

Construction and Demolition Waste Management in

DENMARK

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Screening factsheet

1. Summary

Construction and Demolition Waste (CDW) management national performance

Table 1 Construction and Demolition Waste (CDW) generation (in Mtonnes)

Waste category	2011	2012	2013 ^{iv}
Non-hazardous CDW			
- CDW from buildings	2.42	2.69	2.89
- Soil *)	2.00	2.34	4.18
- Dredging spoils **)	0.004	0.0001	0.0001
Hazardous CDW***	0.76	0.54	0.99
Total CDW	5.19	5.57	8.06

*) excluding soil classified as hazardous.

***) excluding dredging spoils classified as hazardous

****) exclude waste class 17 06 06

^{iv}) not yet official data

In 2013, 2.89 million tonnes of Construction and Demolition Waste (CDW) under Chapter 17 according to the List of Waste, excluding soil, were reported as received at the registered CDW management sites by the Danish Environmental Protection Agency (EPA) in Denmark. The amount of CDW in 2013 represents a 7 % increase compared to 2012 (2.69 million tonnes). Forecasts based on economic indicators for the year 2030 have been estimated for two scenarios: business as usual (BAU) and new resource strategy implemented. The CDW amount is expected to increase in the BAU scenario about 43% from 2012 to 2030 and in the scenario with the new strategy implemented correspondingly 47%.

The waste resource management plan for 2013-2018 published by the Danish EPA focuses on the quality of recycling of CDW. The main focus is to ensure that recycling of CDW does not cause contamination of the environment and at the same time to maintain a high recycling rate. To achieve this, several initiatives are planned or carried out regarding identification, separation and safe handling of problematic substances in buildings before demolition, requirements regarding the qualifications of demolition companies, more stringent requirements for selective demolition of larger buildings, and improving the scientific basis for the future revision of the regulation of recycling of CDW. Today, high recycling rates are obtained in Denmark (86% in 2012), which is mainly due to using crushed concrete and bricks as unbound filler, and is a result of a longstanding focus on recycling of CDW in Danish waste plans, a weight-based landfill tax, and the possibility for recycling CDW without a specific permit under the Environmental Protection Act, provided the CDW is sorted, unpolluted and processed. Focus in the Danish resource plan 2013 - 2018 is also to improve the quality of CDW. Studies on new technologies aiming for high-grade recycling are carried out or planned for specific waste streams (concrete, bricks, wind turbine blades, impregnated wood, district heating pipes, tar paper). Denmark is aiming at maintaining high recycling rates; however, it may be necessary to accept higher disposal rates for CDW in order to eliminate hazardous substances from the waste. The Danish waste resource management plan for 2013-18 includes an initiative to reach the 70% target by 2018.

In 2015, the former Danish Government published a strategy for waste prevention.

As CDW may contain problematic substances, reuse and recycling of CDW must be handled in a way that ensures that health and the safety of buildings are not adversely affected. The construction and renovation of buildings and structures involve many different stakeholders, e.g. producers of construction products, contractors and architects. Cooperation between them is essential in order to optimize recycling of resources in CDW.

The former government's goal is to make it easier for the construction industry to act more resource efficiently, and to improve knowledge sharing across the sector as well as the safe handling of problematic substances in CDW.

The following initiatives are, amongst others, included in the strategy:

- A partnership on sustainable building and waste prevention between key stakeholders

- Development of a volunteer system for sustainability classes for buildings to supplement requirements in building regulation
- A partnership on substitution of chemicals, to enhance sustainable use of chemicals in buildings and building materials
- Partnership for green procurement to support demand of recycled material and new ways to build and demolish
- Tools for estimation of total economics for building (life-cycle costing).
- Analysis of the barriers to recycling of construction products and analysis of resource flows.

CDW management practices

CDW can be recycled without a specific permit under the Environmental Protection Act, provided the CDW is sorted, unpolluted and processed, which together with a weight-based tax on landfill, have promoted recycling of CDW in Denmark. The recycling rate for CDW in Denmark is high and the EU 70% recycling target is already exceeded. The major part of the CDW is mineral waste (concrete waste, bricks) which is currently used as aggregate in roads, parking areas or in embankments.

Table 2 CDW management

Waste category	2011	2012
Recycling	84%	86%
Incineration	8%	6%
Landfilling	8%	7%
Temporary storage	1%	0%

Several activities and actions relate to the improvement of the quality of CDW recycling through identification and sorting of problematic substances, stricter requirement for selective demolition, requirements regarding qualifications of demolition companies and improving the scientific basis for revising regulations on CDW recycling are implemented, in progress or planned.

Members of the Danish Construction Federation are obliged to follow the requirements for selective demolition (NMK96), developed in cooperation with the Environmental Protection Agency. However, this only concerns the members of NMK, representing a minor part of the Danish waste industry.

The Danish Waste Competence Centre, Dakofa, an organization sponsored by different waste management stakeholders, is an important player in the promotion of sustainable CDW management in Denmark and enables dialogue between legislators, consultants and construction and demolition companies. Dakofa arranges workshops, conferences and seminars and establishes working groups collecting information and views on sustainable CDW recycling. The network is working to establish and lay out a common understanding of best practice for sustainable recycling of CDW.

Main obstacles to sustainable CDW management

- Efforts needed to ensure that recycling of CDW does not cause contamination of the environment and to monitor compliance with legislation. Not only environmental properties but also technical properties must be proven for the application in order to fulfil the requirements.
- A high risk of dilution of contaminants if several waste streams of different origin are mixed without information on CDW quality (i.e. occurrence of problematic substances and materials).
- Limited demand for reused and recyclable CDW.
- Lacking practice for coordination of demolition activities between demolition companies, contractors, waste treatment companies, constructors, end-users. Matching requires good planning and time. Collaboration between stakeholders is needed in order to close the material loop.
- Lack of knowledge of high-level recycling technologies. Currently, knowledge of recycling possibilities among key stakeholders is lacking.
- Missing opportunities for CDW recycling and marketing of recycled products and logistic optimization (reasonable transport distance, availability of processing equipment and technologies (e.g. crushers), possibilities for temporary storage, etc).

Main drivers to sustainable CDW management

- Economic and regulatory conditions that enhance sustainable CDW management.
- Business opportunities for secondary resources (CDW).
- Recycling of CDW reduces energy and CO₂ emissions from production of construction materials and saves natural resources.
- Support for business networks with developers, contractors, etc. to create innovative solutions and new business for CDW recycling.

- Certification of new buildings that covers assessment of the whole life cycle of the building, including end of life and therefore CDW.
- Prolonging of the lifetime of constructions and thus reducing CDW generation.
- Cost savings and resource saving (energy, raw materials) through development of prefabricated elements that can be reused.
- Improved attention of building owners, architects and consulting engineers to recycling of CDW as an easy and important element of sustainable buildings, and contribution to the certificate score, e.g. DGNB.
- Exploitation of opportunities for matching demolition and CDW production with supply of materials for new buildings and construction.

2. Definitions concerning Construction and Demolition Waste (CDW) and Management

In this section the definitions of waste used in Denmark are presented.

2.1. Definition of waste

The definition of waste in Denmark is given in the Statutory Order no. 1309/2012 on waste (Affaldsbekendtgørelsen, BEK 1309: 2012) and is identical to the definition in the Waste Framework Directive 2008/98/EC.

2.2. Definition of construction and demolition waste (CDW)

The definition of CDW in Denmark is given in the Statutory Order no. 1309/2012 on waste (Affaldsbekendtgørelsen, BEK 1309: 2012) as follows: 'Construction and demolition waste' means waste from new construction and repairs and demolition of buildings or other fixed structures, civil engineering work or other corresponding construction.

There is not a clear distinction between construction and demolition wastes (e.g. in Denmark CDW is waste from demolition of buildings and constructions such as bridges and roads).

The Commission Decision on the list of waste (2000/532/EC) is implemented in the Statutory Order no. 1309/2012 on waste (Affaldsbekendtgørelsen, BEK 1309: 2012).

2.3. End-of-Waste (EoW) status

There are no national EoW criteria set for any types of waste so far, and at the moment there is no preparatory work ongoing.

2.4. Definitions of waste treatment operations

The definitions of preparing for re-use, re-use, recycling and recovery in the Danish Statutory Order no. 1309/2012 on waste are identical with the definitions in the Waste Framework Directive (WFD).

The categorization of recovery operations (R1 to R14) in Denmark is given in Annex 5 B of the Statutory Order no. 1309/2012 on waste (Affaldsbekendtgørelsen, BEK 1309: 2012) and this is identical to the categorization of Annex II of the WFD.

There is no legislative definition for backfilling in Denmark, nor any official classification code for backfilling

3. Legal Framework – Waste Management Plans and Strategies

In this section the legal framework governing CDW management in Denmark is presented.

3.1. Legislation concerning CDW in Denmark

The Danish rules for recycling of CWD are laid down in the Environmental Protection Act no. 879 26/06/2010, Statutory Order no. 1309/2012 on waste, Statutory Order no. 1662/2010 on recycling of residual products and soil in building and construction work, and on the recycling of sorted, unpolluted CDW, and Circular of 15 July 1985 on the use of crushed asphalt in road-construction.

