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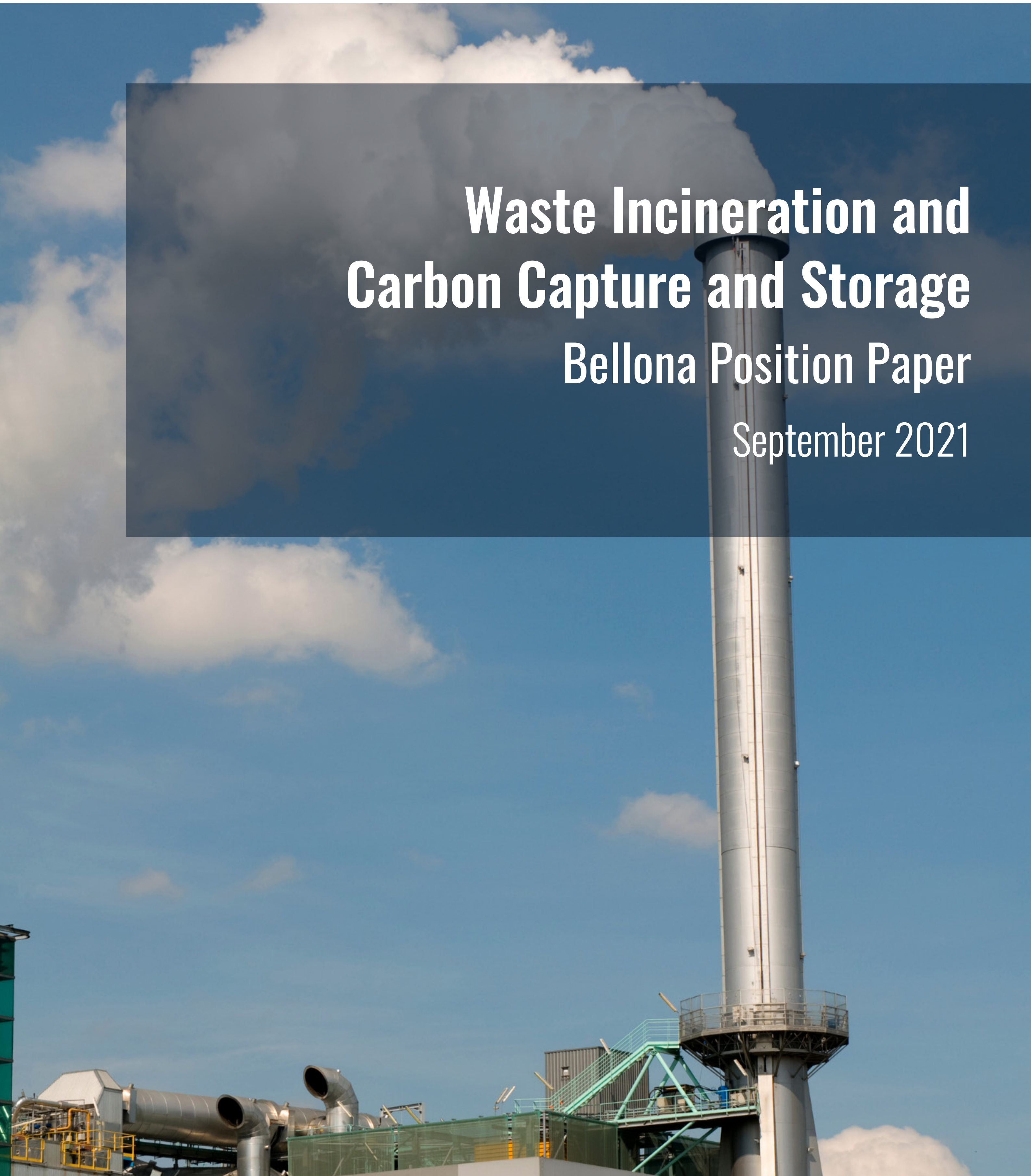

Waste Incineration and Carbon Capture and Storage

Bellona Position Paper

September 2021

In 2019, the European Union (EU) generated 224 Mt of municipal waste.[1] Out of these 224 Mt, 53 Mt were landfilled, 60 Mt incinerated and 107 Mt recycled.[i] Export of hazardous and non-hazardous waste had tripled between 2001 and 2020, growing from 6.3 million tonnes to 32.7 million tonnes respectively.[ii],[iii] With a 3% share of EU greenhouse gas emissions in 2017[iv], the municipal waste sector is the fourth largest contributor to emissions in the EU.[2] In 2017, the emissions registered for the waste sector amounted to approximately 138 million tonnes of greenhouse gases.[v] That number grows even larger when emissions from waste to energy plants, currently covered by emission accounting in the power sector, are included.

