Nordic Grid Development Perspective 2021

Stakeholder webinar 10.2.2021
Materials

ENERGINET SVENSKA KRAFTNÄT FINGRID Statnett

Agenda of the webinar 10.2.2021 9-11 CET

09:00 1. Introduction to Nordic TSO cooperation and NGDP, Daniel Gustafsson, Senior Vice President, Head of Power System, Svenska Kraftnät

09:15 2. NGDP2021 project, Janne Seppänen, Expert, NGDP Project manager, Fingrid

09:30 3. Climate Neutral Nordics scenario, NGDP2021 Scenario group

10:10 4. Opportunity to provide feedback

10:55 5. Summary and next steps, Janne Seppänen, Expert, NGDP Project manager, Fingrid

Register to the webinar here: [Registration link (clickdimensions.com)]

Opportunity to provide feedback

A key part of the Nordic Grid Development Perspective 2021 project is to ask stakeholder feedback on the created common Nordic scenario. Stakeholder feedback is especially requested for:

- Is the scenario fit for purpose?
- Is some essential development missing? Is some development unnecessary?
- Is some technology emphasized too much? Is some technology emphasized too little?

Any other feedback is also welcomed.

Please send your feedback to: NGDP@fingrid.fi by 17.2.2021

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Nordic Grid Development Perspective 2021

TSO planning co-operation at various levels

Europe

- Planning co-operation in ENTSO-E
- Ten Year Network Development Plan
- Focus on cross border connections

Baltic sea

- Nordic countries, Baltic countries, Poland, and Northern Germany
- Regional investment plan
- Focus on cross border connections

Nordic countries

- <u>Nordic grid development perspective</u>, Nordic strategy work
- Focus on cross border connections and most significant internal investment needs

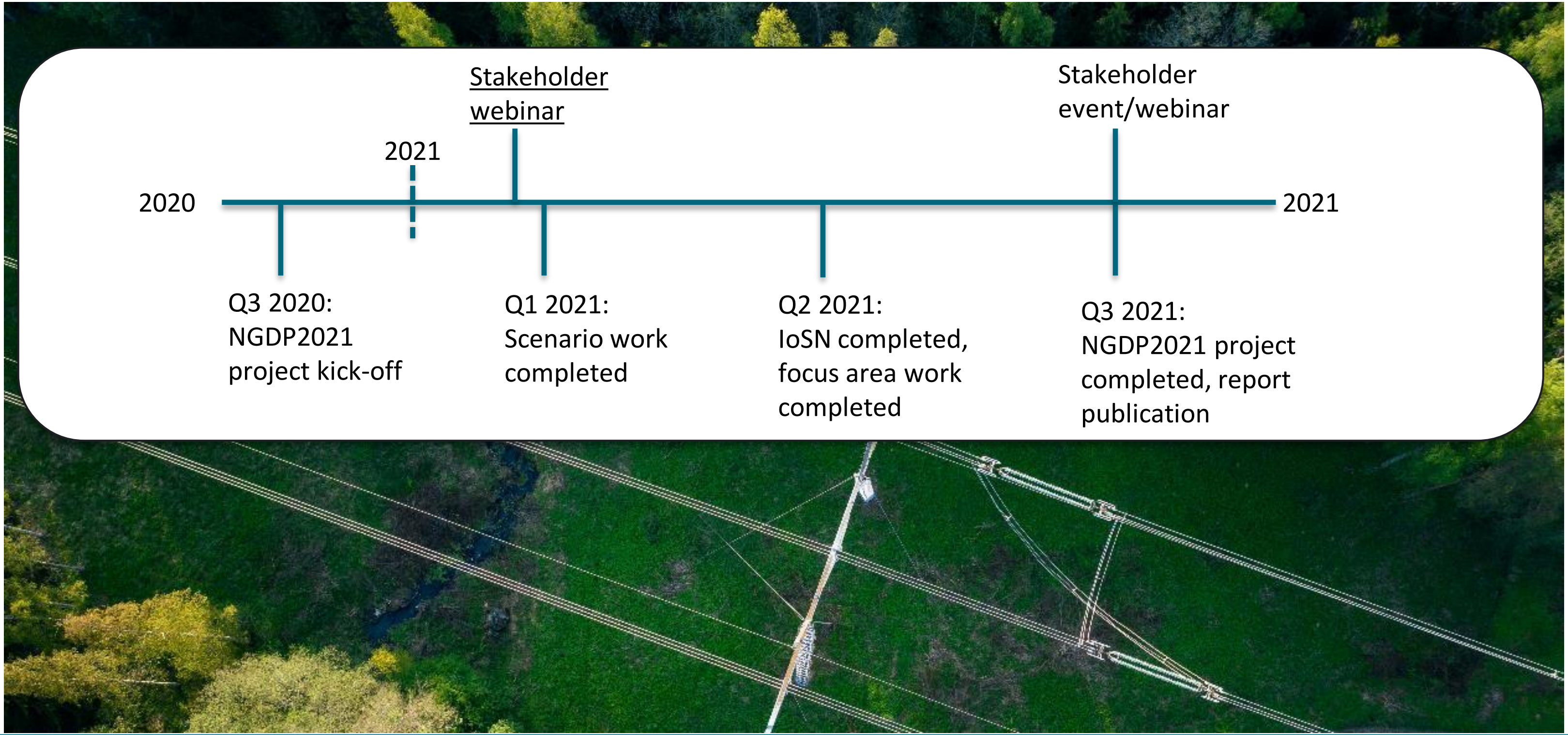
National level

- Grid development plans, etc
- Internal investment needs and cross border connections

Nordic Grid Development Perspective 2021 – Scope

- Create common Nordic scenario “Climate Neutral Nordics” based on ENTSO-E TYNDP2020 scenario Distributed Energy and latest national scenarios.
- Carry out identification of system needs (IoSN) analysis for the Nordic grid in the created scenario.
- Investigate the following focus areas, 1) Offshore wind, 2) North-South transfer issue, 3) Resource adequacy.
- Summarize national planned / ongoing grid projects of "Nordic interest" and refresh the status of the corridors from NGDP2019.