A permit is required under the Environmental Protection Act to recycle CDW that can contaminate groundwater, soil and subsoil. Assessing whether recycling of CDW is permissible under the Environmental Protection Act §§19 or 33 is carried out by the municipal authorities.

The Statutory Order on waste stipulates that waste-producing companies must always separate hazardous waste, PCB-containing waste and double glazing from their CDW, and that CDW has to be sorted on-site or at authorized sorting facilities. CDW shall as a minimum be separated into the following ten waste fractions:

1. Natural stone, e.g. granite and flint

2. Non-glazed tiles (bricks and roof tiles)
3. Concrete
4. Mixtures of stone materials, and non-glazed tiles and concrete
5. Iron and metal
6. Gypsum
7. Rock-wool
8. Soil
9. Asphalt
10. Mixtures of concrete and asphalt

When sorting at the source of fractions 1 to 4, it must be ensured that all other than mortar and possibly reinforcement iron has been removed and handled separately, and that PCB-containing sealant materials have been identified, removed and handled separately. Double-glazed windows have to be removed and handled separately (re-used, prepared for re-use or recycled, and if that is not possible destroyed or landfilled). Sorting on-site may be omitted if the total amount of waste from the construction and demolition operation in question is less than 1 tonne, or if the physical conditions render on-site sorting impossible. In those cases, sorting may take place at a stationary sorting facility approved by the municipality.

Waste-producing companies must, furthermore, ensure that significant parts of their source-separated waste are prepared for reuse, recycled or used for other final material recovery.

Before a demolition or renovation work is started, the developer must undertake a screening in order to assess whether buildings or structures (e.g. bridges) contain PCBs. The screening requirement applies to all buildings and structures that are built or renovated in the period from 1950 to 1977, demolition or renovation work that concerns more than 10 m² or produces more than 1 tonne of waste. If the initial screening indicates that there is a risk that the building or structure - including double glazing - can contain PCBs, the developer must undertake a mapping of the parts of the building that may contain PCBs. The result of PCB-screening or mapping must be notified to the municipality no later than two weeks before the demolition or renovation begins. The notification must also include information on the amounts of waste and waste types, with and without PCBs, produced by the demolition or renovation work as well as information on how the waste will be handled.

Local councils shall lay down regulations for handling municipal CDW and through inspections ensure compliance with the Statutory Order.

CDW can be used, without a specific permit under the Environmental Protection Act, provided that conditions, stipulated in Statutory Order no. 1662/2010 on recycling of residual products and soil in building and construction work and on recycling of sorted, unpolluted CDW, are met. Waste sorted into fractions 1–7 listed above can thus be prepared for reuse, provided it is “uncontaminated”. Waste is sorted into fractions 1–4 listed above can be used for construction purposes provided the CDW is processed and uncontaminated. In the Statutory Order, uncontaminated CDW is defined as CDW for which it can be assumed, with a high degree of certainty, that the waste does not contain polluting materials or substances to such an extent or of such a nature and concentration that the use of the waste may have an adverse impact on the environment or human health. The waste must therefore not contain polluting substances, including substances that can cause contaminating release into soil or groundwater, e.g. impregnated wood, PCB-containing sealants, tar, soot, remains of paint and lacquer.

CDW containing PCB is classified as either hazardous or non-hazardous waste, depending on the PCB content¹:

- CDW containing above 50 mg PCB₇ *5/kg is regarded as hazardous waste and shall, according to the POP’s regulation, be destroyed, e.g. by incineration in a hazardous waste incinerator or stored permanently and safely deep underground
- CDW containing less than 50 mg PCB₇ *5/kg is regarded as non-hazardous waste. Combustible waste should preferably be destroyed in incinerators that are authorized to incinerate the PCB-

¹ <http://www.pcb-guiden.dk/g>

containing non-hazardous waste. Other waste or waste which is difficult to handle in incinerators (e.g. large amounts of concrete) may, according to the POP's regulation, also be landfilled.

CDW considered as not contaminated with PCB can be used according to Statutory Order no. 1662/2010 on the recycling of residual products and soil in building and construction work and on the recycling of sorted, unpolluted CDW. The local authorities (the municipality) have the duty to assess whether the waste should be considered not contaminated with PCB. A limit value of 0.1 mg PCB/kg is currently used as a guideline value. However, the Danish authorities are working on establishing a national limit value for PCB in CDW. A proposal with a limit for PCB content is currently circulated for comments (situation July 2015).

Concentration levels of PCB are to be determined according to EN 15308. The limit values are specified as PCB total, i.e. measurement of the seven selected congeners to be included in the analysis according to the standard, multiplied by a correction factor of 5.

Soil can be recycled according to Statutory Order no. 1662/2010 on recycling of residual products and soil in building and construction work and on recycling of sorted, unpolluted CDW.

According to the Circular of 15 July 1985 on the use of crushed asphalt for road-construction², crushed asphalt can be used for road-construction and road-like constructions without a specific permit under the Environmental Protection Act. It is expected that the circular will be revised, when the scientific basis for this is finalized, in the near future.

A mixture of concrete and asphalt can be recycled according to the Circular of 15 July 1985 on the use of crushed asphalt for road construction, etc., provided that the concrete is uncontaminated.

In Denmark, there is since 1997 a "ban" on landfilling of waste suitable for incineration³.

Statutory Order no 719/2011 on landfills (Bekendtgørelse nr. 719 af 24. June 2011 om deponeringsanlæg) gives procedures for the acceptance of waste at landfills. It also restricts the disposal of asbestos- and gypsum-based waste on landfill and gives limits for PCB content for specific landfill classes.

Legislation or regulatory work in progress:

- The Danish EPA is working on establishing a national limit value for PCB in CDW.

3.2. Waste Management Plans (WMP) and Strategies

In 2013, the Danish Government published a plan entitled 'Denmark without waste – Recycle more, incinerate less'. The plan contains the former government's overall objectives for waste management in Denmark within the next 10 years. The main focus of the plan is to consider waste as a resource to be recycled. The plan addresses, amongst other topics, quality in recycling construction and demolition waste. The following text is an extract from the plan:

- CDW constitutes by far the largest share of the total waste volume. About 86 % of CDW is recycled.
- Part of construction and demolition waste contains hazardous substances. Therefore, it is important to remove these substances to prevent contamination of the environment and be aware of new substances in CDW which may pose a risk for the environment and health. Consequently, initiatives on substances of concern in waste must be supplemented by measures in a new chemicals initiative, amongst other things to ensure that chemicals in building products do not prevent or complicate future recycling, and focus on making it possible for materials and products to return to the resources cycle.
- PCB is a hazardous substance for the environment and health. The initiatives regarding waste in the 2011 PCB Action Plan are being implemented so that construction and demolition waste containing PCB is managed to ensure better quality of recycled CDW.
- The Resources Strategy therefore focuses on the aims of the PCB Action Plan to improve the quality of recycling CDW. There is a need to improve management of the often mixed waste materials. There is also a need to secure better quality of the CDWs which are crushed and used as a substitute for gravel and stone in roads. This may imply that recycling of CDW will drop for a period. This drop has already been apparent over the last couple of years in line with increasing awareness

² Asphalt Circular (1985) Cirkulæreskrivelse om anvendelse af opbrudt asfalt til vejbygningsformål m.v.

³ Fischer, C. 2012. From land filling to recovery – Danish waste management from the 1970s until today.

of PCB. In the long term, the recycling rate shall increase, but such that it does not contaminate the environment with hazardous substances.

- However, there are also other substances harmful to the environment in CDW, which provides potential for better and safer recycling. District-heating pipes comprise an iron core which is insulated with plastic foam. From the 1960s and up to 2002, the plastic foam was produced using halogenated hydrocarbons such as CFCs (e.g. freon). When the plastic foam in the district-heating pipe is treated, technology should be applied which collects the ozone-depleting gas and helps alleviate the greenhouse effect. In the coming years it is expected that many small wind turbines will be replaced with larger wind turbines, and there is thus a need to look at how best to ensure that waste wind turbine blades can be used as a resource.

