	Slovenia
SPW ARNE	Belgium
Swedish Environmental Protection Agency	Sweden
SYVED	France
University of Strasbourg	France
Urząd Marszałkowski Województwa Małopolskiego	Poland
Urząd Marszałkowski Województwa Małopolskiego	Poland
Urząd Marszałkowski Województwa Małopolskiego	Poland
VALAME	France
VALAME	France
Vilnius County Waste Management Center	Lithuania
VšĮ Šiaulių regiono atliekų tvarkymo centras	Lithuania
VTT	Finland
Výzkumný ústav stavebních hmot, a.s.	Czech Republic
ZDB German Construction Confederation	Germany
ZERO	Portugal

Annex 10 Findings of expert consultation

Eighteen semi-structured interviews (0.5-1.5 hour long) were conducted in June – October 2023 with representatives from industry, academia, competent authorities, industry associations and non-profit organisations. All interviewees represented European countries (see the list of interviewees in Annex 11). The MS Teams platform was used for conducting virtual interviews and making the recordings.[233] One interview took place in person. All participants gave their consent to publishing their names in the list of interviewees (see Annex 11). The interview recordings were transcribed, and a thematic analysis was carried out to highlight the main themes that emerged.

The list of two topics is presented in the table below. The majority of interviews covered asbestos waste treatment technologies and their implementation. Remaining interviews focused on asbestos waste management practices. Each topic was covered in six or more different interviews to reach data saturation. The number of interviews that considered each topic is summarised in the table below.

Table A10-1: Responses to the topics of interviews

Topic of discussion	Number of interviews
Topic 1: Asbestos waste management	6
Topic 2: Asbestos waste treatment technologies and their implementation	12

It needs to be noted that these interviews also include consultations with asbestos waste treatment technology providers, who, in most cases, shared comprehensive and useful information about their technologies for the purpose of this project but also answered some more general questions about asbestos waste treatment implementation in the EU. The technology specific questions and answers have not been included in this analysis. This information has been provided in the main report and in the asbestos waste treatment technologies' overview tables presented in Annex 7.

In the following sections, the thematic analysis of each topic is presented.

A10.1 Topic 1: Asbestos waste management

For Topic 1, the discussions aimed to glean insights into the current ACW management practices, including the screening, identification, handling and disposal of ACW. Given the large differences between the Member States with regard to screening and identification of asbestos in buildings, the interviews focussed on the approaches to the screening of buildings for asbestos and its identification during demolition and renovation activities. A particular objective of the interviews was to describe the key features of the national approaches in the relevant Member States, as well as to identify and discuss examples of best practices. Of particular interest were experiences and practices that could be transferrable to other Member States.

[233] Only Topic 2. The interviews for Topic 1 were not recorded.

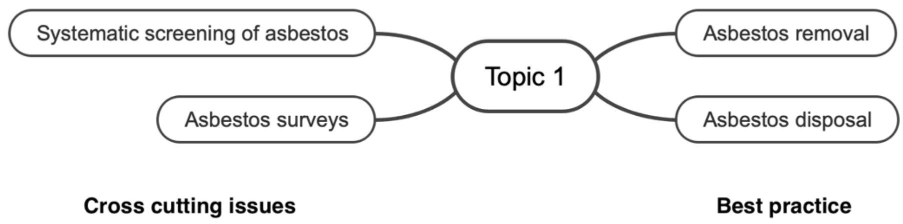


Figure A10-2: Thematic categories in Topic 1

As regards the screening of buildings for asbestos, examples of the issues discussed include:

- Some countries have no national strategy for the screening of buildings for asbestos and its subsequent removal. In these countries, there are no inventories of buildings that contain asbestos.
- Screening can be stimulated by a requirement to screen for asbestos whenever a building changes ownership or by a requirement that all buildings are screened by a target date.
- The requirement to screen and remove asbestos for buildings can be coupled with other measures such as support for energy efficiency (e.g., removing asbestos from roofs before installing solar panels).
- It is also good practice to have a communications campaign – it can take many years to create awareness of ACW.