Nordic Grid Development Perspective 2021 – Timeline



Nordic scenario - Climate neutral Nordics: Background

Climate Neutral Nordics - Background

- All Nordic countries have set ambitious climate goals – aiming towards climate neutrality of the society.
- Decarbonization of the society requires significant investments to the energy production sector as well as large scale electrification of energy consumption.
- Ambitious scenario is built to investigate the transmission needs in the Nordic transmission system.

NGDP2021 project is based on a common Nordic scenario – ”Climate Neutral Nordics”.

The scenario is built for years 2030 and 2040.

Storyline “Climate Neutral Nordics”

The scenario Climate Neutral Nordics delivers on the ambition of decarbonization of the Nordic region. The scenario is based on national scenarios from the Nordic TSOs fulfilling the goal for decarbonization in 2030-2050 and opens up a role for the Nordics of being an exporter of green products such as electricity, hydrogen and steel.

The Climate Neutral Nordics focuses on high direct and indirect electrification throughout the energy systems. With the increased electrification a large increase in electricity consumption is expected, both from the classical demands, but also new demand like EVs, industry, heat pumps and P2X. In order to facilitate this electrification of the Nordic region, large amounts of renewable power production will be built throughout the region, primarily wind, onshore and offshore and to a smaller extend PV.

The Climate Neutral Nordics will seek to benefit from the large onshore wind resources available in the Northern regions as well as offshore potentials in the North Sea and Baltic Sea. The flexibility from hydro reservoirs in the Nordics and new types of demand side response like P2X and batteries from EVs will benefit the electricity system and help balance production and demand when generation from renewable sources are extraordinarily high or low.

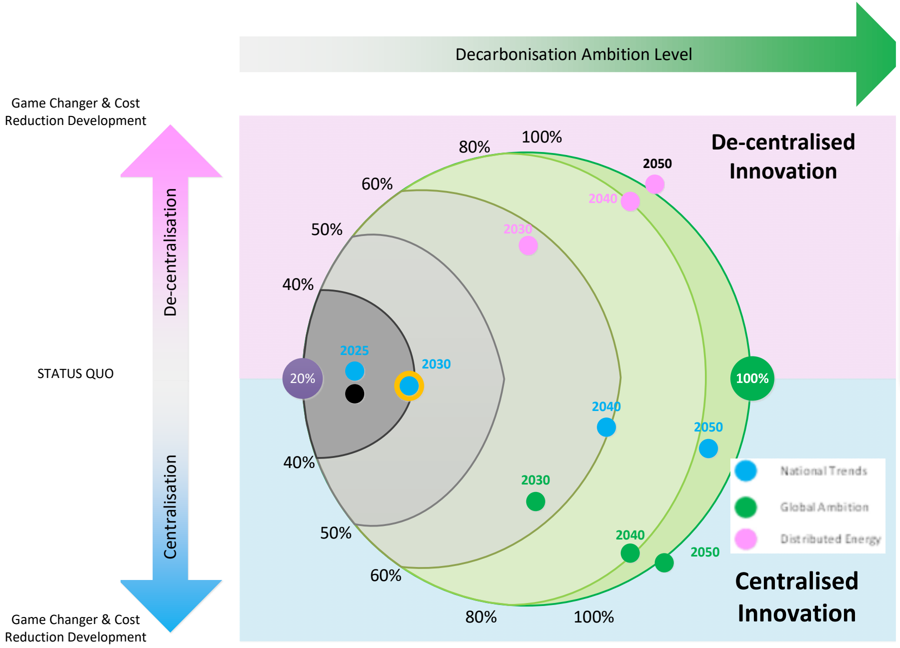
Drivers – from today to decarbonization (Climate Neutral Nordics)

	Finland	Sweden	Denmark	Norway
Hydroelectric power	≈	≈	≈	+
Onshore wind power	+++	+++	+	+
Offshore wind power	+*(+)*	+*(+)*	+++	++
Solar power and energy storage	+	+	++	+
Nuclear power	≈	≈ *(-)*	≈	≈
Other thermal power	-	-	-	-
Electricity consumption	+++	++	+++	+++
P-2-X	+++	+++	+++	+
Demand-side response (excluding P2X)	+	+	+	+
Electricity balance	Balanced	Moderate export	Export	Moderate export
Decarbonization year (sector/society)	2035/2035	2040/2045	2030/2050	2040/2050

+ increase, - decrease, ≈ remain at similar level. The categories for different countries should not be compared between each other.

European scenario

TYNDP 2020 Scenario Storylines



National Trends (NT)

- **Policy** Scenario based on draft EU National Energy and Climate Plans (NECPs)
- EU 2030 Energy and Climate Framework (32 % RES, 32.5 % energy efficiency)
- EC 2050 Long-Term Strategy: 80 – 95 % CO_2 reduction

Distributed Energy (DE)

Scenario used as base for NGDP21

- De-centralised approach to the energy transition: active customers, small-scale solutions, circular approach.
- **COP 21**: +1.5°C target with 66.7 % probability
- Carbon neutrality by 2050

Global Ambition (GA)

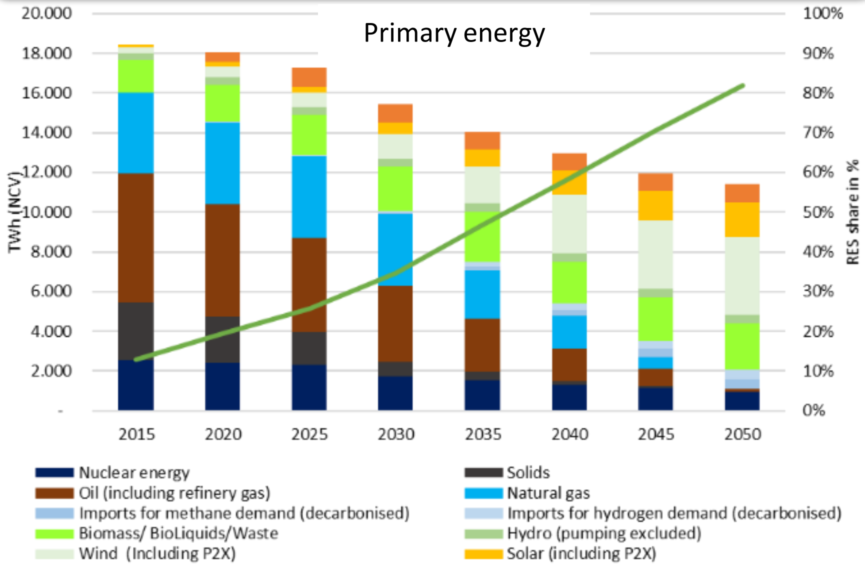
- Future is led by economic development in centralised generation, with large-scale renewables and decarbonisation.
- **COP 21**: +1.5°C target with 66.7 % probability
- Carbon neutrality by 2050

Contrasted scenarios reflect very different pathways to reach EU targets.