Emissions from waste incineration in Europe grew from 5,373kt[3] CO_2 in 1990 to 95,628kt of CO_2 and are now approximately equivalent to emissions coming from landfillsix. Other than its impact on the climate, waste disposal has significant impacts on biodiversity and public health.[vi]

Reducing waste, retaining the value of resources and minimising the overall impact of the products we use and dispose of is essential to reduce the environmental pressures created by the growing amount of waste we create. To do so, we need to establish a set of integrated waste reduction and management measures.

Waste management conditions vary from region to region; due to these differences, waste management measures must be tailored to local waste management systems. Within the EU the amount of generated waste per capita varies from 280 kg in Romania to 844 kg in Denmark (per person, per year).

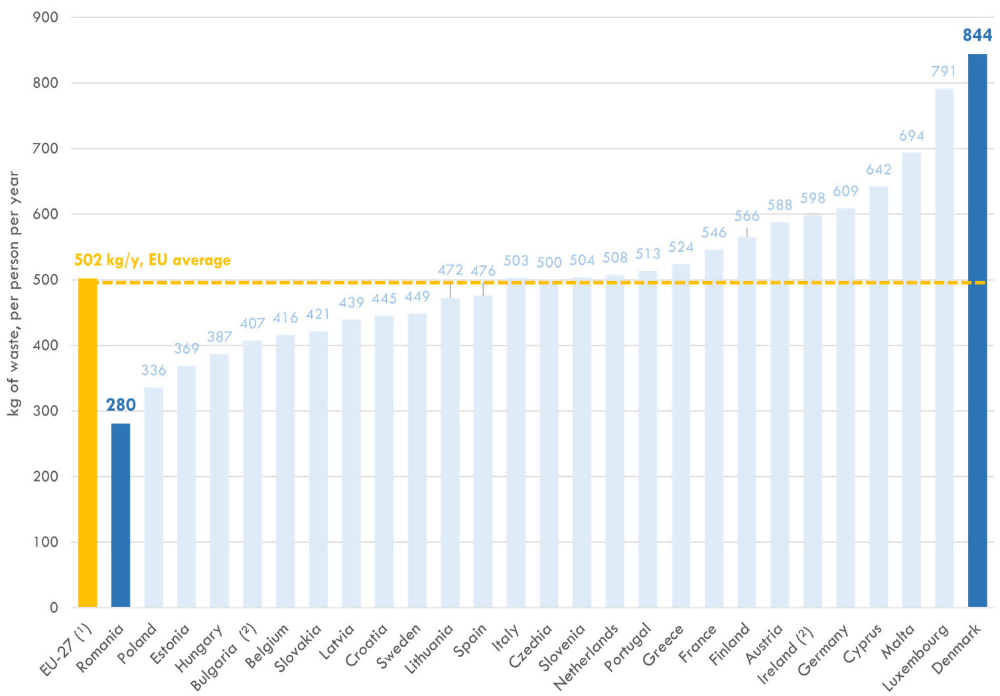

FIGURE 1: MUNICIPAL WASTE GENERATION PER EU MEMBER STATE, IN KG PER CAPITA (EUROSTAT, ENV_WASMUN DATASET)

1 Municipal waste accounts for approximately 10% of overall waste generation in the EU (when compared with the data reported according to the Waste Statistics Regulation) (Eurostat 2021).
2 Emissions from waste to energy plants are excluded from this figure (3%) because they are reported in the power sector. The largest portion of emissions from this dataset comes from the combustion of fossil fuels (77%), followed by agriculture (10%) and industrial processes (8%).
3 Excluding figures from France, Austria and Germany and the Netherlands which weren't reported in 1990.

Apart from a large difference in the amount of waste they generate, countries differ in their waste disposal measures. While Denmark, Norway and Luxembourg incinerate the most waste, Malta, Greece and Cyprus have the highest prevalence of landfills.[vii]

Northern Europe also has different heating patterns to the South due to harsher winters[viii] and therefore has more developed district heating systems which are sometimes connected to waste incinerators.