As regards the identification of asbestos in buildings, examples of issues discussed in the interviews include:

- In some countries, Pre-demolition Audits (PDAs) are not compulsory.
- Achieving a better price for asbestos surveys by tendering them in bulk by means of a central framework contract and allowing individual public authorities to access the framework contract.
- It can be useful to provide a template for the asbestos survey and use behavioural stimuli to incentivise people to remove asbestos.

As regards the removal of ACW, examples of issues discussed in the interviews include:

- Examples of relevant practices include separation at source and immediate packaging.
- Support for private citizens is important – this includes both support when removing and disposing of ACW as well as creating awareness.

As regards the disposal of ACW, examples of issues discussed in the interviews include:

- Currently, landfilling is the main method of disposal.
- Economic incentives can include setting landfill tax for ACW to zero.
- Illegal disposal of ACW is a problem.

Examples of the more general points covered in the interviews are:

- Awareness of asbestos among the general public and public pressure can explain some of the actions taken by some of the Member States. In the Member States where similar level of awareness/pressure does not exist and there is thus some scope for the EU to act and establish EU-wide goals for asbestos collection.
- Information sharing between different Member States is a good idea.

- A good methodological guide for handling ACW would be good practice. However, there were different views as to whether the advice needs to be concentrated in a single document.

A10.2 Topic 2: Asbestos waste treatment technologies and their implementation

Discussions on Topic 2 aimed to get insights into the existing and emerging asbestos waste treatment technologies and recovered materials, understand the potential for applying asbestos waste treatment technologies in asbestos waste management in the EU, identify main barriers and opportunities to implement these technologies, and the role of the European Commission, Member State authorities, the industry and other relevant stakeholders in establishing these types of technologies in Member States. Seven out of twelve interviews took place with representatives from the industry. The purpose was not only to get their insights into the above, but also to collate as much information as possible about the asbestos waste treatment technologies, the processes, types of asbestos and asbestos waste treated, health and safety considerations, benefits and limitations. The remaining interviews were with the experts from academia, associations, and authorities.

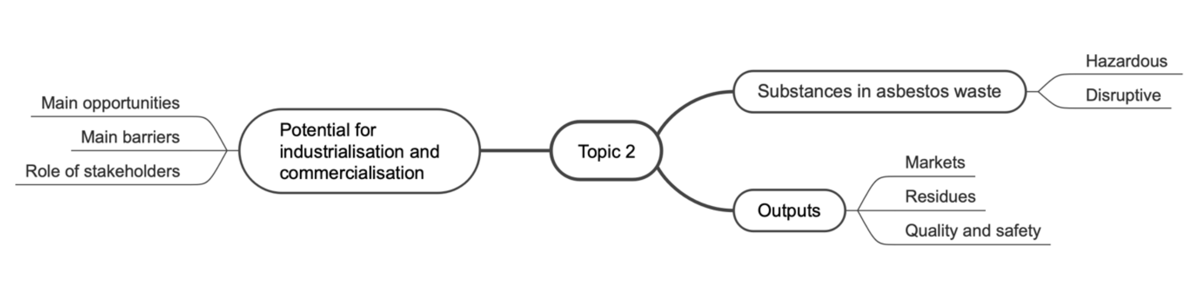


Figure A10-3: Thematic categories in Topic 2

The potential for applying asbestos waste treatment technologies in the EU

Some industry representatives highlighted that landfilling of asbestos waste can become a challenge as landfill space is limited. In addition, landfilling is a source of pollution to air, soil, and water, and is not a definitive solution for getting rid of the asbestos problem. Asbestos waste treatment was also linked to climate and raw materials policies, suggesting that treating asbestos could reintroduce circular materials to various industries.

It was indicated by the industry that the potential for applying asbestos waste treatment technologies in the EU depended on the long-term planning and government support to address the complexities of the issue, cooperation of public-private partnerships, and legislation to support alternatives to landfilling. Building asbestos treatment plants requires significant investment, making it a complex issue, especially when considering uncertainties about the future of landfill policies. Hence, the need for honest discussions with authorities and governments was also emphasised.