The first national waste plan (1993-1997) was developed in 1992 and included also specific initiatives for recycling of CDW. In the subsequent waste plans for 1998-2004, 2005-2008 and 2009-2012, the recycling targets were revised and also waste prevention and actions diverting generated waste from landfills were addressed.⁴

In 2014, the Danish EPA published the fifth plan (“waste resource management plan”) for 2013-18⁵ which, together with the municipal waste plan, constitutes the Danish waste plan. The following initiatives are listed in the Danish EPA’s waste resource management plan for 2013-18 in order to improve the quality of recycling CDW:

- A limit value for PCB in recyclable CDW will be established (A proposed PCB limit value is in public consultation July 2015).
- Update of guidance for sorting of PCB-containing CDW (An inter-ministerial PCB guidance is established on-line, a guide on handling PCB-containing double glazing is published, a guide on handling small PCB-containing capacitors is published).
- Screening and potentially mapping of PCB in buildings before renovation or demolition (PCB-screening/-mapping requirements are included in the statutory on waste).
- Notification requirements regarding expected amounts of waste, waste fractions and waste handling prior to renovation or demolition of buildings and structures. (Notification requirements are included in the statutory on waste).
- Requirements for the qualifications of demolition companies.(Planned).
- Stricter requirements for demolition of buildings to enable a better and more comprehensive overview of the materials and substances contained in building waste/requirement on selective demolition for larger buildings.(Planned).
- Revision of the regulation on recycling of concrete and bricks (The scientific basis for a revision of the regulation is in progress).
- Revision of the regulation on recycling of asphalt. (The scientific basis for a revision of the regulation is nearly completed).
- Study on potential to use concrete waste in high-grade application (e.g. in production of new concrete). (Results of a study into the possibilities of using concrete waste are published).
- Advantages and disadvantages in new treatment requirements for bricks and impregnated wood. (Analysis is under preparation).
- Possibilities for sorting of roofing felt for recycling.
- Support for recycling of end-of-life wind-turbine blades and investigation of the advantages and disadvantages of introducing treatment requirements for end-of-life wind-turbine blades. (Studies on options to utilize wind turbine blades are published, more studies are under preparation).
- Investigation of the advantages and disadvantages of introducing treatment requirements for district-heating pipes. (Analysis is under preparation).

In addition to environmental and socio-economic aspects, assessment of the advantages and disadvantages of introducing new treatment requirements will focus on whether possible requirements will incur increased costs for businesses.

In 2015, the former Government published a strategy⁶ for waste prevention. As CDW may contain problematic substances, reuse and recycling must be handled in a way that ensures that health and the

⁴ Fischer, C. 2012. From land filling to recovery – Danish waste management from the 1970s until today.

⁵ Danish EPA (2014). Danmark uden affald. Ressourceplan for affaldshåndtering 2013-2018.

⁶ Danish Government (2015). Danmark uden affald II. Strategi for affaldsforebyggelse. Document for consultation: a strategy for waste prevention. http://mst.dk/media/131357/danmark_uden_affald_ii_web_29042015.pdf.

safety of buildings are not adversely affected. The construction and renovation of buildings and structures involves many different stakeholders, e.g. producers of construction products, contractors and architects. Cooperation between them is essential in order to optimize recycling of resources in CDW.

The former government's goal is to make it easier for the construction industry to act more resource efficiently, and to improve knowledge sharing across the sector as well as the safe handling of problematic substances in CDW.

The following initiatives are, amongst others, included in the strategy:

- A partnership on sustainable building and waste prevention between key stakeholders.
- Development of a volunteer system for sustainability classes for buildings to supplement requirements in the building regulation.
- A partnership on substitution of chemicals to enhance the sustainable use of chemicals in buildings and building materials.
- Partnership for green procurement to support demand of recycled material and new ways to build and demolish.
- Tools for estimation of total economics for building (life-cycle costing).
- Analysis of the barriers to recycling of construction products and analysis of resource flows.

3.3. Legal framework for sustainable management of CDW

This section aims at identifying specific legislation that would create good conditions for a sustainable management of CDW as a preliminary overview for Task 3. Legal framework for sustainable management of CDW is included in legislation concerning CDW cf. 3.1.

Table 3 Legal framework

Description	Level of occurrence (Yes/No) Key Scope/Exemptions	Year established and policy reference	Further details, information source, related web-site
<i>National/ regional obligation for selective demolition?</i>	Yes Nation legislation, which demands selective demolition of all buildings owned by the government, is carried out according to the guidelines laid down in NMK96.	1997 The government's Action Plan for Waste and Recycling 1993-97	Bekendtgørelse nr. 282 af 18/04/1997 om selektiv nedrivning af statsbygninger https://www.retsinformation.dk/Forms/R0710.aspx?id=84458 To be revised or supplemented cf. The Governments PCB-action plan 2011, and the Resource Plan for Waste Management 2013 – 2018 http://pcb-guiden.dk/file/186399/handlingsplan.pdf http://www2.mst.dk/Udgiv/publikationer/2014/05/978-87-93178-55-7.pdf The future requirements are expected to include more buildings and contain requirements for competences (demolition companies) Contractors, who are members of the Danish Building Society, are obliged to follow NMK96 Guidelines for selective demolition. http://mst.dk/media/mst/70262/NMK-96_01.pdf
<i>National/ regional obligation (on-site or in sorting facility)?</i>	Yes National legislation which demands sorting of CDW on-site or at registered sorting facilities	1995 The government's Action Plan for Waste and Recycling 1993-97	OLD: Cirkulære om kommunale regulativer om sortering af bygge- og anlægsaffald med henblik på genanvendelse, nr 94, 21. juni 1995 (Obsolete) https://www.retsinformation.dk/Forms/R0710.aspx?id=49070 Requirements for sorting CDW are now included in bekendtgørelse om affald nr. 1309, 18/12/2012. https://www.retsinformation.dk/Forms/R0710.aspx?id=144826 CDW from business, which is suitable for recycling, shall as the starting point be sorted at source, but may also be sorted at a registered sorting facility. CDW from households and CDW from business, which is not suitable for recycling, must be deposited at the municipal recycling centre. Objectives and instruments regarding CDW have been part of governmental/ministerial waste management plans at least since 1993. The most recent plan is the Resource Plan for Waste Management 2013 – 2018. http://www2.mst.dk/Udgiv/publikationer/2014/05/978-87-93178-55-7.pdf
<i>National/ regional separate collection obligation for different materials (iron and steel, plastic, glass, etc.)?</i>	Yes National legislation stipulates that municipalities must, establish schemes for collection of a number of waste fractions.	The government's Action Plan for Waste and Recycling 1993-97 – and earlier	OLD: Cirkulære om kommunale regulativer om sortering af bygge- og anlægsaffald med henblik på genanvendelse, nr 94, 21. juni 1995 (Obsolete) https://www.retsinformation.dk/Forms/R0710.aspx?id=49070 Requirements for separate collection of different materials are included in bekendtgørelse om affald nr. 1309, 18/12/2012. https://www.retsinformation.dk/Forms/R0710.aspx?id=144826

Description	Level of occurrence (Yes/No) Key Scope/Exemptions	Year established and policy reference	Further details, information source, related web-site
			<p>Municipalities must offer systems for collection of:</p> <p>Natural stone, e.g. granite and flint, non-glazed tiles (bricks and roof tiles), concrete, mixtures of stone materials, and non-glazed tiles and concrete, iron and metal, gypsum, rockwool, soil, asphalt, mixture of concrete and asphalt, glass, plastic, PVC, impregnated wood and hazardous waste.</p> <p>Objectives and instruments regarding CDW have been updated in the subsequent waste management plans. The most recent plan being: Resource Plan for Waste Management 2013 – 2018. http://www2.mst.dk/Udgiv/publikationer/2014/05/978-87-93178-55-7.pdf</p>
<i>Obligation for separate collection and management of hazardous waste from C&D operations?</i>	Yes National legislation which aims at separating CDW suitable for recycling and separate hazardous waste.	The government's Action Plan for Waste and Recycling 1993-97	<p>OLD: Cirkulære om kommunale regulativer om sortering af bygge- og anlægsaffald med henblik på genanvendelse, nr 94, 21. juni 1995 (Obsolete) https://www.retsinformation.dk/Forms/R0710.aspx?id=49070</p> <p>Only uncontaminated CDW can be recycled under statutory order on recycling of residual product, without a specific permit under the Environmental Protection Act, which implies that contaminated CDW must be separated from uncontaminated CDW.</p> <p>Requirements for separate collection and management of hazardous waste from C&D operations are included in bekendtgørelse om affald nr. 1309, 18/12/2012. https://www.retsinformation.dk/Forms/R0710.aspx?id=144826</p> <p>The statutory of waste requires that:</p> <ul style="list-style-type: none"> • hazardous waste is separated from non-hazardous waste and handled as hazardous waste. • buildings and structures are screened for PCB prior to renovation and demolition, and that PCB-contaminated materials/waste are separated and handled according to the POP Regulation.
<i>Related Green public procurement requirements</i>	n/a	n/a	n/a

3.4. Targets

The overall goal is to obtain a better quality of recycled CDW and at the same time maintain a high recycling rate, cf. Danish Waste Resource Management Plan for 2013-18⁷. This means that contamination of the environment with harmful substances in CDW shall be limited by raising the quality of recycled CDW and that at least 70% of the total amount of CDW shall be recycled.

The targets shall be obtained by revising the legislation on recycling of CDW when the scientific basis is established. An inter-ministerial report regarding mapping of PCB in Danish buildings is published, while reports on the scientific basis for recycling of asphalt, concrete and brick are respectively published and in preparation.

Other targets are to increase the reuse and recycling of concrete and reuse of bricks. The first steps are to investigate opportunities and barriers. A report on the possibilities for reuse and recycling of concrete and a Life Cycle Assessment (LCA) regarding the reuse of bricks are published. A socio-economic analysis on recycling brick is under preparation.

Finally, the advantages and disadvantages of different forms of recycling of impregnated wood, and possibilities for recycling of wind turbine blades and district-heating pipes shall be examined. A report on recycling impregnated wood and a number of reports on recycling wind turbine blades are published.