Note: TYNDP 2020 GA and DE storylines are a continuation of TYNDP 2018 Global Climate Action and Distributed Generation storylines. ENTSO-E's scenario report can be found here: https://tyndp.entsoe.eu/scenarios

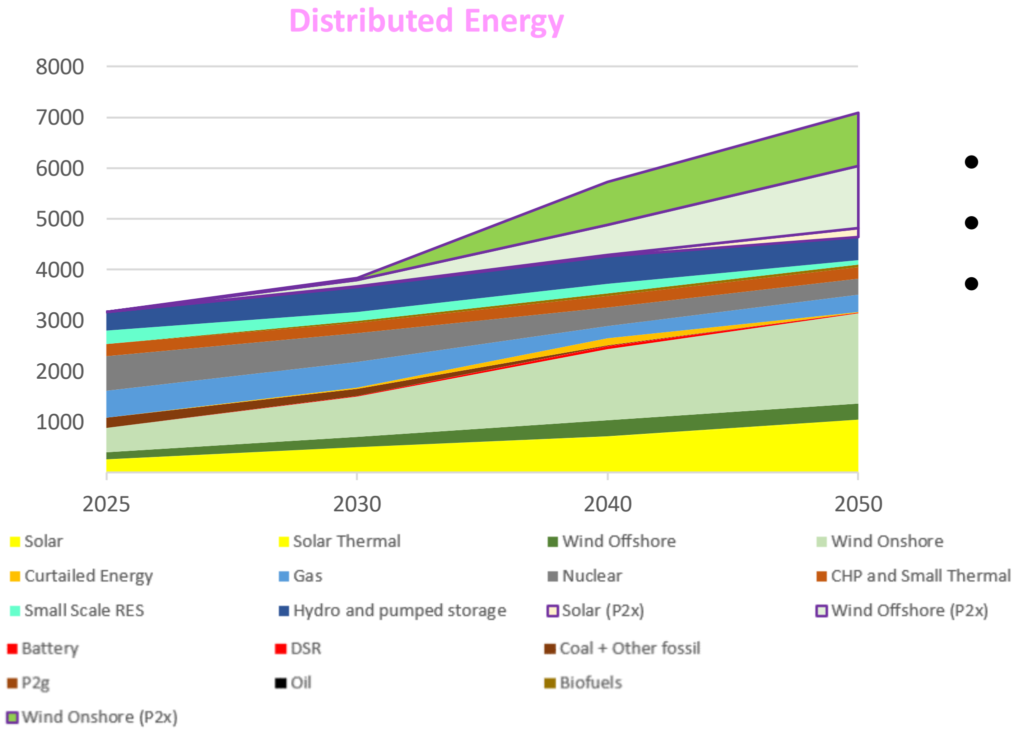
Distributed energy scenario for modeling continental Europe

RES share reaches 82% in Distributed Energy by 2050



- DE is in line with Green Deal decarbonization goals for 2030 (-55%)
- DE is in line with new EU hydrogen and offshore wind strategies
- DE has similar methods of decarbonization as envisioned in the Nordics:
  - energy efficiency
  - direct electrification
  - indirect electrification (P2X)

Electricity Generation with P2X (TWh)

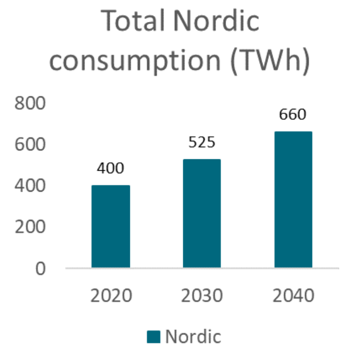


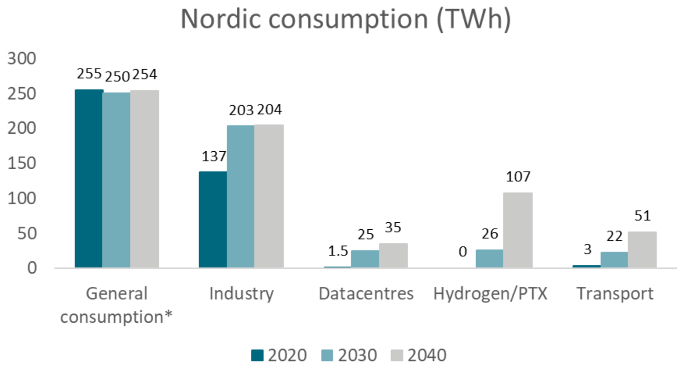
- DE has large increase in renewables
- DE has large amount of P2X
- A lot of renewables dedicated for P2X
  - P2X is included in the market models in NGDP2021

Nordic scenario - Climate neutral Nordics

Electrification drives the demand growth in the Nordic

- Overall consumption growth of about 260 TWh until 2040. Hydrogen/P2X accounts for a significant part
  - Hydrogen production/P2X increases by about 100 TWh
  - Electrification of existing and new industry increases consumption by 65 TWh
- Also, other consumption groups contribute
  - Direct electrification of transport increases by almost 50 TWh
  - Data centers' consumption is about 35 TWh in 2040
- General consumption is stable towards 2040





