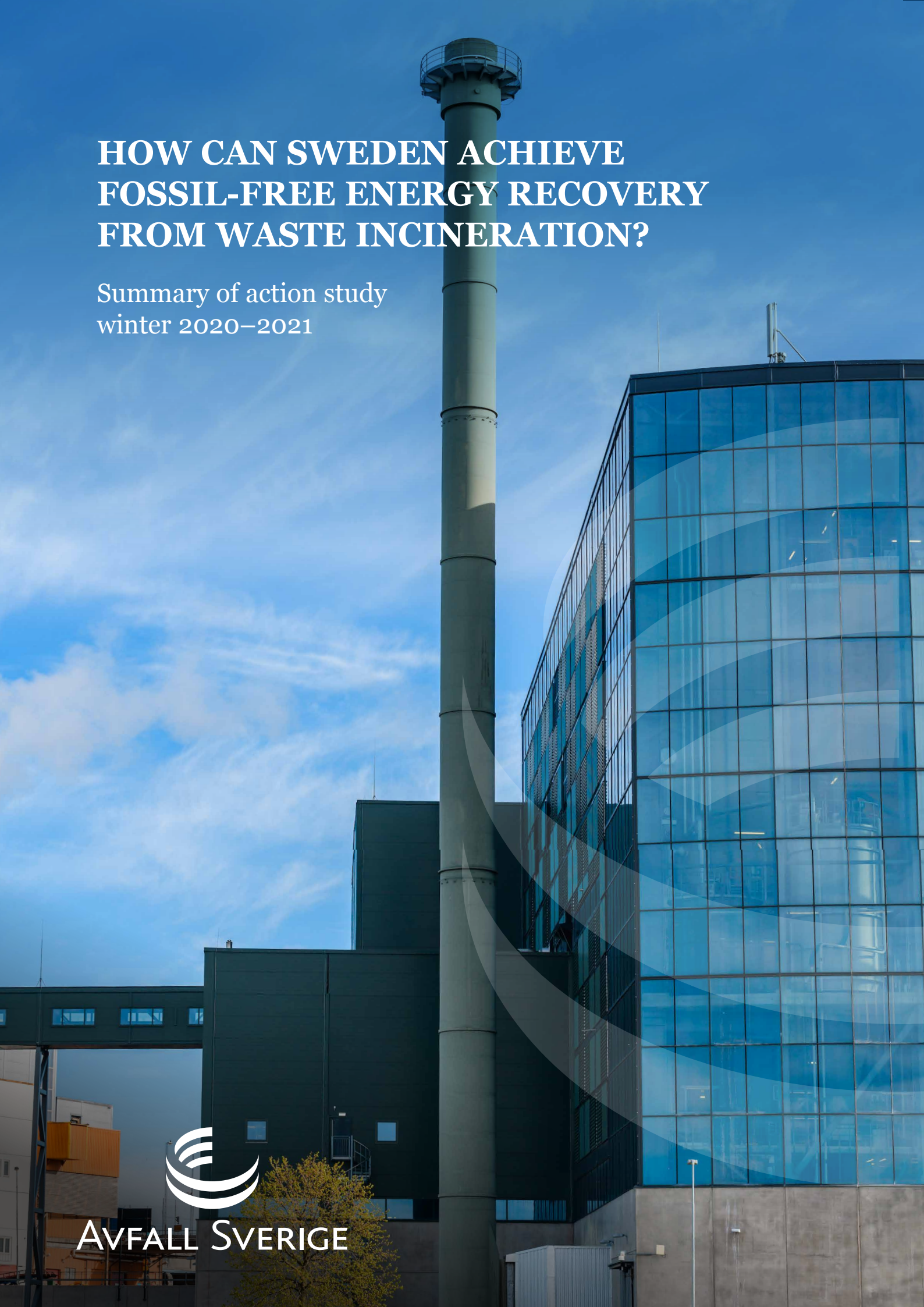


HOW CAN SWEDEN ACHIEVE FOSSIL-FREE ENERGY RECOVERY FROM WASTE INCINERATION?

