

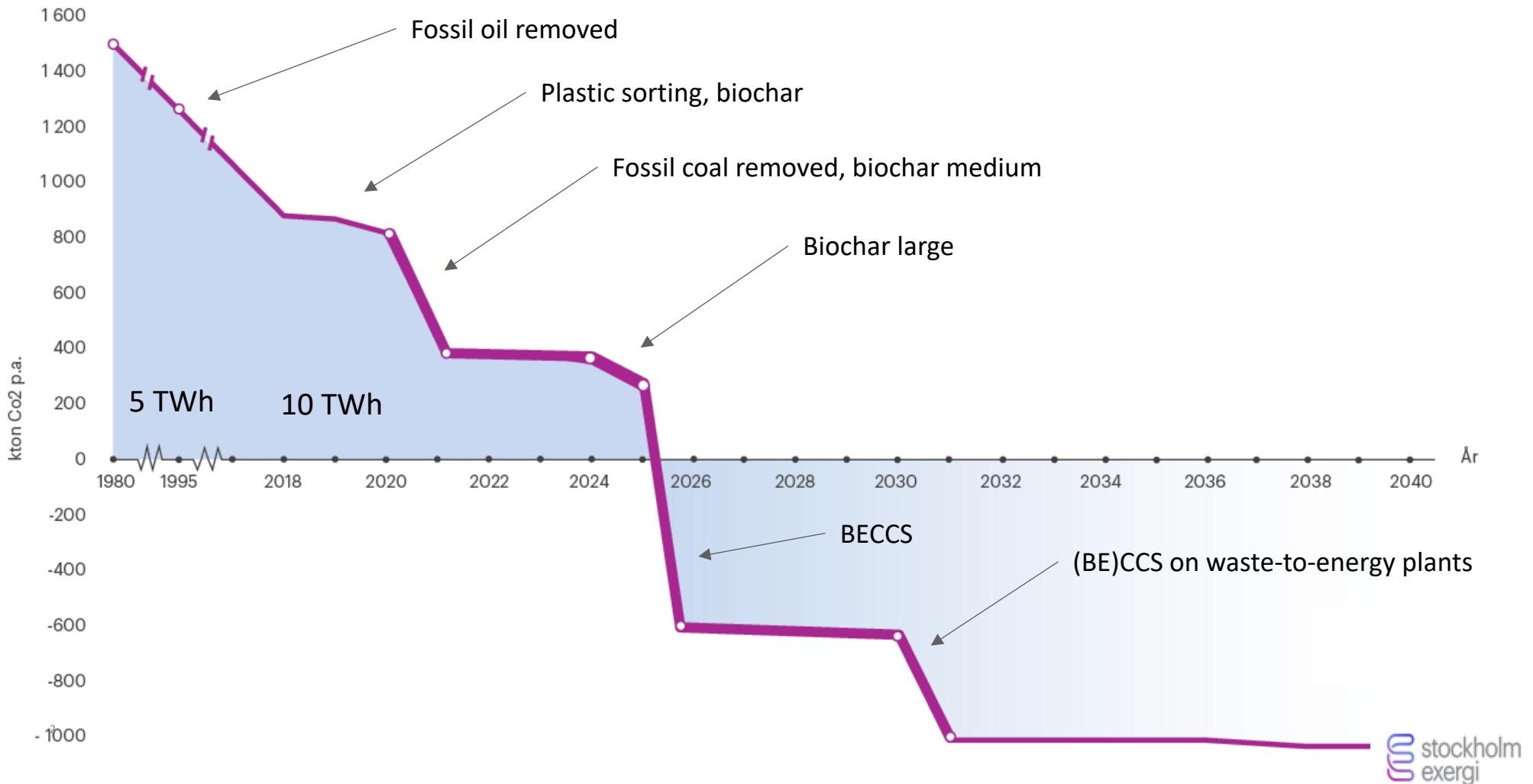


# Negative emissions and policy requirements - in the Stockholm multi-energy system

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# Emissions of CO<sub>2</sub>-eq from district heating and electric power production in Stockholm: 75 % reduction until 2024, negative thereafter





# Production of biochar and district heating

- Minus 100 g CO<sub>2</sub>/kWh heat
- Minus 1 ton CO<sub>2</sub>/year for normal apartment
- Negative emission district heating sold on market in Stockholm



# Test facility for BECCS

- 400 MW biomass fired CHP plant
- Aim: suspend disbelief in technology
- Full scale can remove 800.000 ton of CO<sub>2</sub>/year





# General view on CDR policies

- Several CDR methods should be incentivized, since none is presently foreseen to alone facilitate necessary carbon sinks to meet the 1,5 °C target.
- Policies should be specific for each CDR-method (or group) during initial establishing of technologies in order to reach market readiness, since they differs with regard to
  - permanency
  - scale
  - potential
  - technological maturity
  - investment costs and operational costs
- If possible policies should also add other benefits apart from CDR, such as:
  - fossil emission reduction
  - adaptation to climate change
  - waste reduction

# Required policy support for BECCS

- Focus on supporting operational costs, also covering the investment. Investment funding alone will not ensure that plants are operated.
- Support needed is in the range of 100 €/ton of removed carbon dioxide.
- Several options for financing BECCS from biomass incineration:
  - Tax or market credits for each ton of removed carbon dioxide, financed by fossil carbon tax or market based credits. Will also work towards fossil emission reductions.
  - Public reversed auctions, i.e. governments buying negative emissions. Will ensure cost efficient BECCS deployment. Marginal cost abatement curve will be followed.
  - EU-ETS is not a short term option, but could be a long term alternative if carbon price and BECCS cost converges.