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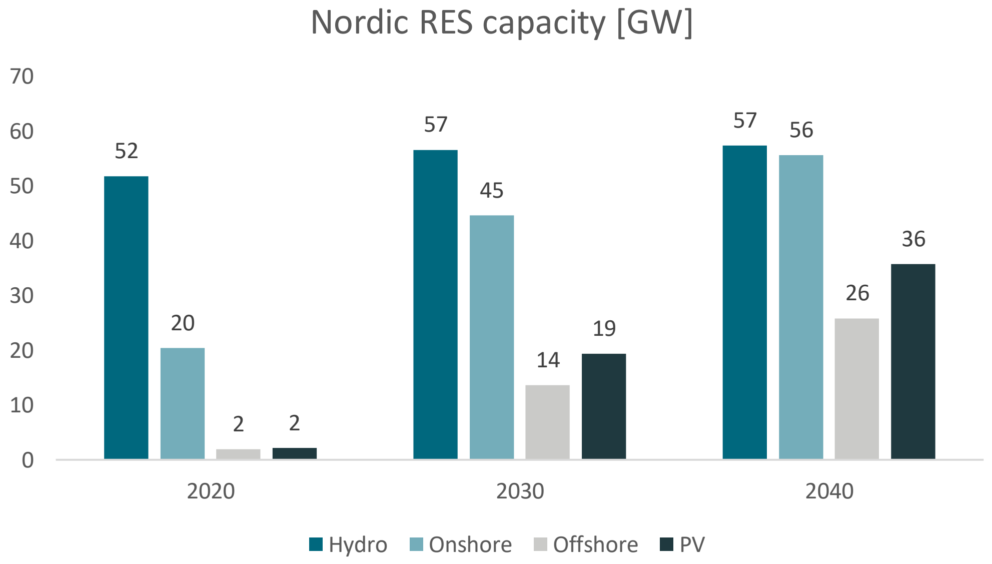
New consumption being more flexible

- High share of the new consumption disconnect in periods with higher power prices
    - Utilization of the lower power prices
    - Development of new technologies with automated solutions
- Increasing flexibility in general consumption – but limited volume
    - High willingness to pay
    - New and more energy efficient buildings increase short term flexibility
- Power intensive industries have high disconnect prices but there are some differences
    - Low flexibility in general
    - Forest industry has lower disconnect prices than aluminum
- Hydrogen production (e.g. Hybrit) will probably avoid highest prices (disconnect in periods with higher power prices)
    - Dependent of alternative energy sources
    - Storage increases the flexibility

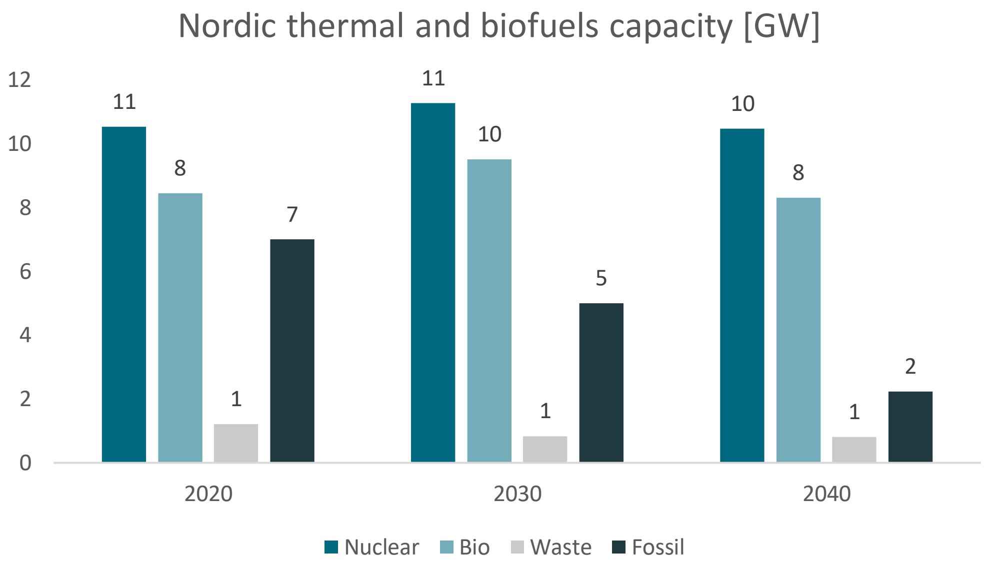
Increasing solar and wind capacity

- Hydro
  - Some expansion of Norwegian small hydro
- Onshore wind
  - Continued expansion in Finland and Sweden
- Offshore wind
  - Expansion in all countries
  - Energy islands in Denmark
- PV
  - Expansion in all countries



Thermal and biofuels capacity

- Nuclear
  - Olkiluoto 3 being built, Hanhikivi planned. No more Swedish reactors planned
- Fossil
  - Fossil fuels being phased out
- CHP
  - CHP plants may turn into heat only when reinvesting due to poor profitability



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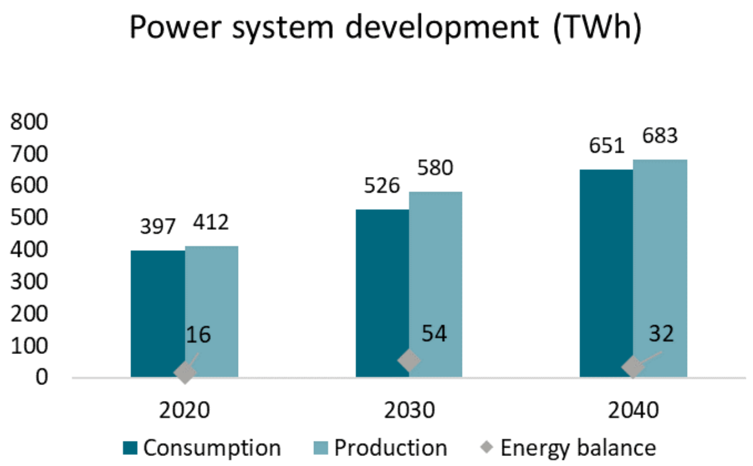
Nordic energy surplus varies throughout the period

- Until 2030: High investment in production increases the power surplus in the region
    - Mainly wind and solar power
    - Some increase in nuclear power
- From 2030 - 2040: Consumption increases more than production
    - Power intensive industry, hydrogen and transport
    - Reduce the energy surplus towards today's level
- The market development in the Nordic will be balanced in the long run
    - High power surplus attracts more consumption
    - Low power surplus attracts more production



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What is filling the gap after fossil fuels are phased out?