Summary of action study
winter 2020–2021

AVFALL SVERIGE

Preface

Cutting emissions in half by 2030 and reducing emissions much further by 2045 are achievable goals. But it will require major changes and stronger instruments.

Fossil emissions from waste to energy recovery are ultimately due to the large quantities of products containing fossil plastics on the market, many of which are not designed to be recycled. In addition, packaging subject to producer responsibility is too often sorted incorrectly and ends up in residual waste. This causes problems, and is one of the factors over which Sweden's energy recovery organisations have no control. Fossil-free energy recovery can therefore not be achieved simply by switching fuels. Municipalities have an obligation to dispose of municipal residual waste, and the landfilling of combustible waste is prohibited. At the same time, climate change is a top priority for the energy recovery industry.

Avfall Sverige's Energy Recovery Working Group has adopted positions on fossil freedom that set ambitious targets. The industry wants to cut its fossil emissions in half by 2030, and reduce them to near zero by 2045.

To achieve these targets, there must be collaboration with actors who have control over other parts of the products' life cycle. Huge steps must be taken in areas such as product design and material recycling. Both producers and legislators have a vital role to play here, but the energy recovery industry must also be part of the solution to the problem. This includes exploring all possible measures that can be taken to reduce emissions from our plants, as well as their potential to bring us closer to our goals up until the year when Sweden is fossil free. This report shows what shape such a journey could take, from the present to 2045. It is an important foundation for showing what room to manoeuvre exists, and what limits it. This is a shorter version of a more extensive report, which is available in Swedish to members on Avfall Sverige's website[1].

Avfall Sverige's Energy Recovery Working Group has commissioned 2050 Consulting to act as process manager and author. The project has been funded by Avfall Sverige's Energy Recovery Working Group.

Malmö, April 2021

1 https://www.avfallsverige.se/kunskapsbanken/rapporter/rapportera/article/backcasting-hur-nar-sverige-fossilfri-energiatervinning-fran-avfallsforbranning/

Background

In 2019, the energy recovery industry agreed on a number of positions to achieve the targets of cutting fossil emissions in half by 2030 and reducing them to near zero by 2045. In addition, the member companies of Avfall Sverige have their own targets, some of which are even more ambitious.

The positions on decarbonisation adopted by the Avfall Sverige Energy Recovery Working Group specify a number of measures to achieve the targets. The focus of this report has been to quantify the measures that are within, or close to being within, the companies' control in order to determine how much progress the industry can make.

A key issue in this context is the relatively low level of control that energy recovery companies have over waste streams. Nevertheless, it is essential that the energy recovery companies take the measures possible within their own operations.

ENERGY RECOVERY IN FIGURES

Approximately half of the waste generated by Swedish households is sent to energy recovery. About one-third undergoes material recycling and close to 15% is sent to biological treatment.

According to a survey commissioned by the Swedish Environmental Protection Agency, a dominant share of household plastic waste goes to energy recovery. In addition to household waste, businesses also generate large volumes of waste that is sent to energy recovery.

In 2019, 6.7 million tonnes of waste were sent to energy recovery (figure also includes imported waste).

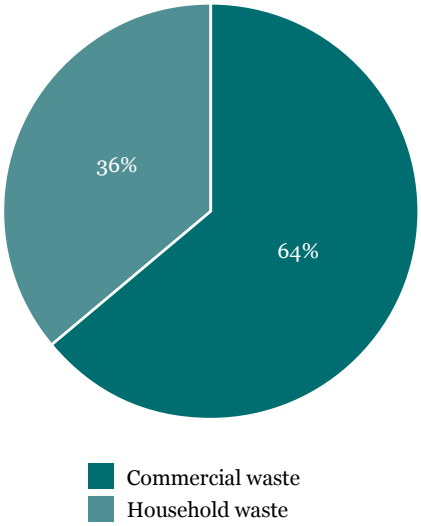
The carbon dioxide emissions from energy recovery are equivalent to (2019):

- 6% of Sweden's total territorial emissions.
- 15% of Sweden's total CO_2 emissions reported to the EU ETS.
- 74% of Sweden's emissions reported to the EU ETS in the electricity and district heating sector.