4. Non-legislative instruments

In this section, any other instruments that may specify how the country is addressing the question of CDW management are highlighted, especially as a preliminary overview for Task 3, as these instruments might create conditions for sustainable management of CDW.

⁷ -Danish EPA (2014). Danmark uden affald. Ressourceplan for affaldshåndtering 2013-2018.

Table 4 Non legislative instruments

Description	Level of occurrence (Yes/No) Key Scope/Exemptions	Year established and policy reference	Further details, information source, related web-site
<p>Landfill tax</p> <p>Lov om afgift af affald og råstoffer (affalds- og råstofafgiftsloven), jf. lovbekendtgørelse nr. 311 af 1. april 2011.</p>	<p>The current landfill tax in Denmark is DKK 475 /tonne (EUR 64 /tonne). Typical landfill fee for recyclable materials is around DKK 366 /tonne (EUR 49 /tonne). The taxation has promoted the development of recycling technologies and decreased the amounts to be landfilled. Landfill of hazardous waste was formerly excluded from the tax but has since 2010 been integrated in the taxing system. After 1.1.2015 where the taxes for the hazardous waste is the same as the regular landfill tax of DKK 475 /tonne.</p>	<p>1987</p>	<p>EEA report, 2012⁸ : http://scp.eionet.europa.eu/publications/WP2012_1/wp/WP2012_1</p>
<p>Sustainability standards that cover CDW (e.g. BREEAM)</p>	<p>Yes</p> <p>DGNB is the certification system used by the Danish Green Building Council for certification of sustainable buildings in Denmark. The certification of new buildings covers assessment of the whole life cycle of the building, including end-of-life and therefore CDW.</p>	<p>The DGNB system was chosen in 2011. It was adopted and the first pilot projects were certified in 2012.</p>	<p>http://www.dk-gbc.dk/english.aspx</p>

⁸ Fischer, C. et al. (2012). Overview of the use of landfill taxes in Europe

Description	Level of occurrence (Yes/No) Key Scope/Exemptions	Year established and policy reference	Further details, information source, related web-site
Public sector sustainability standard that covers CDW	<p>There is no official Danish sustainability standard for buildings for the public sector. However, the Energy Agency has launched a free-of-charge Life Cycle Assessment (LCA) tool for buildings, that covers the whole life cycle of the building, including end-of-life.</p> <p>Furthermore, the Energy Agency has issued the publication Bæredygtigt byggeri – or Sustainable building – which includes guidance on the importance of including the whole life cycle of the building, including the CDW and considerations about resources and recycling.</p>	<p>The LCA tool was launched in April 2015</p> <p>The publication on Sustainable building was published in April 2015</p>	<p>http://www.ens.dk/livscyklusvurdering http://www.lcabyg.dk/ http://www.ens.dk/byggepolitisk-strategi</p>

Table 5 Key CDW management requirements and standards

Description	Occurrence (Yes/No) Mandatory (Yes/No) Scope & exemptions	Year established	National or regional (specify if regional)	Details of Public sector and Industry enforcement/ involvement/ collaboration	Levels of performance e.g. tonnes recycled,% coverage	Further information/ web-site
Requirement for pre-demolition audits	No	n/a	n/a	n/a	n/a	n/a
Quality criteria for recycling of crushed concrete aggregates as unbound road base by Danish Road institute	Yes	2004	National	n/a	n/a	DRD, 2004a (see reference list)
Technical guidelines on the use of reclaimed asphalt in unbound application by the Danish Road Directorate	Yes	2011	National	n/a	n/a	DRD, 2011
Selective demolition/ plan for large demolition sites/demolition standard	No	n/a	n/a	n/a	n/a	n/a
Other CDW planning requirements	Yes, PCB screening and mapping before demolition	2012	National	The municipalities demand an environmental screening of buildings, which is described in a district plan	n/a	SBi-anvisning 241 SBI-anvisning 242

Table 6 Key CDW management guidance and tools

Description of guidance/ tool	Scope	Year established/ produced	National or regional (specify if regional)	Public sector and/or Industry lead organisation	Levels of use (high/ medium/low) or specify	Further information/ web-site
NMK96 : Demolition of buildings, requirement NMK 96 (private control agreement on demolition) www.danskbyggeri.dk	Guidelines provided by the industry.	1996	National	Industrial	n/a	http://www.nedbrydningssektionen.dk/kontrolordningen/nmk96
Guidance on demolition Sbi-guidance 171 (Sbi-anvisning - Nedrivning af bygninger og anlægskonstruktioner)	Basic information for demolition of buildings	1991	National	National	n/a	http://anvisninger.dk/anvisninger/Pages/171-Nedrivning-af-bygninger-og-anlaegskonstruktioner-1.aspx http://www.sbi.dk/byggeteknik/konstruktioner/serlige-konstruktioner/sbiintroside.2006-01-12.9822060673
PCB-guide (internet platform)	Information on management of PCB-containing waste	web updated continuously	National	National	n/a	http://pcb-guiden.dk/fakta-om-pcb

Table 7 Technical guidelines/standards/ Codes of Practice for use of CDW in construction application

Description of guidance/ tool	Scope	Year established / produced	National or regional (specify if regional)	Public sector and/or Industry lead organisation	Levels of use (high/ medium/low) or specify	Further information/ web-site
Vejdirektoratet (the Danish Road Directorate): technical guidance on use in unbound road sub-base	Use of crushed concrete and bricks in sub-base: standards, requirements, construction and control	2011	National	National	Unknown	Report entitled "Vejoverbygning ubundne bærelag af knust beton og tegl. Vejledning" http://www.ythat.dk/wp-content/uploads/Vejledning-Knust-beton-og-tegl-2011.02.pdf
Vejdirektoratet (the Danish Road Directorate): technical guidance on use in unbound road sub-base	Use of granulated asphalt in unbound application	2004	National	National	Unknown	Report entitled « Ubundne bærelag af knust beton - efter europæiske standarder » http://www.vejdirektoratet.dk/DA/viden_og_data/publikationer/Lists/Publikationer/Attachments/286/rap132vi.pdf
The Danish Road Institute: Guidelines (2004)	Use of crushed concrete aggregates as unbound road base materials	2004	National	National	Unknown	DRD. (2004). Ubundne bærelag af knust beton – efter europæiske standarder (Unbound base courses of crushed concrete – after European standards). Danish Road Directorate (in Danish) http://www.statensnet.dk/pligtarkiv/fremvis.pl?vaerkid=35128&repid=1&iarkiv=1
Recycling and reuse of concrete waste – technology review (Literature survey, in Danish)	Study on current and future technological possibilities to reuse and recycle concrete in order to establish whether concrete waste may be reused/recycled in a more sustainable way in the future	2015	National	National	Unknown	Udredning af teknologiske muligheder for genbrug og genanvendelse af beton http://www2.mst.dk/Udgiv/publikationer/2015/04/978-87-93352-03-2.pdf

Description of guidance/ tool	Scope	Year established / produced	National or regional (specify if regional)	Public sector and/or Industry lead organisation	Levels of use (high/ medium/low) or specify	Further information/ web-site
Board established under the Danish Road Directorate (« Vejreglerådet Vejregel ») Dimensionering af befæstelser og forstærkningsbelægninger.	The Danish Pavement Design Guide -Tools	Vejreglerådet (2007)	National	National	Unknown	http://www.trg.dk/B3/Bolet/VR03_G_Dimbef_Vejrgl.pdf
Råstofforsyning i Danmark – sand, grus og sten. Rapport 163.	Mapping of the raw material supply of sand, gravel and stones in Denmark for roads, construction and additives for concrete	Vejteknisk Institut (2008)	National	Public	Unknown	http://rs.viewer.dkplan.niras.dk/media/1070/raastofforsynin-g-i-danmark-sand-grus-og-sten_vi-163_2008.pdf

Table 8 Other CDW initiatives

Description of initiative	Scope	Year established	National, regional, local (specify which local area/region)	Public sector and/or Industry lead organisation	Levels of performance e.g. tonnes recycled	Further information/ web-site
Danish EPA: initiatives for CDW management (published in waste management plan)	Quality of CDW	2013, 2014, 2015	National	Danish EPA	70 % by 2018	http://blogs.ec.europa.eu/orep/denmark-without-waste-recycle-more-incinerate-less/ http://mst.dk/service/publikationer/publikationsarkiv/2014/maj/danmark-uden-affald/ http://mst.dk/media/131357/danmark_uden_affald_ii_web_29042015.pdf
TemaNord 2013:533. Proposals for targets and indicators for waste prevention in four waste streams	Providing first proposals for targets and indicators that can be used in the Nordic countries' waste prevention programmes	2013	Nordic	Nordic Council of Ministers		http://dx.doi.org/10.6027/TN2013-533

5. CDW management performance – CDW data

In this section, the performance of CDW management in Denmark is explored. This section particularly seeks to gather all available data and information about CDW generation and treatment, exports/imports, and treatment facilities in Denmark.

Summary - CDW generation and recovery statistics

In the following table, a summary of CDW generation is presented. It should be noticed that the figures in Table 9 include both soils and hazardous waste.