- Large scale decommissioning of thermal power plants could call for new technologies to fill the gap in hours with high demand and low production from PV and wind.
- Flexible demand and P2X will help in periods with high prices.
- Hydrogen peakers could replace old gas or oil peakers in the market.
- Hydro and batteries serve as methods to shift wind and solar production to periods with high demand.

Including “Power to X”/Electrolyzers in the Nordic scenario

DENMARK

2030	2040
1,000 MW	3,000 MW
5 TWh	*15 TWh*

NORWAY

2030	2040
400 MW	1,000 MW
3.2 TWh	*8.3 TWh*

SWEDEN

2030	2040
3,600 MW	12,600 MW
16 TWh	*57 TWh*

FINLAND

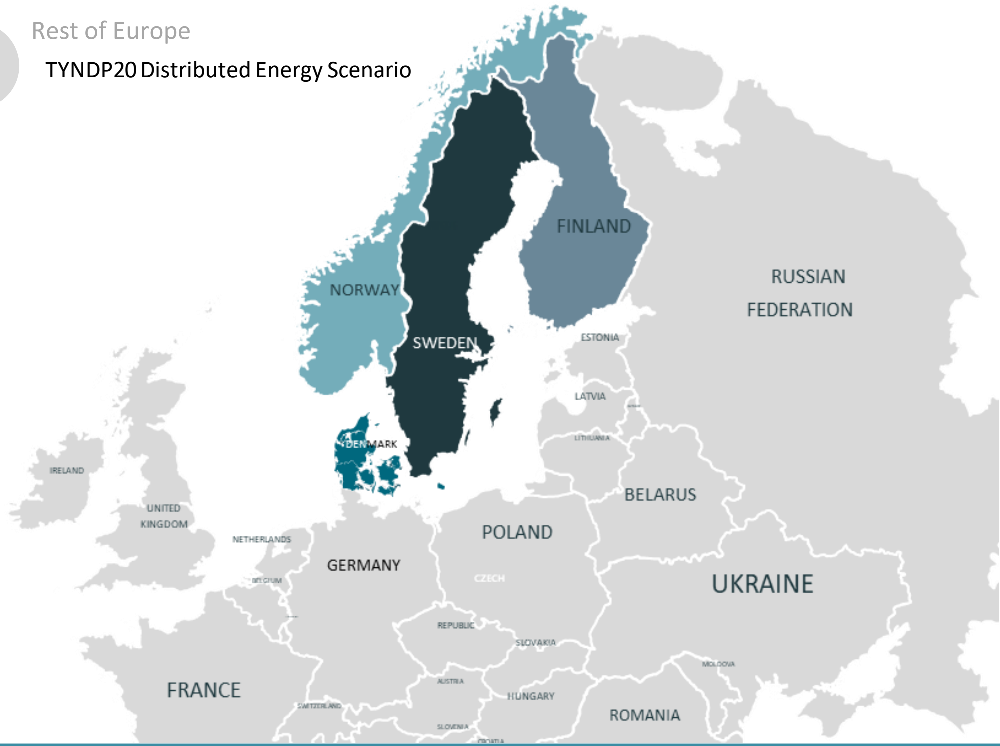
2030	2040
400 MW	6,400 MW
1.8 TWh	*28 TWh*

NORDIC

2030	2040
5,400 MW	23,000 MW
26 TWh	*108.3 TWh*

Rest of Europe

TYNDP20 Distributed Energy Scenario



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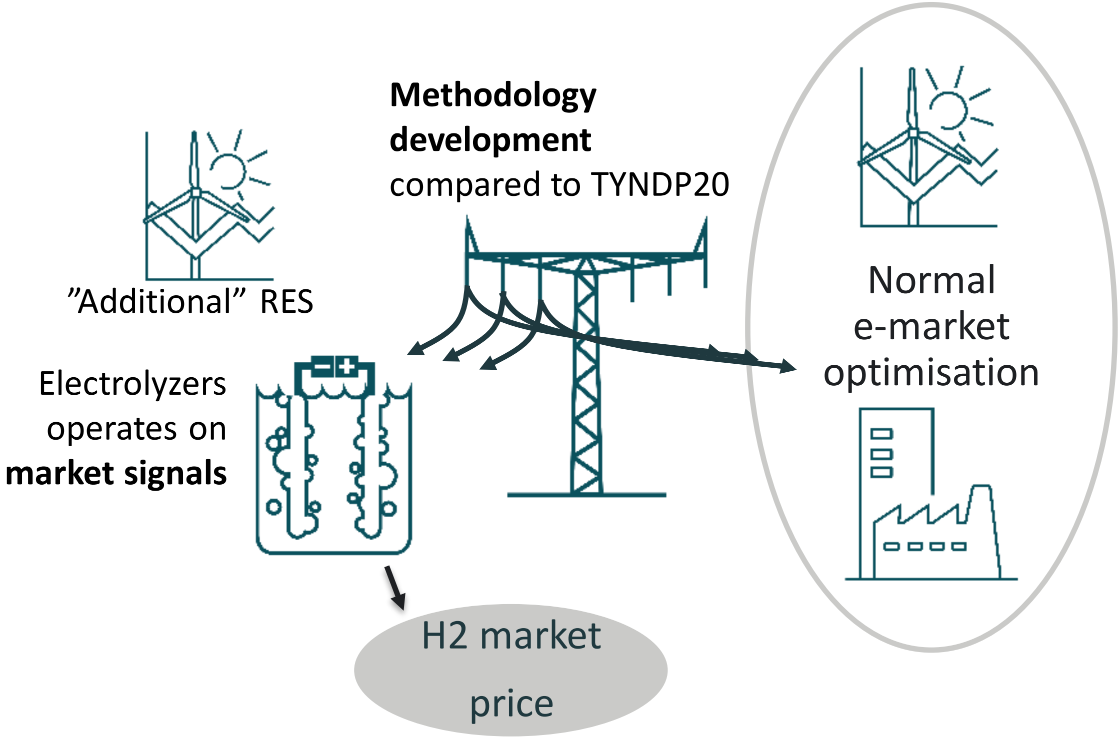
Basic modelling methodology for P2X

Methodology improvement compared to TYNDP20:

- Including P2X in the market models
- Linking dedicated RES and electrolyzers to the market
- Making assumptions on a future hydrogen price

These are first steps as European P2X modelling is in a juvenile stage. There are still many unknowns with regards to actual plant operation and future hydrogen prices.