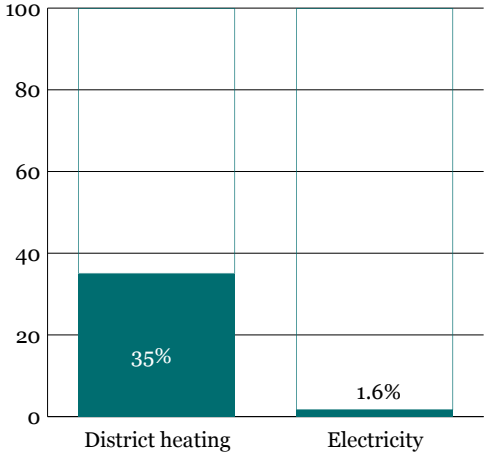
At the overarching level, the industry – and society at large – has two possible strategies to reduce emissions from energy recovery, namely reducing the amount of fossil-based content in the waste and capturing emissions at the plant. This report highlights and quantifies the main measures within both of these strategies.

Energy recovery accounted for 35% of Sweden's total district heating production in 2019, amounting to 17.8 TWh. At the same time, energy recovery produced 2.7 TWh of electricity, equivalent to 1.6% of Sweden's total electricity production.

Waste to energy recovery (2019)



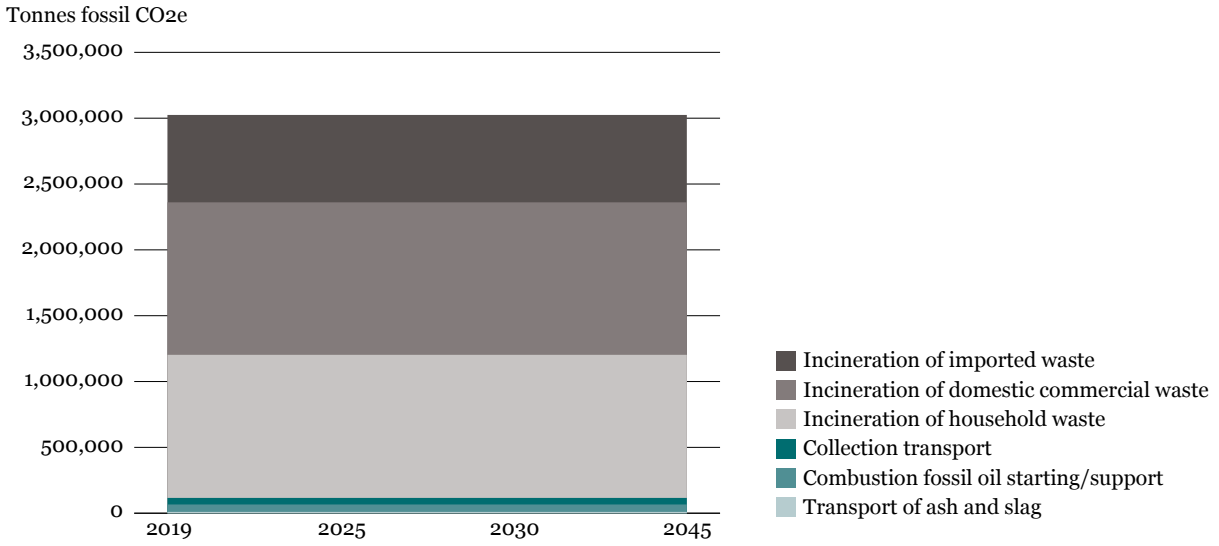
Energy recovery's contribution



Results

The analysis is based on a business-as-usual scenario, where incineration capacity is maintained at the current level until 2045. We assumed that domestic waste becomes a communicating vessel with imported quantities of waste – with the incineration capacity as a ceiling. If domestic waste quantities increase, the amount of imported waste decreases, and vice versa. A key assumption is that the amount of waste for energy recovery remains at the same level as in the business-as-usual scenario, i.e. if a measure reduces the amount of domestic waste for energy recovery, it is assumed that released capacity is filled up with imported waste of the same composition.