Table 9. Summary of CDW generation including soils based on statistics.^{9, 10}

Year	2008	2009	2010	2011**	2012**	2013** and ***
Generated CDW (Mtonnes)	6.01*	4.97*	n/a	5.19	5.57	8.06
Recycled CDW (tonnes)	n/a	n/a	n/a	n/a	n/a	n/a
Backfilled CDW (tonnes)	n/a	n/a	n/a	n/a	n/a	n/a
Landfilled CDW (tonnes)	n/a	n/a	n/a	n/a	n/a	n/a
Energy recovery (tonnes)	n/a	n/a	n/a	n/a	n/a	n/a

* These figures are based on official statistics taken from Danish EPA 2011

** Live data downloaded on June 11, 2015 from ADS

*** The statistics of year 2013 not yet officially published.

The following table presents the generation of CDW as well as the division between soil, spoils and hazardous CDW.

Table 10 Summary of CDW generation, soil, dredging spoils and hazardous CDW based on statistics.^{11, 12}

Year	2008	2009	2010	2011 ^v	2012 ^v	2013 ^{v and vi}
Generated CDW (Mtonnes)	n/a	n/a	n/a	2.42	2.69	2.89
Soil*	n/a	n/a	n/a	2.00	2.34	4.18
Dredging spoils**	n/a	n/a	n/a	0.004	0.0001	0.0001
Hazardous CDW***	n/a	n/a	n/a	0.76	0.54	0.99
Total	6.01^{iv}	4.97^{iv}	n/a	5.19	5.57	8.06

* Excluding soil classified as hazardous.

** Excluding dredging spoils classified as hazardous.

*** Excluding waste class 170606

^{iv} These figures are based on official statistics taken from Danish EPA 2011

^v Live data downloaded on June 11, 2015 from ADS

^{vi} The statistics of year 2013 not yet officially published.

⁹ Danish EPA, 2011. Affaldsstatistik 2009 og Fremskrivning af affaldsmaengder 2011-2050.

¹⁰ Danish EPA, 2015. Waste statistics for 2011, 2012 and 2013. Data downloaded June 11, 2015 the National Waste System (Affaldsdatasystemet - ADS).

¹¹ Danish EPA, 2011. Affaldsstatistik 2009 og Fremskrivning af affaldsmaengder 2011-2050 (ISAG-system).

¹² Danish EPA, 2015. Waste statistics for 2011, 2012 and 2013. Data downloaded June 11, 2015 the National Waste System (Affaldsdatasystemet - ADS).

Table 11 Summary – CDW generation for specific waste types including hazardous waste according to the live data downloaded 11.6.2015 from ADS.¹³

Year	2012
Mineral waste from construction and demolition (tonnes)	2 465 789
Metal wastes, ferrous (tonnes)	225 179
Metal wastes, mixed ferrous and non-ferrous (tonnes)	30 701
Metal wastes, non-ferrous (tonnes)	25 124
Glass wastes (tonnes)	7 163
Plastic wastes (tonnes)	7 823
Wood wastes (tonnes)	40 993
Total (tonnes)	2 802 772

Due to the different classification in Tables 10 and 11, the total quantity of CDW differs, even though the same data source is used in both tables. In addition, in Table 11 hazardous waste are included in the figures.

The corresponding data reported in Eurostat for 2012 are slightly different (total 2.67 Mt) compared to Table 11. The main reason for the difference is that the data in Table 11 is compiled from live data (raw data) from the National Waste System (Affaldsdatasystemet - ADS) and the other is data from published reports.

The figures include exported CDW and exclude imported CDW.

5.1. CDW generation data

CDW data are collected every year through the National Waste Datasystem (ADS) in the Danish EPA. In 2010, the Danish EPA switched to the new Waste Data System to collect waste statistics. The design of the Waste Data System is considerably different from the ISAG Waste Information System which it succeeds. Unlike the previous ISAG system, all waste operators, and not only the plants receiving waste, must now report to the Waste Data System. The fact that waste operators must report to the system makes it possible to collect more accurate data about the industry from which the waste originates.

Concrete waste, bricks and asphalt accounted for nearly 50% of the CDW amount based on old statistics (2007-2009) (Miljøstyrelsen 2011). When excluding soil and stone fraction from CDW, then the share of concrete, bricks and asphalt was 2/3 of the CDW in 2009.

Table 12 CDW generation data for 2007-2009 (ISAG system)¹⁴

CDW generation data	2007		2008		2009	
	tonnes	% (w/w)	tonnes	% (w/w)	tonnes	% (w/w)
Non-suitable for incineration	123 949	2	105 866	2	89 237	2
Concrete waste	1 568 950	27	1 451 830	24	1 283 870	26
Bricks	331 858	6	220 562	4	203 867	4
Other CDW	481 704	8	734 057	12	619 626	12
Asphalt	781 217	14	883 570	15	948 585	19
Soil and stone	1 725 739	30	1 961 028	33	1 391 549	28
Other recyclable CDW	400 562	7	229 636	4	89 686	2
Other fractions	352 747	6	422 242	7	343 339	7
TOTAL	5 766 726		6 008 791		4 969 758	

¹³ Danish EPA, 2015. Waste statistics for 2011, 2012 and 2013. Data downloaded June 11, 2015 the National Waste System (Affaldsdatasystemet - ADS).

¹⁴ Danish EPA, 2011. Affaldsstatistik 2009 og Fremskrivning af affaldsmaengder 2011-2050 (ISAG system).

Table 13 CDW generation for 2011-2013. Live data downloaded on June 11, 2015 from ADS.¹⁵

CDW generation data	2011	2012	2013
	tonnes	tonnes	tonnes
Concrete, bricks, tiles and ceramics	1 160 346	1 090 384	1 097 959
Wood, glass and plastic	103 402	73 263	87 695
Bituminous mixtures, coal tar and tarred products	483 605	885 089	873 237
Metals (including their alloys)	275 593	281 578	278 646
Soil (including excavated soil from contaminated sites), stones and dredging spoil	2 607 051	2 757 567	5 126 303
Insulation materials and asbestos-containing construction materials	63 351	56 411	70 684
Gypsum-based construction material	36 551	32 491	45 029
Other construction and demolition wastes	456 052	394 260	479 365
TOTAL	5 185 951	5 571 043	8 058 917

5.2. CDW treatment data

A major part of CDW is recycled. The target for recycling has already been met.

Concrete constitutes a substantial share of the total volume of construction waste in Denmark, and today more than 90% of concrete waste is recycled. The standard procedure for recycling is now to crush the concrete and use it as an unbound road sub-base in Danish roads, squares and for filling, where concrete replaces natural base gravel material or soil.¹⁶

Table 14 Treatment data for CDW under LoW Chapter 17, excluding soil (17 05 zz).¹⁷

	2011	2012
Total (Mt)	2.971	3.254
Recycling	84%	86%
Incineration	8%	6 %
Landfilling	8 %	7 %
Temporary storage	1 %	0 %
Special treatment	0 %	0 %

5.3. CDW exports/imports data

Danish EPA collects information about amounts of waste imported and exported per industrial sector. The import of CDW composes mostly of metals from Sweden, whereas the export is mostly metals that are exported to Germany and the UK.

Table 15 CDW exported and imported from/to Denmark (data from ADS)¹⁸.

	2011	2012	2013
Export, tonnes	199 564	154 894	84 006
Import, tonnes	16 605	20 029	16 060

¹⁵ Danish EPA, 2015. Waste statistics for 2011, 2012 and 2013. Data downloaded June 11, 2015.

¹⁶ Henriksen, T., Juel-Hansen, L. & Mathiesen, D. 2015. Udredning af teknologiske muligheder for at genbruge og genanvende beton

¹⁷ Danish EPA (2012a). Affaldsstatistik 2012 (Waste statistics 2012)

¹⁸ Kristensen, E. Email contact July 8, 2015.

5.4. CDW treatment facilities data

There is no data about the treatment facilities in Denmark, capacities etc.

In Denmark there are currently 39 landfills in operation situated all over Denmark (Dansk Affaldforening 2014¹⁹). The capacities for receiving wastes have been estimated for 2014, 2018 and 2024. The estimated remaining capacity (between 10 000 tonnes and 12.3 Million tonnes) varies considerably from one landfill to another. In the Copenhagen area and in Nordjylland, there will probably be a lack of landfill capacity in coming years, and it is expected that waste will be transported long distances. This will probably lead to higher disposal costs. Furthermore, according to the national waste plan it is expected that the non-recyclable CDW will increase and needs to be landfilled.

The municipalities and local waste associations have made a resource strategy on how to secure a sufficient landfilling capacity for the whole of Denmark.

Since 1991, it has been the policy in Denmark that the authorities cannot operate new landfills, also including the extension of existing landfills. Today, over 80 % of the landfills are owned by the municipalities or jointly by the municipalities. Only 3 of the landfills are privately owned. Furthermore, private companies can operate their own landfills to dispose of their own wastes generated.

5.5. Future projections of CDW generation and treatment

The Danish EPA published a report²⁰ in 2015 on waste projection. Forecasts of the generation and treatment of waste are required to evaluate the future treatment capacities and the fulfilment of policy targets. Since 1998 the Danish EPA has used the Frida model (Andersen et al. 2012) for this purpose.

