NORDIC CLEAN ENERGY SCENARIOS

Reaching Nordic Carbon Neutrality The Role of Bioenergy and Negative Emissions

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The platform for cooperative energy research and policy development under the auspices of the Nordic Council of Ministers



Nordic Energy Research

"Our vision is to make the Nordic region the most sustainable and integrated energy region in the world."

Klaus Skytte CEO, Nordic Energy Research



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Solutions for Carbon Neutrality

Stepping up Nordic Climate Co-operation

"The aim of the Nordic countries is to be carbon neutral and to demonstrate leadership in the fight against global warming"



The Nordic prime ministers in their declaration at the summit in Helsinki 25.01.19

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Solutions for Carbon Neutrality

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Nordic Energy Technology Perspectives 2016



Project Partners

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Norwegian University of Life Sciences















Three scenarios

Carbon Neutral Nordic (CNN)

Nordic powerhouse (NPH) Climate Neutral Behaviour (CNB)



Five Solution Tracks to Carbon Neutrality



will lower the demand for energy and make the transition easier

The Important but Shifting Role of Bioenergy



Biomass share Total energy consumption



Bioenergy use increase, and partly change



Total bioenergy use - CNN scenario

Bioenergy use increase, and partly change



Forest biomass – the main biomass resource in the Nordics



Forest biomass potential split on biomass types

Increasing potential:

- + Increased use of wood in construction
- + Less use of wood for printing paper

Decreasing potential:

- Increased use of low quality wood for other purposes
- Extended environmental restrictions



Source: Adapted from Pöyry & Nordic Energy Research, 2019

Bioenergy growth is more moderate than in previous studies...

...partly due to higher pace of electrification in transportation



Bioenergy challenges and trade-offs

1. Environmental impacts from biomass harvesting





Bioenergy challenges and trade-offs

- 1. Environmental impacts from biomass harvesting
- 2. Managing short- and long term climate impacts



Managing trade-offs

Prioritise solutions that use waste resources and forest industry residues



Bioenergy challenges and trade-offs

- 1. Environmental impacts from biomass harvesting
- 2. Managing short- and long term climate impacts
- 3. High energy efficiency in heating, or fuels for hard to abate sectors?



Managing trade-offs

Long-term competing technology tracks for bioenergy in the NCES

Bioenergy primarily competes with	Heavy-duty transport	Industry processes	Heat
Direct electrification	Х		Х
PtX	X	X	
CCS/BECCS		Х	

- Biofuel have lower efficiency but higher substitution effect in the long run
- Bioheat may provide much needed long-term flexibility to largely electrified heating systems

Key messages Bioenergy in the Nordic Clean Energy Scenarios

- Wood waste and forest industry residues remain important renewable energy resource towards 2050
- Biomass can to a larger extent be utilised in hard-to-abate sectors
- Offers flexibility in the transition
- Sustainable biomass supply is a key factor
- Deliver negative emissions needed to meet Nordic climate targets

Negative Emissions are Essential for Reaching Nordic Targets



Included Nordic GHG Emissions

The Nordic GHG emissions covered by national targets **and the emissions covered by the NCES project**



NCES Open-Source Toolbox





-Non-CO₂

-LULUCF

Energy related CO₂

Sum of Nordic historic GHG emissions and plotted sum of Nordic national targets



-Net total

-Non-CO₂

-LULUCF

Energy related CO₂

Country specific GHG balance





-Net total

-Non-CO₂

-LULUCF

Energy related CO₂

Country specific GHG balance



Negative emissions are necessary to reach Nordic national targets



From 2025 CO₂ capture need to increase at a rapid rate until 2035

90% of captured CO₂ is from biogenic sources and 10% from fossil

20-30% of captured CO₂ in 2050are reused for fuel production

All scenarios reach national target's but amount of CO₂ captured in 2050 depends on cost and acceptance





7.5Mton CO_2 Storage potential exceed projected captured volumes 4Mton CO₂ Iceland > 7000Mton CO₂ 1.5Mton CO₂ ...or more than 230 years of storing 0.5Mton CO₂ Nordic capture needs ~14 Norway > 35000Mton CO₂ ...or more than 1200 years of 7Mton CO₂ storing Nordic capture needs 5Mton CO₂ Denmark > 21000Mton CO₂ ...or more than 700 years of storing Nordic capture needs Sweden > 1700Mton CO₂ ...or more than 55 years of storing Nordic capture needs 6.5Mton CO₂ 2.5 Mton CO₂

 $6Mton CO_2 6.5Mton CO_2$

7.5Mton CO_2 Ongoing and planned CCS projects in the Nordics 4Mton CO₂ Capture Storage Iceland Online - Basalt Orca: Online -1.5Mton CO₂ 0.4Mton CO₂/year rock 0.5Mton CO₂ ~14 Norway Northern Light, Online - oil 2024: 1.5Mton field reservoir CO_2 /year 7Mton CO₂ Denmark Waste and Nini oil field: 4-5Mton CO₂ 8Mton CO₂/year cement Harald oil field: 3-2025: 1-2Mton CO_2 /year 16Mton CO₂/year Sweden Power plants and Danish and industry Norwegian 2025: 1.2Mton CO₂ storages 6.5Mton CO₂ 2030: 5Mton CO₂ 2045: 18Mton CO₂ 2.5 Mton CO₂ 6Mton CO₂ 6.5Mton CO₂

Carbon capture options included in the model



Modelled CO₂-flows



The Nordic countries go for different CCS solutions



Drivers for carbon capture in the Nordic countries

Denmark and Iceland:

Driven by need to compensate large LULUCF emissions and other non-energy emissions

Norway: Easy access to storage

Sweden and Finland:

Heavy industries where replacing fossil fuels is costly

Least costs vs. real life development



Remaining Emissions in the CNN Scenario

About 33 Mton of energy-related CO_2 emissions remain in hardto-abate sectors by 2050.



Key messages CCS and BECCS in the Nordic Clean Energy Scenarios

- Negative emissions are a necessary to reach carbon neutrality targets
- In 2050 12% of needed Nordic emission reductions come from capture and storage
- 90% of captured CO2 in 2050 is from biogenic sources and municipal waste
- Nordic countries are well suited for CCS and negative emissions
- The competition between different CCS options is tight

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Thank you!

Join us January 19th for the second results webinar

Access the Nordic Clean

Energy Scenarios report at

WWW.NORDICENERGY.ORG