Figure 1. Business-as-usual scenario for energy recovery.
Industry targets for 2030 and 2045 are marked.



There are projections pointing to increased plastic use in society, which could likely increase the proportion of plastic in waste – and thus fossil emissions. At the same time, we see a strong focus on measures and instruments for a shift towards more circular material flows and an increased proportion of renewable plastic raw materials. This analysis does not include any projections of increased plastic volumes, but rather a business-as-usual scenario that assumes plastic use in society will remain constant.

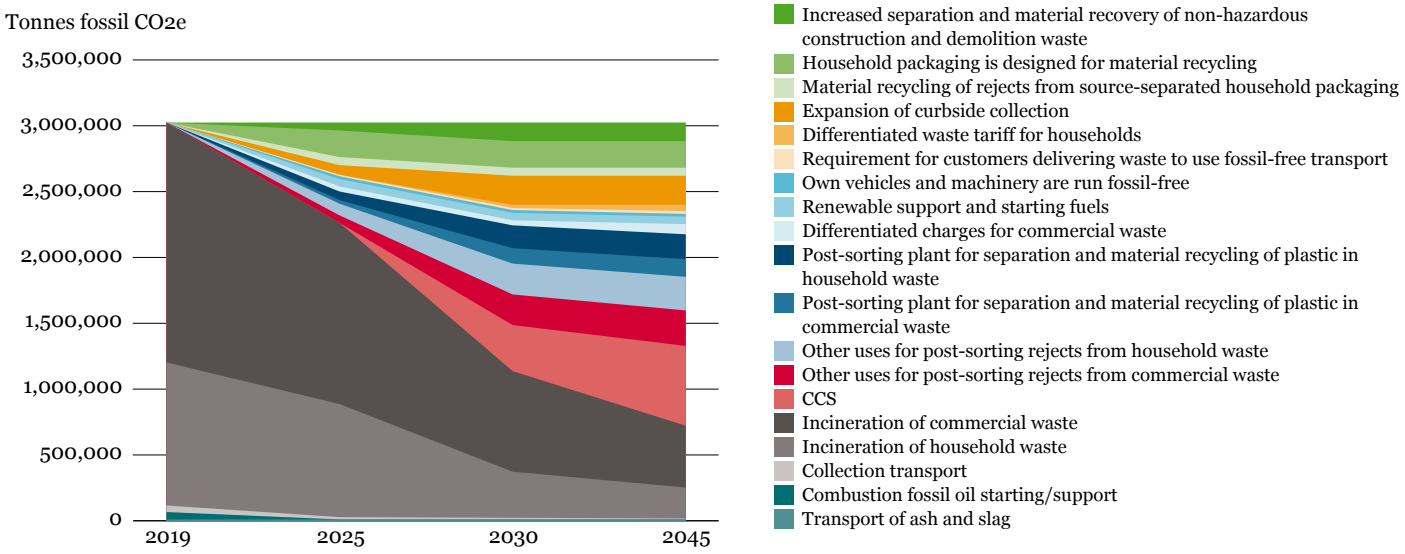
The table below provides an overview of the different measures included in the action analysis. The climate impact of a selection of the measures identified during the initial stages of the project has been quantified using the backcasting method.