Model implementation in NGDP

- Methodology development compared to the basic TYNDP20 scenario
- Update the Nordics with new capacities
- Common agreement on modelling principles for electrolyzers
- Assumptions on hydrogen prices:

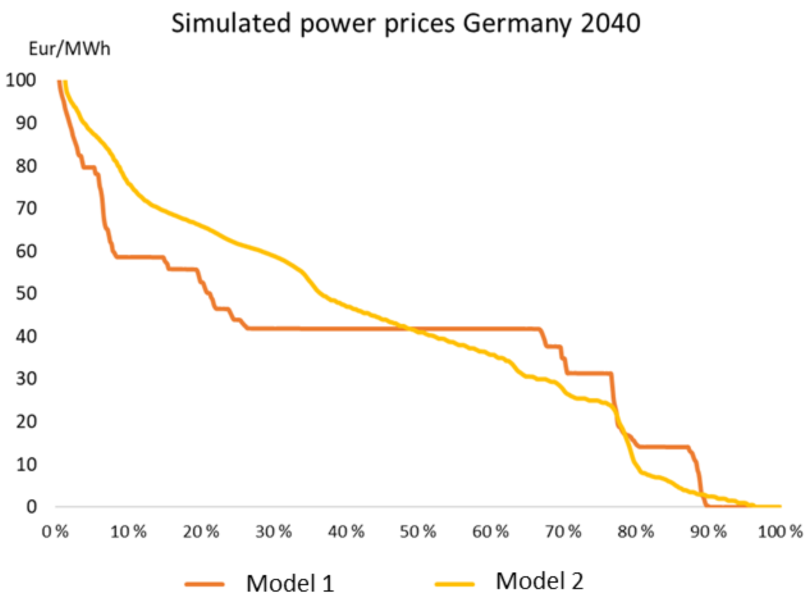
  2030: ~2.5 €/kg   Cut in*: ~48 €/MWh_e

  2040: ~1.8 €/kg   Cut in*: ~38 €/MWh_e

*activation price for P2X in the market (at prices below the activation price the electrolyzers will operate, at prices above they will not operate)

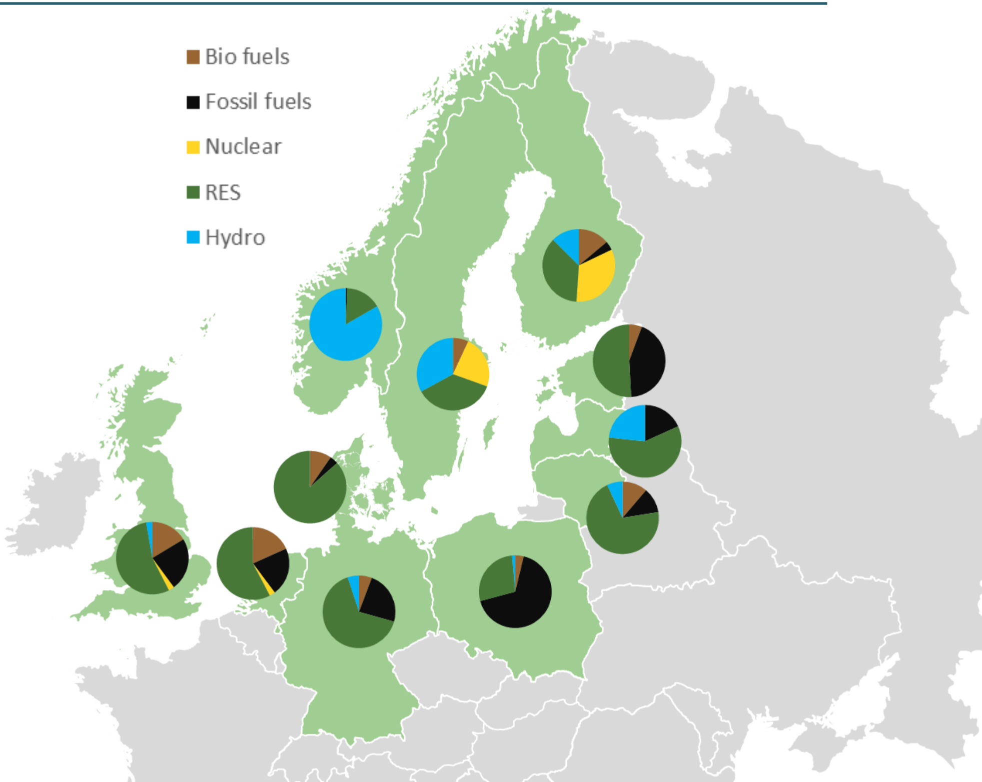
Open questions regarding P2X modelling

- Modelling of hydrogen (P2X) has significant impact on the power prices
    - How will P2X reduce the lower price levels
    - What will be disconnect prices
    - Volume of hydrogen
- Model 1 – one price level (plateu)
- Different price thresholds in Model 2
    - Disconnect prices (25 – 35 – and 50 €/MWh)
    - Too smooth curve?
- How should we model P2X in the scenario – great impact on benefit of interconnectors?



2030 Generation Mix for Nordic Scenario

- Large amounts of RES already in 2030
  - For some countries RES productions is primarily used for P2X
- Nordic system is almost completely fossil free
- Fossil fuels are still being used in certain countries in 2030.