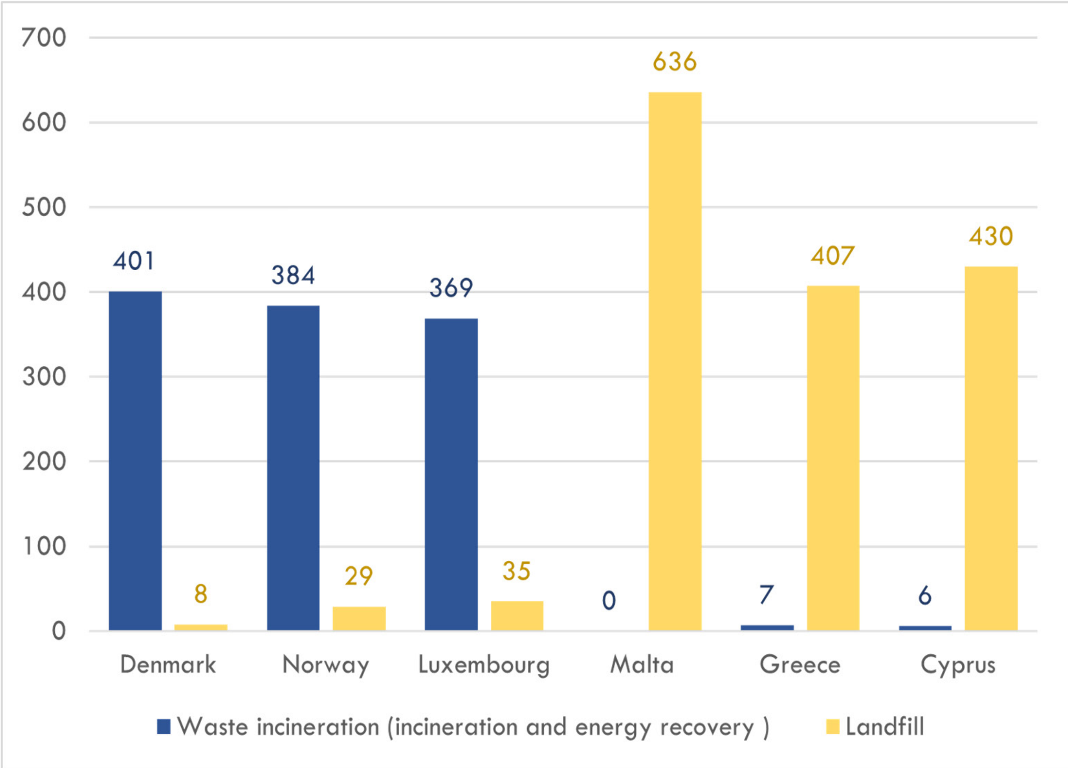

FIGURE 2: MEMBER STATES WITH THE HIGHEST LANDFILL AND WASTE INCINERATION RATES, IN KG PER CAPITA [4] (EUROSTAT, ENV_WASMUN DATASET)

Where possible, preventing waste, repurposing existing resources and redesigning products to increase their lifespans should be prioritised. For waste that cannot be prevented, measures should be put in place to maximize its re-use and recycling. Even though these measures should minimise the creation of waste, some materials will still reach the end of their lifetimes. Some materials will always be subject to deteriorating quality throughout the recycling chains (e.g., for materials such as paper and plastics, this can limit the potential for recycling to a few cycles). When materials cannot be cycled back into the economy, their end-of-life treatment should ensure minimal damage to the climate, environment and human health.

4 The figures in this paper represent the amount of waste generated and treated per person. When measured in thousands of tonnes, Italy and the Netherlands incinerate the most waste, while Italy, Poland, France, Romania landfill the most.

Reducing emissions from waste incineration

With increasing targets for the closure of landfills across Europe and exports of waste coming to a halt, waste incineration is becoming the single largest means of final waste disposal in Europe. Incinerators are becoming a large source of greenhouse gas emissions in the EU; in 2018, they added an estimated 95 million tons of CO_2 to the atmosphere[ix], adding up to approximately 2% of total EU emissions and amounting to two-thirds of overall emissions from the waste sector.[x,xi]