Table 1. Measures outside of and within Avfall Sverige member companies' control. *All assumptions, references and other details of each measure can be found in the report.*

Measure	Description and estimation assumption
Outside of member company's control	
Increased separation of non-hazardous construction and demolition waste	Approx. 11% of plastic in commercial waste comes from construction and demolition waste. The law requiring the separation of construction and demolition waste, which came into force in summer 2020, is assumed to result in the separation and recycling of 70% of construction and demolition waste by 2030.
Household packaging is designed for material recycling	Several initiatives have been implemented from different industries to increase the recycling rate of plastic packaging. The proportion of packaging designed for recycling is expected to increase from 55% to 95% by 2025, reducing the amount of plastic rejects collected for source separation.
Material recycling of rejects from source-separated household packaging	Current rejects from the sorting of source-separated household packaging are used to make new plastic products. 90% of the rejects from the sorting of source-separated plastic packaging are assumed to be recycled to lower quality.
Expansion of curbside collection	At present, approx. 40% of Swedish households have access to curbside collection. The proportion should increase to 60% by 2025, and reach 100% by 2030. It is assumed that this will reduce the amount of packaging in residual waste by approx. 37%, from 1.9 kg to 1.2 kg, for the households that get access to curbside collection.
Other uses for post-sorting rejects from household residual waste	Rejects from post-sorting of household packaging are used for new plastic products or sent for energy recovery with CCS. It is assumed that 90% of new reject streams from post-sorting will be used for new products or set for energy recovery with CCS.
Other uses for post-sorting rejects from commercial and industry waste	Rejects from post-sorting of household-like commercial and industry waste are used for new plastic products or sent for energy recovery with CCS. It is assumed that 90% of new reject streams from post-sorting will be used for new products or set for energy recovery with CCS.
Within member company's control	
Differentiated waste tariff for households	Individualised waste tariff and feedback for correct sorting of food waste and/or packaging. If possible to implement from a GDPR perspective, it is assumed that the measure could result in 10% of plastic packaging in residual waste being diverted to source separation and recycling.
Requirement for customers delivering waste to use fossil-free transport	Contractors managing waste collection/transport to waste incineration plants are required to use fossil-free transport. External waste suppliers are assumed to account for 50% of connection transports. It is assumed that 50% will have converted by 2025, 75% by 2030 and 100% by 2045.
Own vehicles and machinery are run fossil-free	Own vehicles and machinery used in collection transport and at plants are converted to renewable fuels. Assumed to account for 50% of the total collection transports. Switch to renewable fuel is assumed to reduce WTW emissions by 85% on average.
Renewable support and starting fuels	A measure several of the member companies have already implemented; others are in progress. Should be completed by 2025. It is assumed that all plants will have phased out fossil support and starting fuel by 2025.
Differentiated charges for commercial and industry waste	Differentiated treatment charges can steer towards increased separation of recyclable materials, including plastic fractions, in commercial and industry waste. This is assumed to result in 5–10% of the plastic stream in mixed commercial and industry waste could be diverted to other uses.
Post-sorting plant for separation of plastic in household residual waste	Post-sorting of all residual household waste that arrives at the plant. It is assumed that the 15 largest plants will have post-sorting installed by 2045, with two already by 2025 and ten by 2030. It is assumed that post-sorting will be able to remove 75% of the incoming plastic, of which it is assumed that approx. 60% will become rejects in subsequent sorting and sent back for energy recovery.
Post-sorting plant for separation of plastic in commercial waste	Post-sorting of all mixed commercial and industry waste and waste from the manufacturing and service sector that arrives at the plant. It is assumed that it will also be possible to run household-like commercial and industry waste and mixed combustible waste through the post-sorting plants. The same assumption on number of plants as for the preceding measure, but it is assumed that 70% of separated plastic will be sent back for energy recovery.
CCS (Carbon Capture and Storage)	Installation of CCS at own plant It is assumed that ten of the largest plants will have installed CCS by 2045, with five of these by 2030. It is assumed that 90% of emissions from these plants will be captured.