Based on the economic projection by the Danish Ministry of Finance related to the EU convergence programme 2014, the model is applied for two scenarios; a business as usual scenario (BAU) where no new waste policies are implemented, and a scenario where targets in the Danish Government's resource strategy 'Denmark without waste' from October 2013 are fulfilled. The calculation is based on waste statistics available in 2011 and year 2012 is the first year of model calculations.

The activity within the building and construction sector is expected to increase by 45% from 2012 to 2030 (more than GDP), and the amount of waste is expected to increase to year 2030 with 43% calculated from the baseline for year 2012 in the BAU scenario and respectively 47% in the scenario with resource strategy fulfilled. According to the report, it is concluded that capacities for recycling of materials from building and construction appear sufficient for a very long period.

Table 16 Projection of CDW generation²¹

	Scenario: Business as usual, Mtonnes	Scenario: Resource strategy targets fulfilled, Mtonnes
1997	1.844	1.844
2000	1.685	1.685
2005	2.203	2.203
2010	1.989	1.989
2012	2.173	2.173
2015	2.321	2.287
2018	2.640	2.571
2022	2 913	2 836
2025	2 978	2 899
2030	3 106	3 204

¹⁹ Danish EPA. (2012b). BEATE Benchmarking af affaldssektoren 2011 – Deponering (Benchmarking of the waste sector 2011 – Landfilling),

²⁰ Andersen et al. (2015). Fremskrivning af generering og behandling af affald.

²¹ Andersen, F.M. et al. (2015). Fremskrivning af generering og behandling af affald.

5.6. Methodology for CDW statistics

The Danish EPA is in charge of collection of statistical data of data. The contact person for the official statistics is Mr Rasmus Toft (affaldsdatasystem@mst.dk) at the Danish EPA.

All waste producers, receivers, exporters and importers in Denmark are, according to the Statutory Order on Waste data system no 1306/2012, obliged to give information of waste amounts, waste origin, planned treatment and waste receiver. Fines can be imposed in case the stakeholder does not submit data. The waste is classified according to the LoW codes and the waste producer is classified according to industry or NACE code.

The statistics are based on total reports from every waste operator in Denmark. The report includes information about waste producer, recipient, type of waste, and treatment, weight in metric tons. The report includes all types of waste including CDW. The statistics are published yearly, and raw data are available to the public on the system's website (<https://www.ads.mst.dk>).

The quality of waste data is checked through checking with earlier data- and own control systems at the Danish EPA. In case of uncertainty, direct contacts are taken to the stakeholder in order to ensure correct raw data.

6. C&D waste management in practice

In this section the CDW management “on the ground” in Denmark is explored.

6.1. CDW management initiatives

Table 17 Projects or specific initiatives showing how the legal and non-legal framework is applied

Description of initiative	Scope	Year established	National, regional, local (specify which local area/region)	Public sector and/or Industry lead organization	Levels of performance e.g. tonnes recycled	Further information/ web-site
Eracobuild-project	Tools for the assessment of environmental sustainability of construction products & identification of current and future substances of concern with regard to recycling and reuse of construction products and renovation wastes.	2014	Nordic	Both	Unknown	http://www.nordicinnovation.org/Global/_Publications/Reports/2014/Environmentally%20Sustainable%20Construction%20Products%20and%20Materials_Final_report.pdf
Report on requirements from construction products regulation	Procedures related to CE marking of recycled waste.	2010	Nordic innovation	Nordic	Unknown	http://www.nordtest.info/index.php/technical-reports/item/handbook-environmental-assessment-of-construction-products-an-introduction-to-test-methods-and-other-procedures-related-to-ce-marking-nt-tr-618.html?category_id=3
ENCORT	Environmental Consequences of the EC Recovery Target for Construction and Demolition Waste.	2014	Nordic Council of Ministers	Nordic	Unknown	http://dx.doi.org/10.6027/NA2014-916 , NA 2014:916. ISSN 2311 – 0562
Gypsum recycling	The GtoG project aims at transforming the European gypsum demolition waste market to achieve higher recycling rates of gypsum waste, thereby helping to achieve a resource efficient economy.	2001	European	Industrial	Currently around 60 % of all Danish gypsum is being recycled.	www.gypsumrecycling.biz

Description of initiative	Scope	Year established	National, regional, local (specify which local area/region)	Public sector and/or Industry lead organization	Levels of performance e.g. tonnes recycled	Further information/ web-site
Marmormolen and UN – building	On-site use of concrete waste, project covering the whole recycling process from survey of hazardous substances to use in road construction	2012-2013	National	Industrial ?	saving of 35 ktonnes natural aggregate	See presentation nr 15 in following link : https://www.dakofa.dk/element/konference-bygge-og-anlaegsaffald-vejen-til-de-store-maengder/
Skive Genbyg	Pilot project on reuse of CDW in a Danish region Skive (includes several cases)	2013-2015	National	Public/industrial	Unknown	http://www.energibyenskive.dk/en/projects/rethink-business/ Final report (in Danish) http://www.energibyenskive.dk/da/projekter/genbyg-skive/afslutningsrapport/
Reuse of buildings	Challenges and drivers in reuse (focus also on environmental impacts), examples of innovative solutions in reuse.	2014	National	National	Unknown	http://concito.dk/files/dokumenter/artikler/groen_genanvendelse_endelig150914.pdf
Sustainable Build platform Purpose is to bring different stakeholders together	Networking, exchange of knowledge between actors in the whole value chain	Last update 2015 (February)	National	National	Unknown	Sustainable Build aims to support sustainable building with special focus on production, use and recycling of construction materials and components Further information: http://www.dac.dk/da/dac-build/sustainable-build/
The REBRICK process/Gamle Mursten ApS	Old bricks are cleaned by vibrational technology, manually sorted and stabled by a robot	2003	Danish	Industrial	Unknown	www.gamlemursten.dk www.gamlemursten.eu www.oldcleanbricks.eu http://mst.dk/media/mst/9049972/Gamlemursten20120511Milj%C3%B8styrelsenworks-hop.pdf

Description of initiative	Scope	Year established	National, regional, local (specify which local area/region)	Public sector and/or Industry lead organization	Levels of performance e.g. tonnes recycled	Further information/ web-site
Nordic Built Component Reuse	The project explores, by means of 1:1 mock-up modelling, new practices for reuse of dismantled building components and materials, for new ways to organize, tender and trade reused building components. The aim is to stimulate the Nordic market for recycled components, thus saving energy while concurrently creating profitable business and architectural identity.	2014-15	Nordic	Nordic innovation	Unknown	http://www.nordicinnovation.org/nordicbuilt/funding-opportunities/funded-projects-through-nordic-built-in-2013/component-reuse/
Recycling of Stone Wool	The project aims to develop a recycling concept for stone wool. This will primarily include the reprocessing of used stone wool to new stone wool. But the project will also seek to find alternative uses. Pilot testing included.	2011-12	National	Public/industrial		http://markedsmodningsfonden.dk/projekt/0/34/123
"From Roof to Road" Innovative recycling of bitumen felt roofing material	Tarpaper recycling : use in asphalt (bitumen/filler)	2010	European	Ejere/Investorer: Enviso Group (85%) Investeringselskabet Rasmussen Aps: (15%)	20 000 tonnes used as raw material	EU-Life project (2009-2010) http://tarpaper.eu/ http://mst.dk/media/mst/9049978/Tagpapopfindelse2powerpoint.pdf
Gypsum Recycling International (GRI, 2013)	EU-funded Life+ project on gypsum recycling Aim : "to close the loop effectively and transform the plasterboard demolition waste market to achieve higher recycling rates of plasterboard waste"	2013-15	EU	EU	Manufacturers involved in the project will strive to include 30 % recycled gypsum in the	http://gipsrecycling.dk/ The major obstacle to close the loop is that buildings are currently demolished and not dismantled in the majority of the Member states of EU. This leads to unsegregated waste going to landfill without having the

Description of initiative	Scope	Year established	National, regional, local (specify which local area/region)	Public sector and/or Industry lead organization	Levels of performance e.g. tonnes recycled	Further information/ web-site
					plasterboard, also including construction and production waste	possibility to recover valuable recyclable materials, among others gypsum plasterboard waste.”
Dakofa	Network for key actors involved in CDW recycling. Conferences, courses, network, and working groups on CDW management	2012	National	Public, industrial		https://dakofa.dk/element/bygge-og-anlaegsaffald/
Partnership for recycling of CDW (CLEAN 2015)	Tendering of two demolition and recycling programmes by dialogue in competition (konkurrencepræget dialog)	2015	Municipalities of Slagelse and Skive	Public, industrial	Demolition and recycling of a number of buildings.	Demolition of a number of small houses in Skiev Municipality, and demolition of old warehouse in Slagelse. Integrated processes of demolition, recycling and use of recycled materials in new buildings.

Within these initiatives, the following could be selected as interesting case studies for Task 2:

- Dakofa: collaboration of actors in the CDW value chain
- SUSTBUILD: Sustainable Build aims to support sustainable building with special focus on production, use and recycling of construction materials and components

6.2. Stakeholders' engagement

The table below aims to gather information on the existing initiatives – identified above – or other initiatives identified by the stakeholders themselves, together with a preliminary assessment of the enabling factors/obstacles, advantages/drawbacks, and other relevant comments.