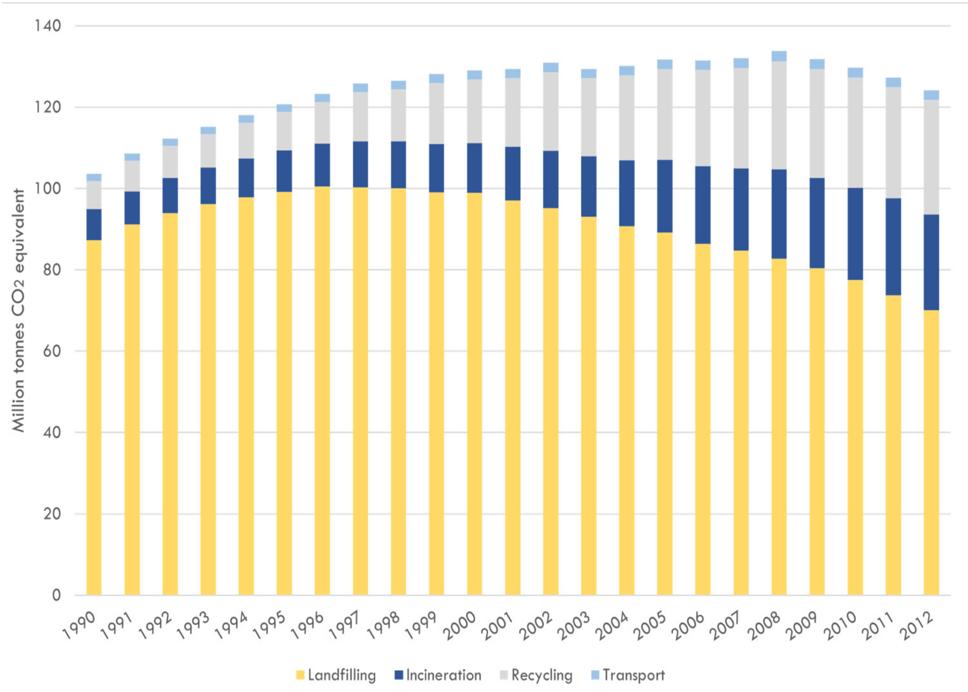

FIGURE 3: DIRECT EMISSIONS FROM WASTE MANAGEMENT, INCLUDING LANDFILLING, INCINERATION, RECYCLING AND TRANSPORT (EUROSTAT, ENV_WASMUN DATASET)

While waste incineration should decrease over time as other waste management strategies develop, its damaging effects, including greenhouse gas emissions to the atmosphere, need to be mitigated as soon as possible. Sorting of residual waste before incineration should also be obligatory to ensure that all of the potentially recyclable waste is separated before incineration.

To reduce emissions from waste incineration, the CO_2 produced by burning municipal solid waste can be captured, transported and permanently stored in geological storage sites to prevent the emission of the CO_2 to the atmosphere. By capturing and permanently storing CO_2 away from the atmosphere, carbon capture and storage (CCS) prevents further climate change.[xii,xiii]

To ensure that emissions will be reduced, CCS on waste incinerators must be planned within a certain timeframe and be obligatory. 'CCS-ready' waste incineration with no action plan and timeline for CCS implementation should not be funded.