The estimated impact of a measure depends on what other measures have already been implemented. In order to be able to scale the impact of different measures, it is therefore necessary to determine the order in which different measures are implemented. The analysis assumes that upstream measures are prioritised and implemented first. This means, for example, that measures to separate and recycle part of the plastic in the waste are counted before the effect of installing CCS in a waste incineration plant.

Figure 2. All measures – both within and outside the companies' control – are expected to reduce emissions from energy recovery.

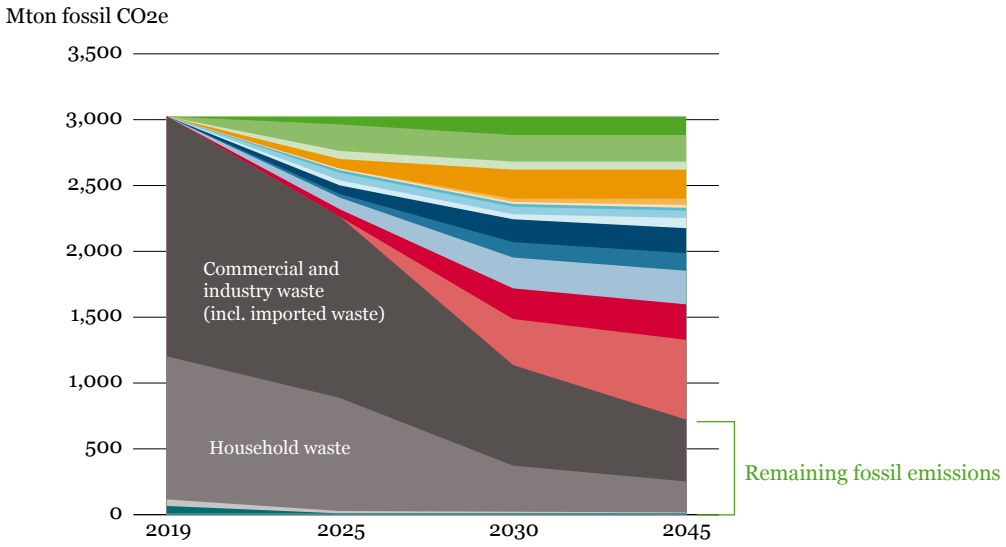


GAP ANALYSIS

Based on the business-as-usual scenario assumed and the extent to which the analysed measures are implemented, fossil emissions can be reduced by more than 60% in ten years' time, which well meets the commitment to cut fossil emissions from energy recovery in half by 2030. This is a development that requires active commitment from both Avfall Sweden member companies and other societal actors, but the analysis nevertheless indicates that it is a goal that is achievable or even surpassable.

By 2045, however, some 0.7 million tonnes of fossil carbon dioxide emissions still remain. This gap could be partly filled by more ambitious implementation of certain measures and/or the introduction of other types of measures not included in the current analysis.

Figure 3. The gap between the near-zero emissions target for 2045 and the estimates for all measures combined.



NEED FOR NEW OR MODIFIED INSTRUMENTS

The instruments and innovations highlighted by the member companies themselves in this study focus on the measures quantified in the report and over which the companies have more or less control.