Table 18 Stakeholders' engagement.

Description of initiative	Scope, year established, actors involved	Advantages/ Enabling factors	Disadvantages/ Obstacles	Further information/ web-site
DAKOFA	2012, platform for all actors involved in sustainable recycling of CDW, especially actors linked to demolition, consulting, treatment/processing of CDW and authorities (national and local).	The network aims to bring up future key focus and priority areas related to CDW. Key areas: waste quality (environmental and technical quality)- mapping and removal of hazardous substances, auditing activities, demolition activities, good practices throughout all activities generating secondary resources, documentation of quality, interpretation of legislation		https://dakofa.dk/element/bygge-og-anlaegsaffald/
SUSTAINABLE BUILD - Platform		platform for actors involved in the whole building chain		http://www.dac.dk/da/dac-build/sustainable-build/
Recycling of rockwool	2012, RGS 90 & Rockwool plants	Rockwool waste collected by RGS 90 and recycled in production of new rockwool		

6.3. Waste legislation enforcement

Supervision responsibilities

Local environmental authorities are responsible for inspections concerning the management of construction and demolition waste (Statutory Order nr 669 of 18/06/2014). The inspections are performed according to the Statutory Order nr 497 of 15/05/2013 on environmental supervision. However, there are no tools nor guidance on how issues concerning the removal of hazardous substances, recycling and resource efficiency should be managed within the inspections. In addition, the resources allocated (no. of staff) are in many municipalities insufficient. However, the inspection is on the areas in focus in the Resource Strategy "Denmark without waste"²².

²² Danish EPA (2014). Danmark uden affald. Ressourceplan for affaldshåndtering 2013-2018.

Compliance with the waste hierarchy

The management of CDW in Denmark complies to a large extent with the waste hierarchy. Only CDW not suitable for recovery or reuse is landfilled according to classification (classified by local authorities). During the last 10 years there has been an awareness of sorting hazardous substances and material from buildings before demolition. However, there is in many cases still a lack of economic incentives to up-cycle materials according to the waste hierarchy. Part of CDW is recycled as backfilling or used for energy production.

Sanctions

According to the Statutory Order nr 1662/2010, Chapter 10, waste handling contrary to the waste regulations can be punished by deprivation of liberty of up to two years.

Probably due to increased awareness of hazardous substances in CDW and increased costs for legal demolition, sorting and handling of CDW, there is an increasing number of cases concerning illegal dumping also on private properties. Some cases of illegal management have been brought up in local channels (newspapers). Often it is, however, challenging to find the offender after dumping, but some cases have led to trials and the offenders have been convicted.

CDW shipments

The competent authority in the exports and imports of waste is the Danish EPA. An approval from the Danish EPA is usually required for the export or import of waste.²³ The fee for handling a notification in Denmark is from the 1st of March 2015 DKK 13 600 (EUR 1 800).

6.4. Drivers / barriers to increase CDW recycling

The main drivers and barriers that affect (directly/indirectly) the recycling efforts and boost (impede) CDW recycling rates and overall performance in Denmark are listed in Table 9.

²³ <http://eng.mst.dk/topics/waste/shipments-of-waste/how-to-apply-for-shipment/>

Table 19 Drivers and barriers of recycling.

Factor / characteristic / element in CDW recycling chain	Drivers	Barriers
Treatment facilities territorial network	Over 400 recycling facilities in Denmark providing good opportunities for recycling.	Risks for dilution if several waste streams are mixed.
Market conditions	<p>Economic support (loans) for refurbishment and use of recycled material.</p> <p>Good cooperation between construction producer and waste treatment sector leads to cost savings and supports sustainable recycling and enable new business.</p> <p>Tax on non-reusable CDW.</p> <p>Tax on natural resources.</p>	<p>A prerequisite for CDW recycling is sufficient waste amount at reasonable transport distance, availability of processing equipment (e.g. crusher), possibilities for temporary storage – here matching between the needs of stakeholders involved.</p> <p>The price for CDW recycled product must be competitive to traditional product.</p> <p>Marketing of CDW important taken into account the sector features.</p> <p>Confidence in environmental quality (unpolluted).</p> <p>Documentation of quality – environmental and technical.</p> <p>Small market for recyclable CDW.</p>
Recycling process and techniques	Opportunities for substituting natural resources and reducing impact on the environment.	<p>Use in high-grade applications sets requirement needs for better sorting.</p> <p>Simple and robust processing schemes important (e.g. crushing).</p> <p>Recycling of CDW requires planning and time already at an early stage of demolition.</p> <p>Lack of information on possibilities for recycling.</p> <p>Need of matching recycled CDW with demand of resources with respect to time, sites and cost.</p>
Quality	<p>Strict requirements for demolition activities in combination with on-site sorting promote high-quality recycling.</p> <p>Competence and education of demolition company provide a platform for sustainable recycling.</p>	<p>Only CDW with low contaminants and suitable properties are suitable for recycling.</p> <p>Uncertainty in interpretation of proposed criteria for PCB (how it will be implemented in legislation).</p> <p>High costs for checks of contaminants (PCB)</p>
Construction products	<p>Design of products for reuse/recycling.</p> <p>Requirement for use of recycle materials in construction products (e.g. in public procurement).</p> <p>Sustainability aspects important to be considered in development of construction products.</p>	Ownership and responsibility in the whole value chain must be clear.

7. CDW sector characterization

In this section some specific characteristics of the CDW management sector in Denmark are explored.

7.1. Sector characteristics

The actors involved in the management of CDW Denmark are the following:

- Building owners
- Architects and consulting engineers
- General contractors
- Specialized demolition contractors
- Waste handling companies and recyclers
- Transport companies
- Municipal authorities

The building owners supported by their architects and consulting engineers decide the renovation, reconstruction or demolition of the actual buildings and manage the tendering process according to the EU directives²⁴.

In the case of a major urban development or new construction, which requires demolition work, a general contractor will be the main contractor, and he will hire a demolition contractor on a sub-contract basis. However, the demolition contract might be contracted directly as a separate contract.

Based on the tender documents, including information on the building object, assessment of materials and mapping of pollution of the building the demolition contractor will be responsible for selective demolition of the building in accordance to the NMK 96 in the following steps²⁵:

- Cleaning of building for polluted substances, such as PCB and heavy metals
- Stripping the building of all installations, floors, windows, doors etc.
- Demolition of the main construction / raw house
- Levelling and finishing the site.

The demolition contractor sorts all materials on site. Depending on the size and type of the object, crushing might take place on-site by the use of a mobile crusher, or the recycled materials are transported to a permanent recycling facility. Other materials are transported to treatment plants, disposed of, or landfilled²⁶.

The general contractors, the major demolition contractors, and the waste-handling companies/recyclers are organized in the Danish Demolition Association under the Danish Construction Association (Dansk Byggeri). Demolition Section of Dansk Byggeri has approximately 20 members (www.nedbrydningssektionen.dk). The minor demolition contractors are mostly general contractors, and they are organized in the Danske Maskinstationer og Entreprenører DM&E (www.demoge.dk).

Figure 1 illustrates actors involved in the CDW chain. Dialogue and common understanding between the different actors are important for efficient recycling.

²⁴ Email contact with Erik K. Lauritzen, July 10, 2015

²⁵ Email contact with Erik K. Lauritzen, July 10, 2015

²⁶ Email contact with Erik K. Lauritzen, July 10, 2015



Figure 1 Examples of actors involved in CDW management for recycling²⁷

In the 1980s and 1990s, municipalities were heavily involved in sorting of CDW. This was partly because the responsibility for providing treatment capacity lay with the municipalities, but also because few private investors were interested in shouldering the risks involved in introducing new treatment methods.²⁸

In Denmark the sorting and pre-treating of waste is now mainly undertaken by private enterprises. Some municipalities or inter-municipal waste associations still maintain their own sorting plants, for specific purposes like for sorting of certain types of construction and demolition wastes. The end-processing of waste for recycling has always, with some important exemptions, been undertaken by private companies. The final recycling of construction and demolition waste (concrete, brick, asphalt and wood) has been a tradition for private-public partnerships.²⁹

Municipalities are obliged to collect PVC, construction and demolition waste, impregnated wood, creosote treated wood, as well as other hazardous waste from households or to accept these wastes at the waste recycling centres.³⁰

The Danish waste infrastructure is characterized by a division of work during the last 30 to 40 years but also by a shifting of roles. Where waste management practices are well established and pose few problems – for example in waste collection and the recycling of glass, metals and paper – the private sector has been heavily involved and operated in market-based conditions. Municipalities have taken the lead in more complex and potentially environmentally problematic waste management areas, for example those that require a steady and reliable flow of materials like hazardous waste plants and incineration plants, as well as in developing and implementing new technologies.³¹

CDW treatment scheme:

CDW recycling and storage facilities can be operated by different types of actors: building firms, waste recycling professionals, and quarries.