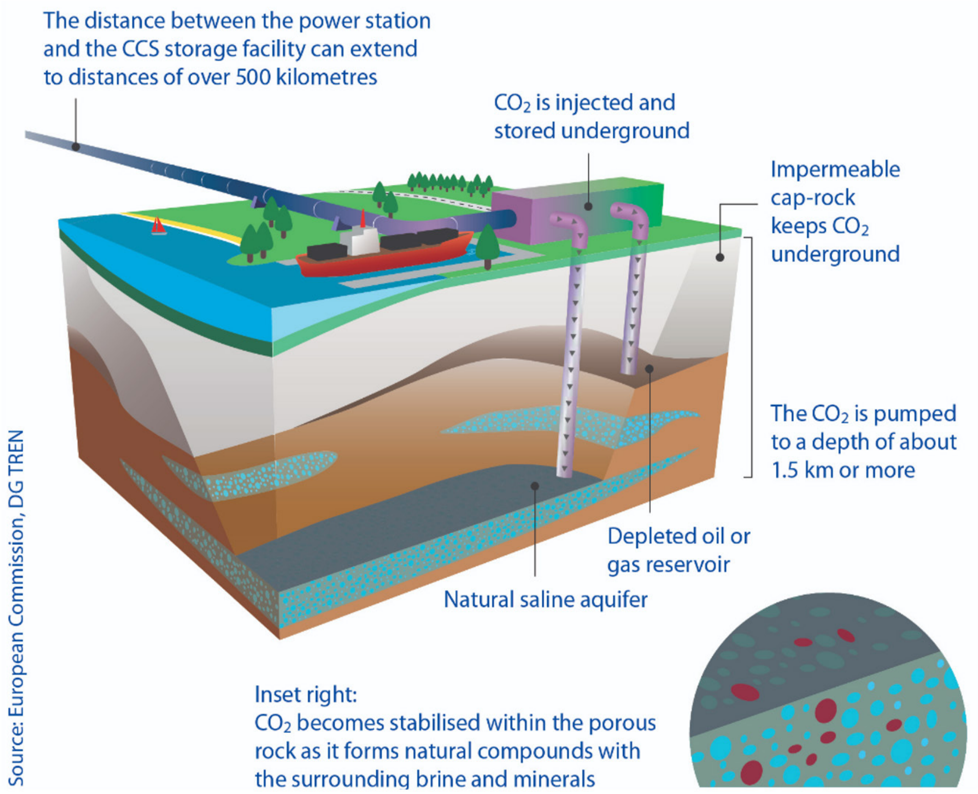

FIGURE 4: STORING CO_2 PERMANENTLY ISOLATES IT FROM THE ATMOSPHERE, THEREBY AVOIDING CLIMATE CHANGE (ILLUSTRATION BY EUROPEAN COMMISSION, DG TREN 2021).

Since the emissions from waste incinerators are usually a mixed stream of biogenic and fossil CO_2, capturing and permanently storing the biogenic fraction of CO_2 can potentially result in carbon removals. However, its final climate impact depends on the share of biogenic CO_2 that is captured and stored and on the upstream and downstream emissions associated with the overall process, including the lifecycle emissions of producing the biogenic material in the first place.[xiv]

Despite its potential to reduce the climate impact of waste incineration, CCS should not be seen as a substitute for reducing, re-using and recycling collected and residual waste. **CCS is a tool that can be complementary to other waste management solutions and can mitigate the final emissions from waste generation after all of the materials have been reused, separated and recycled, including materials from residual waste.**

Parallel development of CCS on waste incinerators and waste reduction is needed

Waste incinerators require a steady supply of a large quantity of municipal solid waste to operate. Due to this requirement, incinerators create demand for municipal solid waste locally and could go against waste reduction targets set in the legal framework for treating waste in the EU.[xv] To prevent this from happening, a comprehensive European strategy for regional waste incineration and management should be created. [5]

In other words, CCS deployment on waste incinerators should be complementary to waste reduction strategies.

An increase in recycling and waste reduction needs to be taken into account

By 2025, at least 55% of municipal waste[6] will have to be recycled. This target will increase to 60% by 2030 and 65% by 2035.[xvi] Given the potentially long timelines for CCS projects, higher targets and upcoming policy developments should be considered during the drafting of comprehensive waste management strategies.

To reach these targets, the residual municipal solid waste going into waste incinerators today will have to be sorted according to stricter criteria and in some member states, state-of-the-art recycling capacities will have to be developed or ramped up. According to some studies, recycling efforts in the EU could be substantially improved, particularly when it comes to separating various sources of waste.[xvii]

To improve recycling efforts and reach waste reduction goals, the development of new waste incinerators should be avoided if possible, particularly in areas that don't have a developed sorting and recycling structure in place.[7][xviii]

Even though member states that have underdeveloped sorting capacities often generate less municipal solid waste per person than the EU average, their waste management system often relies on the very bottom of the 'waste hierarchy' (e.g., landfilling)[xix] ; which is why more reduction, reuse and recycling should be encouraged.

Comprehensive waste strategies should also include the changes in the regulations regarding waste shipment outside of the EU.[xx] In the short term, these trends will significantly change the dynamics in the waste management sector and should be taken into account.

5 While EU has some targets aimed to increase material efficiency and minimise waste, an overall strategy or roadmap outlining the trajectory for the sector would be beneficial. For instance, such a strategy should coordinate waste reduction targets with phaseouts of waste incinerators and landfills.
6 55% of the weight of total municipal waste generated in the EU.
7 Data from the Netherlands, Germany and the United Kingdom showing that their incineration capacity is already bigger than their national generation of waste (Sora 2013).