Measure	Perceived obstacles and need for instruments
Differentiated charges for commercial and industry waste and household residual waste	• Technological developments are important. Tools are needed to determine plastic content and differentiate tariffs. • There is a need for better enforcement and a clearly regulated market to prevent waste from going to the wrong place. • For commercial and industry waste, it needs to be easier to perform solid waste analyses on the waste delivered, and penalties need to be applied for high plastic content.
Requirement for customers delivering waste to use fossil-free transport	• Instruments are needed from the National Agency for Public Procurement to set the right requirements in transport procurement. • It must also be possible for waste companies, as the contracted party, to set their own requirements within the framework of the contract.
Own vehicles and machinery are run fossil-free	• Instruments that promote fossil-free transport in general.
Renewable support and starting fuels	• The carbon dioxide price needs to go up so that fossil alternatives become more expensive than fossil-free alternatives. • Long-term tax relief for bio-oils should also be made more permanent. • Technological development of renewable fuels, as these are more difficult to store for longer and sometimes have unclear operating parameters.
Post-sorting plant for separation of plastic in commercial and industry waste and in household residual waste	• The business model for a post-sorting plant is uncertain, as the responsibility for large parts of the waste lies with the producers, according to the Producer Responsibility regulation. • Quota obligations on recycled plastics may make post-sorting plants economically viable.
CCS	• For CCS to be realised on a larger scale, new instruments are needed, such as reverse auctions specially adapted for waste CCS. • To some extent, the fossil part will be financed by reducing the need for emission allowances in the EU ETS. • Another way to finance CCS is through higher costs for waste suppliers, which requires political decisions. When a municipality procures waste incineration, they should also procure the carbon sink for the corresponding amount. • In future, CCS should be a requirement in environmental assessments of cogeneration plants, if they are to be allowed to burn fossil residual products.

The energy recovery industry has often highlighted that measures are also needed higher up the waste hierarchy to address fossil emissions from waste management. Several other studies, including by the Swedish Environmental Protection Agency and Energiföretagen Sverige, have investigated what instruments are currently lacking to achieve the fossil-free energy recovery targets.

Some of the instruments and measures discussed and investigated are:

- a requirement for an increased proportion of renewable plastics in products
- a requirement to recycle all fossil plastics
- introducing various climate charges on the sale of fossil plastics and plastic products
- phasing out fossil plastics through a ban
- a change in society's view of what constitutes waste and new legislation to facilitate reuse at recycling centres
- increased supervision and sanctions in connection with source separation
- the introduction of a requirement for emission allowances for methane emissions from landfills
- requirement for product design to promote recycling

Conclusions

A backcasting analysis based on long-term goals shows a simplified picture of reality. Backcasting for an entire industry generalises even more than the corresponding exercise for a single company would. The description and quantification of measures in the backcasting aim to provide a platform for individual companies' strategic work towards reducing their carbon footprint. While it is unlikely that all companies will implement all the measures, backcasting can provide a knowledge base for making informed decisions when formulating company-specific strategies. The report is also supplemented with proposals for a number of milestones that member companies can work towards, linked to the quantified measures.

The study has shown that it is entirely possible for the sector to more than halve emissions by 2030. This is very positive as cutting emissions in half in the current decade is crucial to mitigating global warming. The backcasting analysis also shows that the industry has an opportunity to decouple energy recovery emissions from population growth and economic growth.

With the measures known today, the goal of near-zero emissions by 2045 will not be achieved. Naturally, these figures become increasingly uncertain the further out in time one looks, but the remaining gap clearly demonstrates the need for greater innovation in the sector and underlines the need for stronger instruments upstream in the value chain – at the waste end it is often too late.

An important factor for energy recovery in the future will be the price development of EU emission allowances. From being a marginal cost, it is now becoming a relatively large cost. The EU ETS does not affect the amount of residual waste generated, but is likely to be the main driver for some of the proposed measures in the future.

However, it is not clear that increased regulatory costs alone will be sufficient to motivate investment in CCS technology.

A number of factors have been identified for which there is insufficient credible evidence to quantify the impacts. Some of these represent future opportunities that could lead to an improved outcome, but there are also some factors that could lead to a worse outcome. Some examples of these uncertainty factors are whether and how quickly a transition to renewable raw materials in plastic production can take place, how increased demand for recycled materials (e.g. due to quota obligations) may affect the levels of material recycling in society, how the use of plastics in society will develop, and what form the technology development of Carbon Capture and Storage will take.