According to non-industry stakeholders, the potential for applying asbestos waste treatment technologies in the EU could be significant, with a current momentum driven by the renovation wave, economic considerations, and the urgency of addressing asbestos issues before it becomes more challenging to manage. The success of these technologies was seen as dependent on factors such as economic viability, interest from waste management companies, client demand, and support from Member States for research and development.

Main barriers

According to the industry, the main barriers for implementing and commercialising asbestos waste treatment technologies involve:

- Financial constraints, such as raising enough funds to initiate and sustain asbestos treatment projects;
- Financial risks, for example, the uncertainty about the facility's performance and the availability of sufficient waste for treatment;
- Economic feasibility that is closely tied to government control over landfill costs, which directly influences the competitiveness of asbestos treatment;
- Regulatory uncertainties and constrains, for instance, the process of obtaining regulatory validation, such as the End of Waste status;
- Sustainability concerns, which arise from the difficulty in proving that treated material is free from asbestos, with limitations in detection methods and uncertainties about regulatory acceptance;
- The need for standardised testing methods;
- Authorisation process, as to build and operate asbestos treatment plants involves navigating country-specific regulations, adding complexity to the process;
- Exposure-risk relationships and the lack of a clear exposure threshold for asbestos in the EU add complexity to the industry's development.

The main barriers identified by other stakeholders include:

- Cost considerations, as the cost per tonne for asbestos treatment compared to landfilling costs is a significant barrier. Landfilling may be economically more viable, making it challenging for treatment technologies to compete;
- Economic business case for treatment plants is influenced by factors, such as the phasing out of landfilling, increased costs for renovation and asbestos removal, and the need for government initiatives to support alternative treatments;
- Lack of the uniform framework for certification. A uniform framework to certify the end product as asbestos-free is crucial. Differing protocols, analysis methods, and criteria across countries call for a standardised approach to ensure the safety of treated materials;
- The need for high temperatures for thermal technologies, especially for chrysotile fibres, can impact the efficiency, cost-effectiveness and sustainability of the treatment process;
- Chemical treatments using strong acids face challenges related to the constant availability and quality of these acids. Price fluctuations in the global market for strong acids can impact the economic feasibility of chemical treatment methods;
- The need for temporary storage near treatment plants may be required due to potential mismatches between the pace of asbestos waste generation and the treatment plant's capacity. Temporary storage comes with its own challenges, including obtaining environmental permits and community acceptance;
- Regulatory approval and safety concerns, such as obtaining regulatory approval, given that asbestos is a hazardous material. Ensuring worker and environmental safety during the treatment process is also a critical consideration;
- Awareness and perception, for instance, the lack of awareness among potential users, such as construction firms, about the existence and benefits of new treatment methods can impede the adoption of these technologies. Public perception and acceptance of such technologies are also crucial;
- The "Not In My Backyard" (NIMBY) factor, resulting in community resistance to having new treatment plants in their vicinity;

- Infrastructure changes, as integrating new technologies may require significant changes to the existing infrastructure;
- Competition with established disposal methods.

According to stakeholders, addressing these challenges requires coordinated efforts, government support, collaboration with authorities, behavioural change, effective communication strategies and a clear regulatory framework that considers both economic feasibility and environmental sustainability.

Main opportunities

According to the industry, the main opportunities for commercialising asbestos waste treatment technologies lie in:

- Technology accessibility: some of these technologies are not very complex, making it accessible for implementation. The requirement for locations with water and electricity suggests flexibility in choosing suitable sites for building treatment facilities;
- A licensing model, which avoids the need for the company to build and scale treatment plants independently, promoting quicker adoption of the technology in other countries;
- Market demand: there is a significant amount of asbestos waste still present in buildings;
- Government restrictions on landfilling would create a growing need for alternative solutions, creating a market niche for asbestos waste treatment technologies;
- Environmental responsibility, for example, the disclosure by large companies of the amount of asbestos-containing waste removed annually may incentivise such companies to focus on environmental responsibility, potentially driving demand for asbestos waste treatment services;
- Potential reuse of treated material, for example, as a cement replacement, offering a sustainable solution and contributing to the economic viability of treatment facilities;
- Regulatory validation: establishing precedents for the use of treated material in specific applications enhances the credibility and acceptance of asbestos waste treatment.