Continued emissions from waste incineration are not compatible with climate goals

Emissions from material use and consumption will decrease as we work our way towards a more efficient and circular material management system. In the meantime, existing waste incinerators that will operate in the coming decades need to reduce their greenhouse gas emissions.[xxi] The new IPCC report has shown that every tonne of greenhouse gas emitted into the atmosphere plays an important role in exacerbating climate change. Therefore, incinerators that are projected to remain operational when all the waste reduction measures are taken, should be required to have carbon capture and storage to substantially reduce their climate impact.[8]

Reforming the current policy system to incentivise these emissions reductions will be crucial. For instance, including municipal solid waste incineration into the EU ETS could lead the sector towards substantial emissions reductions.[xxii]

CCS is an option for waste incinerators but depends on their location and size

Waste incinerators are localised and stationary sources of emissions spread out across most western Europe.[xxiii] Whether CCS is a viable option for a given incinerator will depend on its location and size.[xxiv]

The availability of neighbouring CO_2 transport and storage networks is crucial for determining CCS potential for a waste incineration plant. Plants that are located close to eligible CO_2 storage sites or industrial clusters are more likely to have access to an existing CO_2 transport and storage network. Initial CCS projects on waste incinerators should focus on such areas. For more isolated plants, ships, trucks or trains have the potential of providing an alternative transport mode for CO_2.

In addition to their location, the size and function of a particular incinerator might determine its potential for emission reductions via CCS. Due to a better business case with larger quantities of captured CO_2, CCS potential may be limited to larger facilities.

Currently, two CO_2 capture facilities are operating in the Netherlands (Twence Holding plant in Hengelo and the waste facility of the Rijnmond Industrial Waste Processing Company in Duiven).[xxv,xxvi] The CO_2 captured from these two facilities is then used, so the climate impact of these projects could still be improved by permanently storing the CO_2 away from the atmosphere. Several other projects have been developed and are awaiting final investment approvals (e.g., the Amager Resource Centre in Copenhagen[xxvii] and the Fortum plant in Oslo[xxviii]).

8 The existing waste incinerators should also comply with the best-case practices regarding pollution prevention outlined in the Best Available Techniques (BAT) reference document for waste incineration (Neuwahl et al. 2019) to prevent the emission of toxic pollutants (Toxicowatch 2018).

Additional energy use for CO_2 capture should be taken into account

Some waste incinerators convert their process heat to electricity and/or hot water for district heating systems. While this is generally beneficial and increases the efficiency of the process because it uses the heat from the combustion of waste, it means that there is no spare heat and energy to capture the CO_2 coming from the waste incineration process. Thus, additional energy may be required to run a CO_2 capture process in facilities where the heat and energy are already used in district heating systems. Conversely, a waste incinerator that produces little or no other energy services would have a surplus of process heat to run a CO_2 capture facility.

These factors need to be taken into account when applying CCS to waste incineration. If the waste incinerator already uses its process heat to provide electricity or heat to the district heating systems and cannot redirect that energy to power the capture process, the additional energy required for the CO_2 capture process should come from renewable sources.

Overall, waste incinerators that:

1. Process large amounts of waste and thus produce large volumes of carbon dioxide,
2. are located near existing CO_2 transport and storage networks and
3. can use the energy and heat they generate for the process of carbon capture

are most suitable for the application of CCS.

Policy recommendations

The current waste policy framework of the EU, spearheaded by the Waste Framework Directive, aims to prevent and reduce the generation of waste to mitigate its adverse effects on human health, the environment and the climate.[xxix]

To create a climate-neutral waste sector that is based on the most efficient use of resources extracted from the environment and minimised disposal of waste that is harmless to the climate, waste management policies need to be coordinated with the EU climate goals.

Despite the improvements in waste reduction and recycling targets, the current waste policy framework falls short of outlining a climate-neutral pathway for the sector. Such a strategy should include the following points:

- Where possible, preventing waste, repurposing existing resources and redesigning products to increase their lifespans should be prioritised.

- For waste that cannot be prevented, measures should be put in place to maximize its re-use and recycling. Increased biogenic waste separation is also needed to reduce the contamination of recyclable waste. Residual waste sorting should also be added to ensure that recyclable materials are not being incinerated.

- EU waste reduction and recycling policies need to be taken into account in waste management strategies.

- Existing waste incinerators that will operate in the coming decades need to reduce their greenhouse gas emissions and cannot continue to release greenhouse gases into the atmosphere.

- CCS can reduce emissions in the waste incinerators that will be operational in the decades to come and should be a requirement for their operation.

- Waste incineration should be included in the EU ETS to incentivise emission reductions.

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