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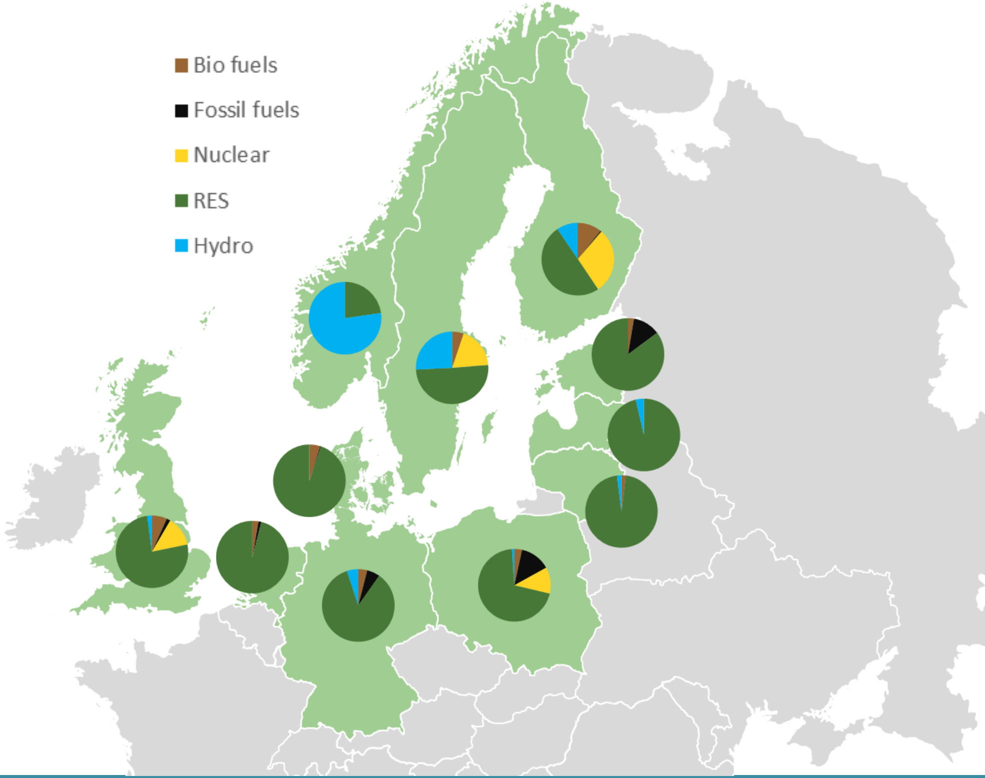
2040 Generation Mix for Nordic Scenario

- No fossil fuels used by 2040 in the Nordic region
    - Generation is mainly based on RES, hydro and Nuclear
- System is almost fossil free
- Large amounts of P2X is increasing the value of RES in the system.



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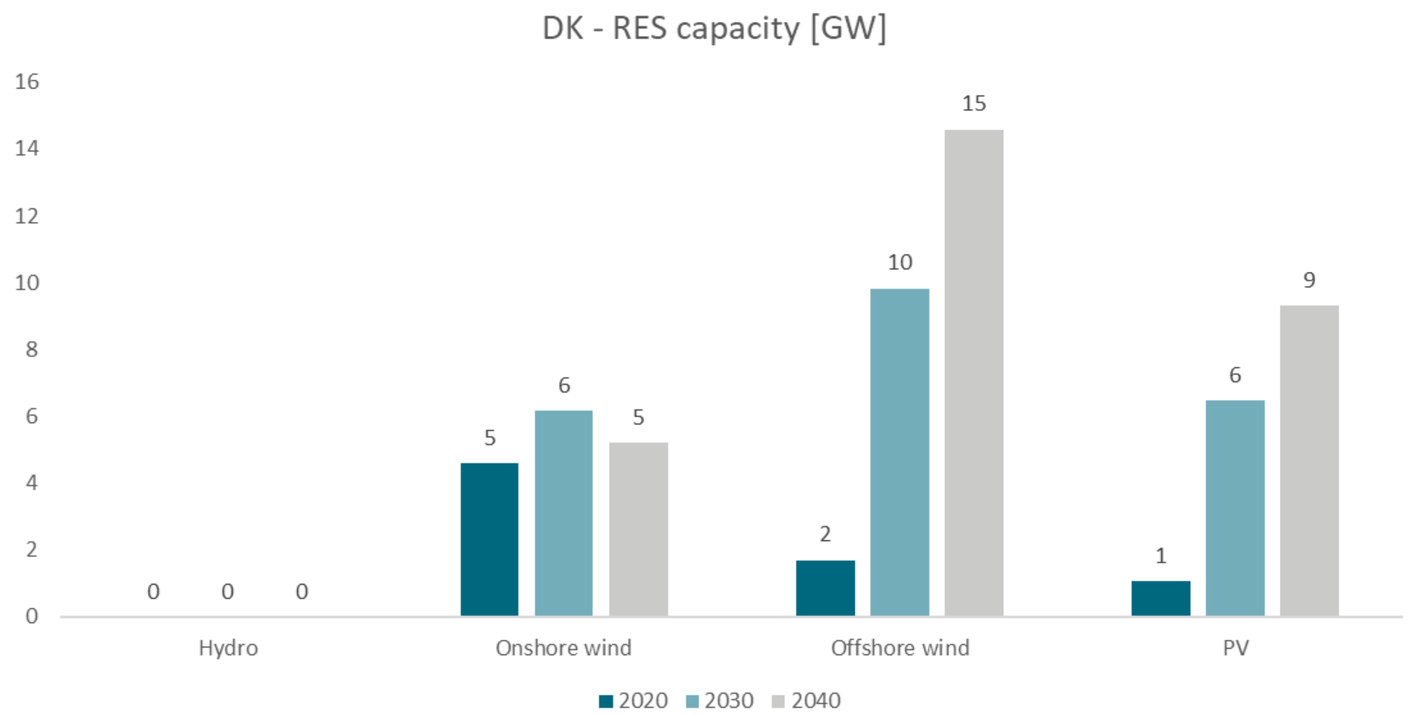
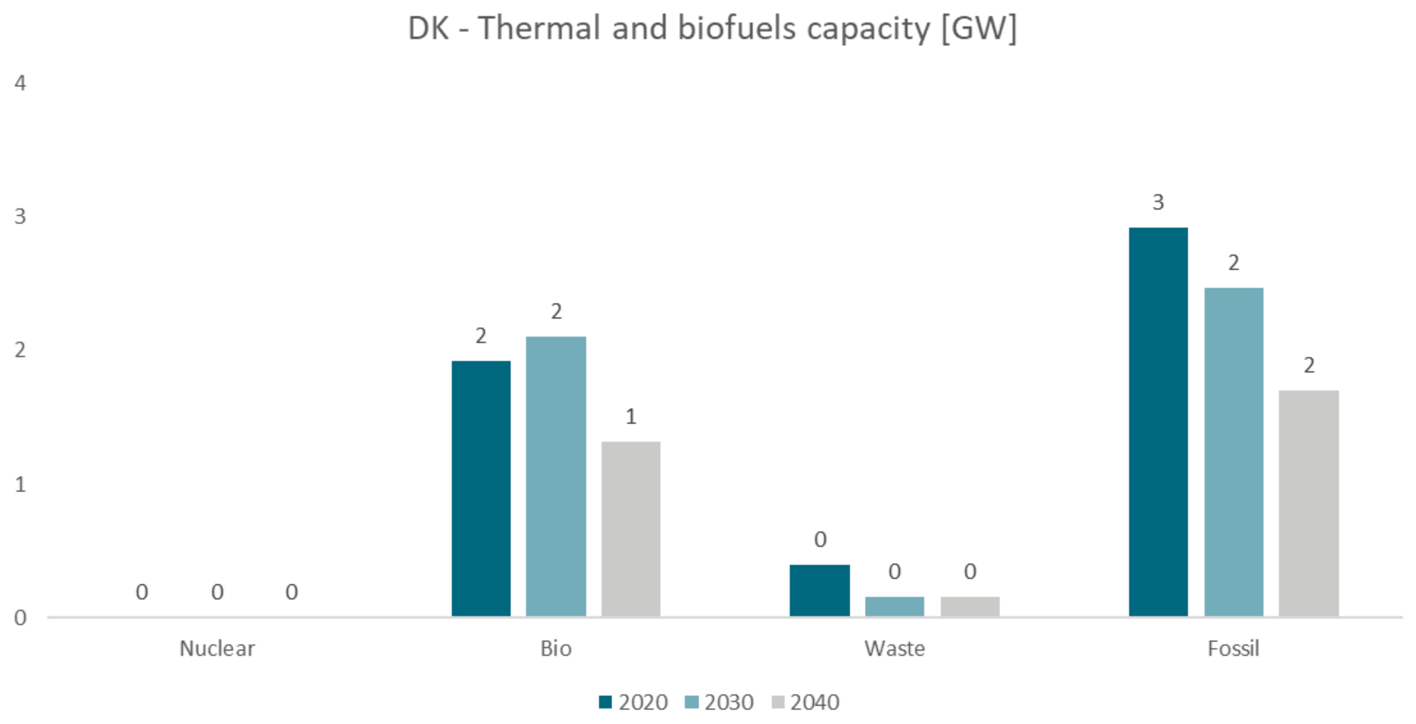
Generation at country level