Even if progress is rapid, the analysis shows that the management of fossil content in residual waste is to some extent stuck in limbo. The current regulatory framework is incomplete. Producer responsibility only covers certain materials, collection responsibility is weak and consumer responsibility is unclear to the general public. These shortcomings, in turn, lead to an unclear picture of who should actually take responsibility and where in the value chain the cost should be borne. The more this is clarified, the easier and cheaper it will be to achieve fossil-free energy recovery. The challenge is common throughout the value chain, and there is a need for increased cooperation between the energy recovery industry and the actors up the value chain.

Read more about Swedish energy recovery from waste on Avfall Sverige's website (www.avfallsverige.se).

Links

Rapport 2021:09 Backcasting – hur når Sverige en fossilfri energiåtervinning från avfallsförbränning
https://www.avfallsverige.se/aktuellt/nyhetsarkiv/artikel/backcasting-hur-nar-sverige-fossilfri-energiatervinning-fran-avfallsforbranning/

Avfall Sveriges ståndpunkter om energiåtervinning
https://www.avfallsverige.se/fileadmin/user_upload/1_om_oss/Staandpunkter_energiaatervinning.pdf

Avfall Sveriges ståndpunkter om plast
https://www.avfallsverige.se/fileadmin/user_upload/1_om_oss/staandpunkter_plast_2020.pdf

Avfall Sveriges rapport 2020:05 Allokering av fossila utsläpp från energiåtervinning till producent- och konsumentled
https://www.avfallsverige.se/kunskapsbanken/rapporter/rapportera/article/allokering-av-fossila-utslapp-fran-energiatervinning-till-producent-och-konsumentled-forslag-till/

Avfall Sveriges rapport 2018:28 Hur når vi en fossilfri energiåtervinning - en scenarioanalys
https://www.avfallsverige.se/kunskapsbanken/rapporter/rapportera/article/hur-nar-vi-en-fossilfri-avfallsforbranning-en-scenarioanalys/

Färdplanen för en fossilfri uppvärmningsbransch
http://fossilfritt-sverige.se/wp-content/uploads/2020/10/ffs_frdplan-fossilfri-uppvrmnin_200908.pdf

Energiföretagen Sverige's Energy roadmap [in Swedish]
https://www.energiforetagen.se/fardplan-energi/

Swedish Environmental Protection Agency's page summarising the report on plastic streams in Sweden [in Swedish]
https://www.naturvardsverket.se/Miljoarbete-i-samhallet/Miljoarbete-i-Sverige/Uppdelat-efter-omrade/Plast/Plastfloden-i-Sverige/

Report on instruments to reduce the climate impact of plastic [in Swedish]
http://www.naturvardsverket.se/Om-Naturvardsverket/Publikationer/ISBN/6900/978-91-620-6928-5/

Det går om vi vill – förslag till en hållbar plastanvändning (SOU2018:84)
https://www.regeringen.se/rattsliga-dokument/statens-offentliga-utredningar/2018/12/sou-201884/?TSPD_101_R0=088d4528d9ab2000c2e88edefceeff49df3cbad4ce8982a981cfa3d5081f455df19686ae031c8aca08765f167514300098342 81d964751e7ad3d8ed6d00b3c93fa244da27925c7b9d229f3d9b493b2badcea576886739e7d5ec0409a3b40f096b9d229f3d9b493b2badcea576886739e7d5ec0409a3b40f096

Swedish Waste Management [in Swedish, English version available]
https://www.avfallsverige.se/fileadmin/user_upload/Publikationer/SAH_2020.pdf

Avfall Sverige is the municipalities' trade association in the field of waste management and recycling. Avfall Sverige's members ensure that waste is collected and recycled in all Swedish municipalities. We perform our work on behalf of society: in an environmentally sound, sustainable and long-term manner. Our vision is "Zero Waste". We are taking action to minimise waste, promote reuse and ensure that the waste produced is recycled, recovered and managed in the optimal manner. Municipalities and their enterprises are the ambassadors, catalysts and guarantors of this change.

AVFALL SVERIGE

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