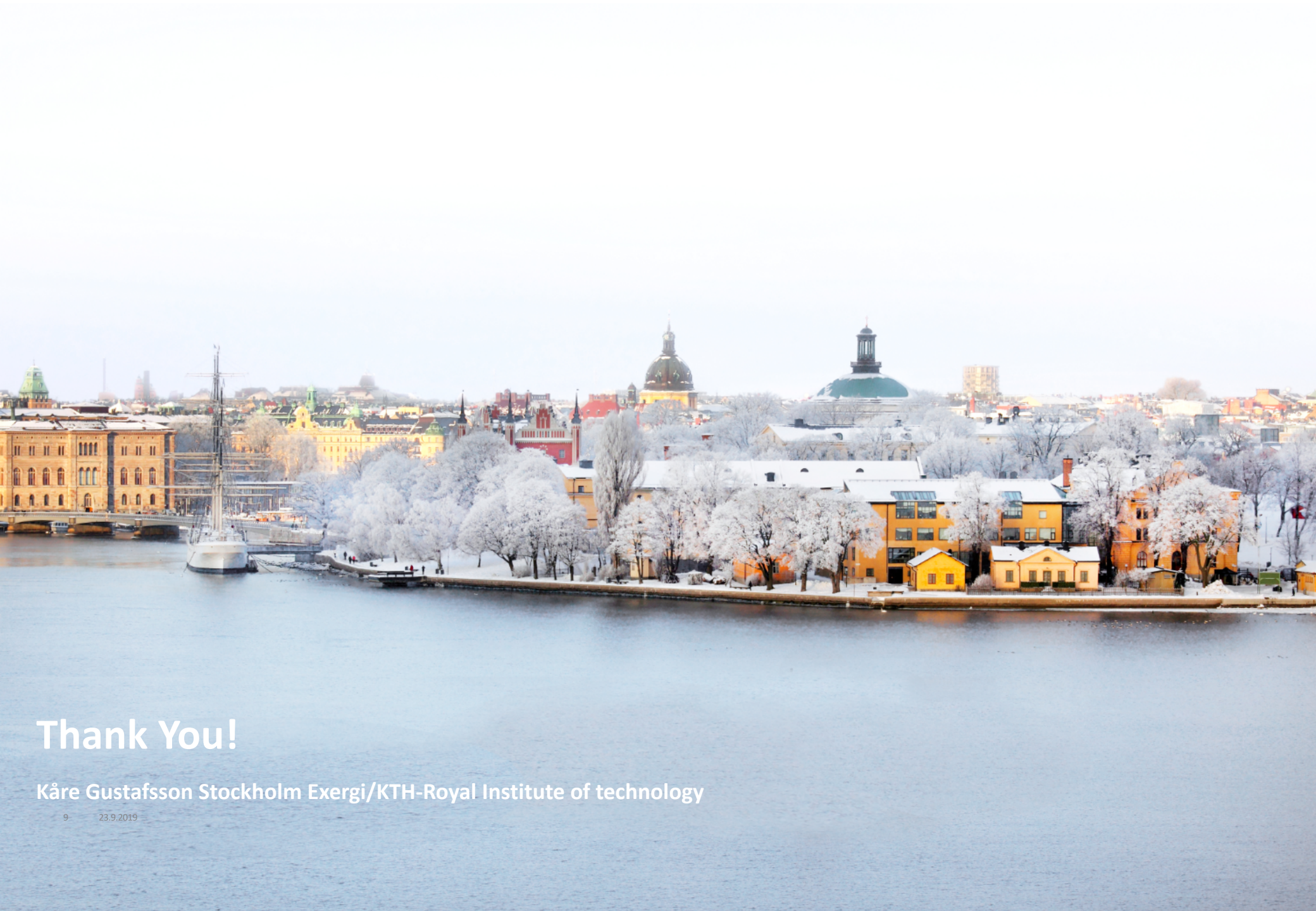
# Required policy support for Waste-to-Energy (BE)CCS

- Two thirds of the energy in waste is of biogenic origin, therefore net negative emissions will be the result of carbon capture on Waste-to-Energy plants.
- Two options for financing:
  - Packaging fee on fossil based packaging materials. Is likely to lower amount of fossil waste.
  - Regulation that dictates that Waste to Energy fossil emission should be countered by CDR. Either directly with CCS on the Waste-to-Energy plant, or by trade with market based carbon credits. Cost burden will transferred to the public and organizations that generates waste. Could drive towards less waste generation.

# Required policy support for Biochar

- Focus on investment costs for smaller units, up to 10.000 tons of biochar per year.
  - A support level of around 40 % of the investment is likely to ensure profitability for projects.
  - Biochar is assumed to be sold for usage in commercial soil or as a feed additive, with corresponding high biochar price level.
  - Farm scale biochar units will be deployed by this incentive, since there are added benefits for farmers. Shown by current incentive scheme in Sweden.
- For large scale biochar units is support of operational costs might be a better option.
  - Biochar would be aimed at the agricultural market with lower price level.
  - Either supply or demand side can be incentivized, but should be harmonized between regions to avoid unfair competition.
  - To reach agricultural mass market, incentives of around 100 €/ton of removed carbon dioxide is foreseen as needed, based on our market analysis of agricultural benefits and paying capacity of farmers in Sweden.
  - Will have additional benefit of adaptation to climate change.
  - Financing could be by reversed auction, carbon tax credits, i.e same as for BECCS.
- Compulsory Biochar carbon sink certification necessary to avoid flooding of market by low grade biochar with a fast degradation rate.





Thank You!

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