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Nordic Clean Energy Scenario

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Five Solution Tracks to Carbon Neutrality



Direct Electrification is Central to all Decarbonisation



CARBON NEUTRALITY

Direct Electrification Dramatically Improves Energy Efficiency

- Changing from fossil fuel to EV reduces the energy demand per km by 80%
- Not only emission reduction but also an increase in energy efficiency
- New ways of transport may reduce the numbers even more
- The same effect may be valid for many applications





Direct Electrification is Accelerating in all Transport Modes





Electricity demand grows in all sectors



7

Least cost (CNN)



- - Electricity share of final energy consumption increases from 30% today to more than 50% in 2050.
 - In the least cost solution increase the energy demand by 40%.
 - It will be important to electrify everything that is possible.



Power-to-X and Hydrogen is not just Hype





Significant Impact on Nordic Electricity Production

- EU hydrogen demand offers export revenues but put pressure on the electricity system
- Not necessarily the cheapest option to produce huge amounts of hydrogen
- Hydrogen ay be a source for flexible demand
- May introduce many land use conflicts
- Bioelectricity may deliver for 33-35 TWh







Demand of bioenergy

- Slightly increase in bioenergy from industrial processes, mainly from waste and by-products
- 20% reduction in district heat and power outputs, mainly reduced use of pellets
- Bioenergy in households is expected to reduce, due to more use of electrical heating
- Biofuel use in transportation is assumed to increase towards 2025 for than to be reduced. Biofuel may be the most important liquid source in aviation in 2050



Bioenergy Use Increase



...but growth in demand for liquid biofuels is significantly lower than in previous studies





Biofuel may become competitive





Four Bioenergy Takeaways

- Development in transport electrification could lower the pressure on bioenergy resources
- Biomass and biofuels play an important interim role in most sectors
- Maintaining sustainability despite increased demand will continue to be an important topic
- Biomass demand should shift to increasingly be utilized in hardto-abate sectors such as heavy transport, steel and cement

Target areas for bioenergy



- Facilitate electrification of heating, but plan for flexible heating systems where biomass may supplement electricity in periods of high heat demand and low electricity supply.
- Rely on technologies that can use waste resources, wood waste, and forest industry residue resources.
- High-quality wood should be allocated for building materials and other applications storing carbon in products.
- The biofuel blending requirements deployed in the Nordic countries should be strengthened, mainly advanced biofuels.
- Priorities development of technologies that can provide fuels for aviation.

Carbon Capture and Storage, along with Negative Emissions, are Essential to Reach Nordic Climate Neutrality Targets



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17

Remaining Emissions in the CNN Scenario

- After direct electrification, change to hydrogen and biomass is still about 33 Mton of energy-related CO2 emissions remain in hard-to-abate sectors by 2050.
- CCS will be important to reduce the last fossil emissions
- Opportunity for bioenergy?





Negative emissions are necessary to reach Nordic national targets

Upstream

Waste





- 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 2050 are reused for fuel production

Biogas



Behavioral change and social acceptance will directly impact the Nordic energy transition



The ten messages of NORDIC CLEAN ENERGY SCENARIOS

- Direct electrification is central to all decarbonisation strategies
- Power-to-X: A potential game-changer with a profound impact on the Nordic power sector
- 3. Bioenergy remains important, but with a shifting role
- 4. Carbon capture and storage, and negative emissions are essential
- 5. Behavioral change and social acceptance for infrastructure must be considered

- 6. The large Nordic wood biomass resources remain important renewable resource towards 2050.
- 7. Biomass should to a larger extent be utilized in hard-to-abate sectors towards 2050.
- 8. Biomass offers flexibility in the transition of the Nordic energy system as it is storable.
- 9. Bioenergy can deliver negative emissions through BECCS.
- 10. Nordic collaboration is instrumental and would strengthen the Nordics' Role in the European transition