Other stakeholders identified the following opportunities:

- The political and policy context, especially the European Union's guidelines and directives for the phasing out of asbestos, presents a significant opportunity. Renewed guidelines, directives, and initiatives for screening buildings on asbestos and creating a central database create a favourable environment for investing in asbestos treatment technologies;
- Win-win scenario with the Renovation Wave: the combination of the asbestos removal goals with the energy renovation wave in the EU creates a "win-win" scenario. Making buildings energy-efficient can simultaneously ensure they are asbestos-safe. The context of screening buildings for asbestos before demolition or renovation allows for mass balance and estimation of asbestos present, aiding investors in planning treatment capacities;
- Environmental and economic opportunities from viewing standing buildings as potential resources rather than waste. Reusing valuable minerals and resources from asbestos-containing materials in existing buildings can contribute to sustainability and cost savings;
- Global market demand, as asbestos waste management technologies that provide sustainable and eco-friendly approaches have the potential to address a global challenge. With increased awareness of the health risks associated with asbestos and strict regulations on disposal, there is a growing market demand for safe and effective asbestos waste management technologies;
- International opportunities, since asbestos is a global concern. Technologies that offer effective solutions could find applications beyond national borders;
- Reducing reliance on traditional disposal presents an opportunity for companies providing alternative solutions;

- The global challenge of asbestos waste management creates an opportunity for companies to contribute to a sustainable solution.

According to stakeholders, these factors collectively contribute to the attractiveness and feasibility of adopting asbestos waste treatment solutions. Companies that navigate these opportunities effectively can contribute to addressing the challenges associated with asbestos waste management in the EU and beyond.

The role of stakeholders

According to the industry stakeholders, the European Commission's role is multifaceted, encompassing financial support, encouragement of common legislation, confidence building, knowledge dissemination, facilitation of collaboration and support for initiatives related to asbestos. The European Commission is seen as having an important role in supporting EU Member States that are committed to addressing the asbestos problem. It was suggested that subsidies from the European Commission were crucial, indicating a financial support mechanism to facilitate the adoption of asbestos waste treatment technologies. Some industry stakeholders emphasised the idea that the European Commission could play a role in encouraging Member States to adopt a common view and legislation regarding asbestos treatment. The suggestion is that, despite the sovereignty of individual states, having a unified approach within the EU could be beneficial, treating it as one market with consistent legislation. Information sharing among different countries and stakeholders was also considered crucial. Stakeholders highlighted challenges in obtaining clear information about the current situation regarding asbestos waste. The European Commission could facilitate collaboration and information exchange among EU Member States, creating a more unified approach.

The industry representatives mentioned the importance of support for companies with alternative and innovative asbestos treatment solutions, especially start-ups. Such companies need assistance, especially in terms of financial support and regulatory backing. Industry stakeholders also suggested that the European Commission should help such companies learn more about the market and provide information to bridge communication gaps between different countries. The European Commission was also mentioned as playing a role in building confidence in the industry among Member States. There is the need for confidence in new technologies, especially considering past instances where technologies faced challenges such as high costs or lack of safety legislation. There are also disparities in knowledge about asbestos treatment technologies among different EU countries. The European Commission could play a role in addressing these knowledge gaps and fostering a shared understanding of the dangers of asbestos cement and how to treat it.