- These different actors are represented by several sectoral organizations, the main ones being:
 - The Danish Waste Association - members are municipalities and municipal recycling companies dealing with waste including C&DW.
 - The Danish Construction Federation - The Danish Construction Association, developed as a result of a merger between the federation of Danish Building Employers and the Danish Contractors' Association, is an employers' organization for approximately 6 000 companies, comprising about 70 000 workers from contracting and manufacturing companies within the Danish building and construction sector. The Danish Construction Association also represents demolition companies.

²⁷ Dakofa (2013), Dakofa's netværk for bygge- og anlægsaffald.

²⁸ Fischer, C. (2012). From land filling to recovery – Danish waste management from the 1970s until today.

²⁹ Fischer, C. (2012). From land filling to recovery – Danish waste management from the 1970s until today.

³⁰ Fischer, C. (2012). From land filling to recovery – Danish waste management from the 1970s until today.

³¹ Fischer, C. (2012). From land filling to recovery – Danish waste management from the 1970s until today.

7.2. Exports / imports of CDW

The existing capacity for CDW in Denmark is sufficient and no actual export is needed. Small amounts of CDW (mainly metals) have been exported to Germany and UK for recycling. Small amounts of CDW (also mainly metals) have been imported from Sweden for recycling.³²

7.3. CDW as landfill cover

Reclaimed concrete is used as aggregate in road constructions. The use of CDW in landfill covers is not currently common practice in Denmark.

7.4. Market conditions / costs and benefits

The landfill taxes promote the development of recycling technologies. Almost all concrete waste and brick waste and part of asphalt are recycled. In the future, focus is on upgrading the CDW recycling. However, the concern of potential hazardous substances in CDW is a barrier for recycling.

The landfill costs depend on the waste type. The current landfill tax in Denmark is DKK 475 /tonne (EUR 64 /tonne). The typical landfill fee for recyclable materials is around DKK 366 /tonne (EUR 49 /tonne)³³. The taxation has promoted the development of recycling technologies and decreased the amounts to be landfilled. Landfill of hazardous waste was formerly excluded from the tax but has now been integrated in the taxing system, and since 1.1.2015 the taxes for the hazardous waste are the same as the regular landfill tax of DKK 475 /tonne.

Much of the construction and demolition waste contains hazardous substances. Therefore it is important to remove these substances so that they do not spread into the environment and to be aware of new substances which may pose a risk for the environment and health. Consequently, initiatives on substances of concern in waste must be supplemented by measures in a new chemicals initiative, amongst other things, to ensure that chemicals in products do not prevent or complicate future recycling, and focus placed on making it possible for materials and products to return to the resources cycle. Stakeholders have indicated the following needs for promoting recycling of CDW especially by setting appropriate quality requirements for CDW:

- Technical properties must be proven for the application and fulfil the requirements.
- The purity of the CDW fraction needs to be documented (constructor not willing to take risks).
- Guidance on which hazardous substances to be analyzed and to which extent.
- Clear criteria for hazardous substances in CDW.
- Guidance for testing strategy in sampling.
- Development of tracking system for CDW.

The market conditions / cost and benefits depend on the opportunities for matching the production of CDW-recycled materials with the need for resources in new construction as indicated in the figure below. Recycling on-site and the use of the recycled materials on-site will save natural materials and transport of materials, as well as reduce energy consumption and CO₂ emission.

³² Kristensen, E. Email contact July 8, 2015.

³³ Example of pricelist: http://www.rgs90.dk/documents/10926/20980/prisliste_januar2015_enkeltsider.pdf/7002ccbd-27f7-4668-b60e-ec7d1be0fd80

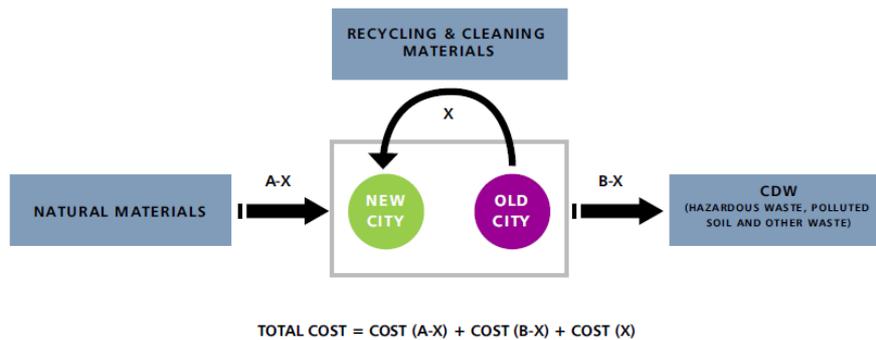


Figure 2. Model of matching CDW-recycled materials and substituting natural materials for new construction³⁴.

7.5. Recycled materials from CDW

The risk of pollution hampers the market of recycled CDW products in Denmark. Generally, building owners are very careful with respect to the risk of pollution and they are rather sceptical of using recycled materials for other purposes than fill.

Almost all concrete and brick waste and a significant part of asphalt waste are recycled as materials in road construction replacing gravel and stone. The high recycled waste amount today means that there is a big saving of natural resources of gravel and stone.³⁵ The driving force for development of recycling technologies has been the introduction of the landfill tax³⁶.

In order to be recycled as aggregates CDW must fulfil both application-specific functional and environmental criteria. The Danish Road Institute has produced guidelines for the use of crushed concrete aggregates as unbound road base materials³⁷ (DRD, 2004). This guideline sets quality criteria for the crushed concrete in terms of elasticity, particle size distribution, strength/resistance to abrasion and purity (i.e. content of other materials than concrete). Based on purity, the crushed concrete is split into three different quality groups. It should be noted that these purity criteria are purely functional, and they are not approved by the Danish EPA in relation to environmental protection.

In Denmark, technical guidelines on the use of reclaimed asphalt in unbound application have been published by the Danish Road Directorate.³⁸

In 1990 Denmark developed technical specifications for the use of crushed recycled concrete as aggregate in new concrete. Full-scale building projects with concrete based on recycled aggregates were performed with very good results. However, the risk of pollution and various problems have reduced the interest of high-quality recycling of concrete in Denmark.

Example of an R&D programme:

- Possibilities for recycling of concrete in cement production mentioned in the waste management plan for 2013-18³⁹. This would lead to upgrading of the concrete waste. The first step is to conduct a study on bottle necks and opportunities.⁴⁰

³⁴ Basztura, J. (ed). Model of the City Concept, according to the EU 5th framework programme. Project IRMA, contract no. EVK4-CT-220-00092, 2007

³⁵ Danish EPA. (2012b). BEATE Benchmarking af affaldssektoren 2011 – Deponering (Benchmarking of the waste sector 2011 – Landfilling),

³⁶ -Bruckmann, C. 2013. Construction and demolition waste management. Current legislation and the potential of material upcycling. Master Thesis.

³⁷ DRD, 2004b. Unbound base courses of crushed concrete – after European standards). Danish Road Directorate (in Danish)

³⁸ DRD, 2011. Vejoverbygning ubundne baerelag af knust beton og tegl. Vejledning

³⁹ Danish EPA (2014). Danmark uden affald. Ressourceplan for affaldshåndtering 2013-2018.

⁴⁰ Henriksen, T., Juel-Hansen, L. & Mathiesen, D. 2015. Udredning af teknologiske muligheder for at genbruge og genanvende beton

7.6. Construction sector make up

The total production value of the Danish construction sector is estimated next year to be DKK 163.8 billion (EUR 22 billion). This is a significant decrease since year 2000 with a production value of DKK 176.2 billion (EUR 23.6billion).⁴¹

Weak growth in the new building sector is expected for this year and the production value is estimated for next year to be on the level of DKK 39.5 billion (EUR 5.3 billion).⁴²

The number of construction enterprises in 2013 was 15 837 (Eurostat, 2015). The construction sector represents 5 % of the economy and employs about 150 000 people and it has great potential for growth.⁴³

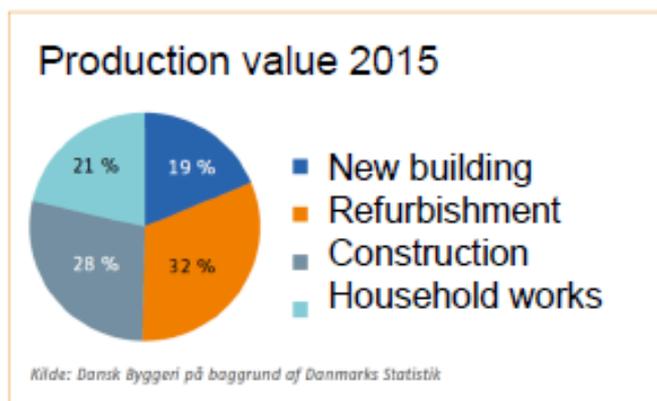


Figure 3 Production value divided on the key market 2015.⁴⁴

⁴¹ Danish Construction Association, Konjunkturanalys 2015

⁴² Danish Construction Association, Konjunkturanalys 2015.

⁴³ KEBMIN (Danish Ministry of Climate, Energy and Building. 2014. Danish government to strengthen construction sector.

⁴⁴ Dansk Byggeri 2015. Konjunkturanalyse. February 2015

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