The roles of other stakeholders in the implementation of asbestos waste treatment technologies mentioned by industry stakeholders included cooperation and intervention by national governments, support and information sharing by industry players and start-ups, regulatory efforts by authorities, and considerations from the scientific and economic communities. National governments are crucial stakeholders, and their cooperation is deemed essential. Industry stakeholders emphasised the need for government intervention, including the implementation of legislation and policies related to asbestos waste treatment. The openness of national governments to innovation was also highlighted. Industry players, especially those involved in asbestos treatment technologies, play a vital role.

The scientific community was also mentioned as important actor in the development and validation of asbestos treatment processes. Hence, the need for a balanced approach to risk assessment and the importance of considering scientific evidence in regulations was highlighted.

According to other stakeholders, the industry bears the responsibility for ensuring the technical readiness and asbestos-free operation of waste treatment technologies. However, success is contingent on government market organisation and providing supportive frameworks such as certification and economic and legislative incentives, like landfill bans or environmental taxes. Collaboration among researchers, industry, and regulatory authorities was deemed crucial, with government support playing a significant role in promoting technology development. According to stakeholders, the European Commission's role encompasses market organisation, regulatory influence, collaboration facilitation, and support through funding and policies.

Hazardous and disruptive substances and materials

The interviewees mentioned the following hazardous substances found in asbestos-containing waste or other substances and materials that can have a negative effect on the treatment of asbestos waste:

- Heavy metals, particularly in association with asbestos coating or asbestos-containing painting. Examples of heavy metals mentioned include lead, mercury, and cadmium;
- Polychlorinated biphenyls (PCBs) was mentioned as a potential hazardous substance in asbestos-containing materials found in nuclear sites, military bases, and utilities;
- Chromium VI that can be found in cement;
- Polyaromatic hydrocarbons as contaminants in asbestos-containing materials that could influence the treatment process;
- Adhesives, insulation materials, coatings and sealants that can alter the behaviour of asbestos during treatment;
- Organic materials like moss, ivy or other vegetation residues, polyurethane foam or fragments from wooden constructions of roofs or facades can have an impact on the treatment.

One of the interviewees explained that hazardous substances may undergo chemical reactions during treatment processes, leading to unpredictable outcomes and potentially generating toxic by-products. In addition, there is a possibility of unknown substances that could be present in asbestos waste.

Outputs of asbestos waste treatment and the market

The interviewees mentioned the following outputs and products of asbestos waste treatment:

- Sand and cement that can be used in a cement kiln;
- Calcium silicate hydrate that can be used in the cement or concrete industry, paint industry;
- Non-hazardous inert material that can be used as a filler in the cement industry, as "cement" through granulation, as an aggregate in to bricks manufacturing, as a storage of hazardous materials;
- Liquid calcium chloride with two potential valorisations: as a de-icing agent for roads and as an additive for concrete drying;
- Magnesium sulphate found in the liquid phase after treatment that can be further processed to extract magnesium, which is valuable for its characteristics in strength and weight, potentially used in products like smartphones, computers, and cars;
- Silica (crystalline and amorphous) derived from waste products like fibre cement or mineral floor tiles that can replace sand in concrete formulation and be used as a filling product for road construction;
- Mixture of calcium, aluminium, magnesium, silicate, sulphates and oxides resulting from thermal treatment that can be used in cement production;
- Aggregate that can be used in road construction;
- Non-toxic slag generated through high-temperature treatment using a plasma torch on asbestos-containing materials that can be used in construction materials or safely disposed of in specialised landfills;
- Vitrified mineral material from vitrification processes that can be used in construction.

When asked about possible residues or outputs that cannot be reused, the majority of industry stakeholders said that the emphasis was on recycling and reusing materials as much as possible. However, any residues and outputs that cannot be reused are disposed of in suitable landfills or are incinerated.

According to stakeholders, the outputs that are or could be demanded by the market include sand, cement, steel, and copper. The shortage of sand for building materials and the need for metals drive the demand for these materials. The obtained non-hazardous products can potentially be in demand for construction sector if they meet relevant quality and safety standards, providing a good alternative to traditional materials. The main reasons for market demand mentioned by some stakeholders are the carbon-negative or carbon-neutral footprint and the increasing scarcity of raw materials. Also, the material can be cost-competitive compared to virgin material. Availability, technical characteristics, costs, and standard quality would be crucial factors in determining its priority in specific sectors.

The following aspects were considered important for guaranteeing the quality and safety of the end product:

- Certification: establishing a framework and obtaining a certification for asbestos-free products that is widely accepted throughout the European Union and beyond. This certification would serve as a standard and validation, ensuring that the end product is reliable and asbestos-free.
- Constant quality and availability: ensuring a consistent quality of the treated outputs and maintaining availability over time. The product must meet certain standards, and any changes in quality or availability should be carefully managed to meet client expectations.
- Cost and technical characteristics: balancing cost considerations with technical characteristics to make the product economically viable and suitable for various applications. This involves assessing the technical properties of the end product to meet industry requirements.
- Health and safety: prioritising health and safety as a crucial aspect. This involves neutralising and transforming asbestos fibres effectively, reducing the risk of exposure, and minimising health impacts. Compliance with regulatory requirements and standards related to waste management, disposal, and environmental protection is essential.
- Regulatory adherence: adhering to local, national, and international regulations governing the treatment and disposal of waste. This includes compliance with codes and standards to ensure responsible waste management practices.
- Environmental impact: carefully assessing and mitigating the environmental impact of the treatment methods. This involves identifying potential risks to ecosystems and taking appropriate measures to prevent harm to soil, water, or air.
- Long-term stability: considering the long-term stability of the treated materials to prevent potential releases of hazardous substances in the future. Conducting stability testing and evaluations over time ensures continued safety and reliability of the treated materials.
- EU-wide 'End-of-Waste' criteria: advocating for EU-wide 'end-of-waste' criteria, which can facilitate the process by guaranteeing product quality and officially designating waste materials as products. This harmonisation would aid smoother material shipment across different Member States.
- Legislation and standardisation: recognising the importance of legislation and standardisation criteria to shape the industry's perception of these materials. Industry involvement in the development of standardisation criteria at both European and national levels is crucial for ensuring the confidence of all actors in the supply chain.

In summary, a comprehensive approach involving certification, consistent quality, regulatory compliance, environmental impact assessment, and long-term stability testing is crucial to guarantee the quality and safety of end products from asbestos waste treatment processes.

Annex 11 Interviewed Experts

Table A11-1: The list of interviewees	
Last name, first name	**Organisation (Country)**
Bogaert, Kristof	DENUO Belgian federation of the waste and recycling sector (Belgium)
Campanella, Paolo	FEAD European Waste Management Association (EU)
Camus, Nathalie	VALAME (France)
De Mulder, Sven	OVAM (Belgium)
Geoffroy, Valérie	University of Strasbourg (France)
Graham Gould	Thermal Recycling (United Kingdom)
Guichard, Frédéric	De Dietrich (France)
Hofs, Jos	Asbeter (Netherlands)
Krejza, Zdeněk	Research Institute for Building Materials (Czech Republic)
Lenoble, Emmanuel	BlackAsbestos (France)
Lepers, Pierre Emmanuel	VALAME (France)
Nocito, Tony	ABCOV® (United States)
Omari, Kamal	BlackAsbestos (France)
Palomino, Luis	ASEGRE Asociación de Empresas Gestoras de Residuos y Recursos Especiales (Spain)
Postema, Inez	Asbeter (Netherlands)
Reef, Anton	D-Nature (Netherlands)
Sharma, Shelja	Institute of Plasma Physics (Czech Republic)
Staněk, Theodor	Research Institute for Building Materials (Czech Republic)
Urbanová, Petra	Ministry of the Environment (Czech Republic]
van der Burg, Cornelis	Asbeter (Netherlands)
Waterman, Yvonne	European Asbestos Forum (Netherlands)
Windsor, Tony	ARI Global Technologies (United Kingdom)
Zahareva, Roumiana	Faculty of Structural Engineering, UACEG (Bulgaria)

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