Denmark - RES capacity by year



Denmark - Thermal and biofuels capacity by year



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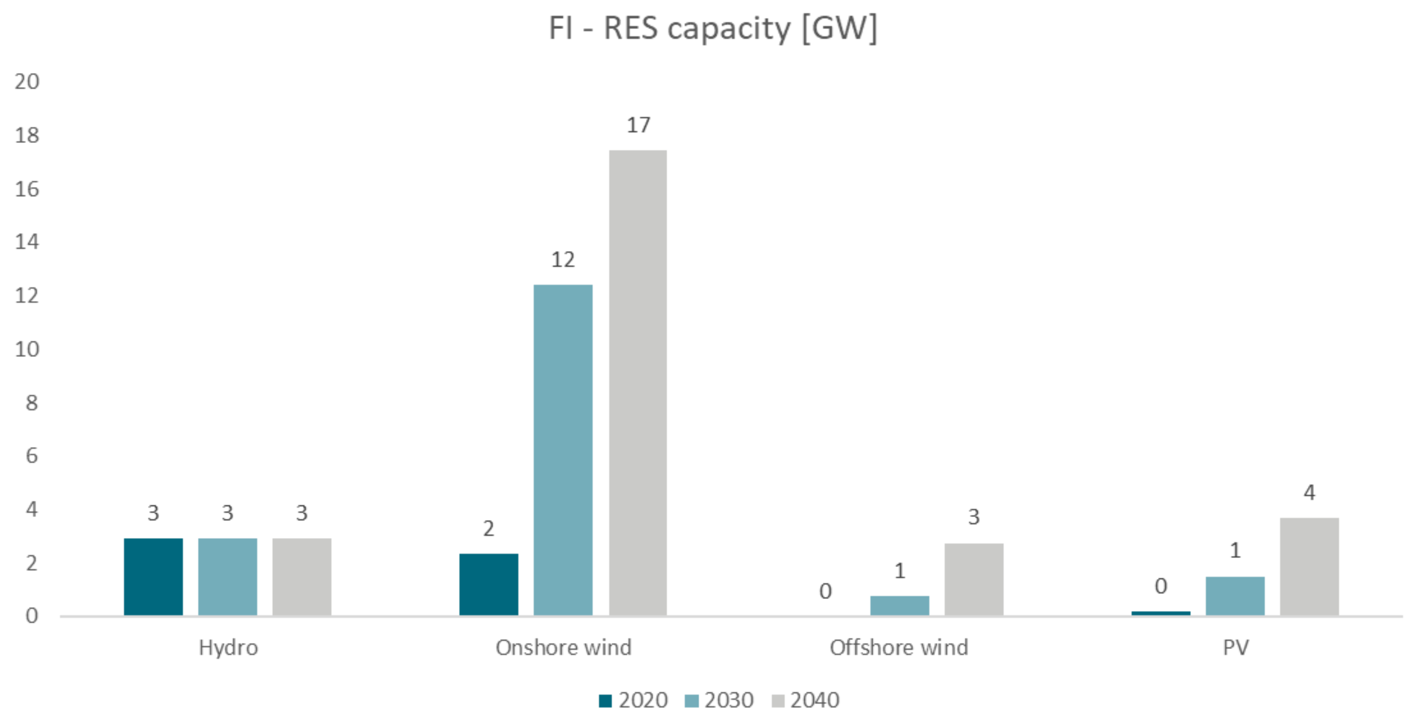
Finland - RES capacity by year



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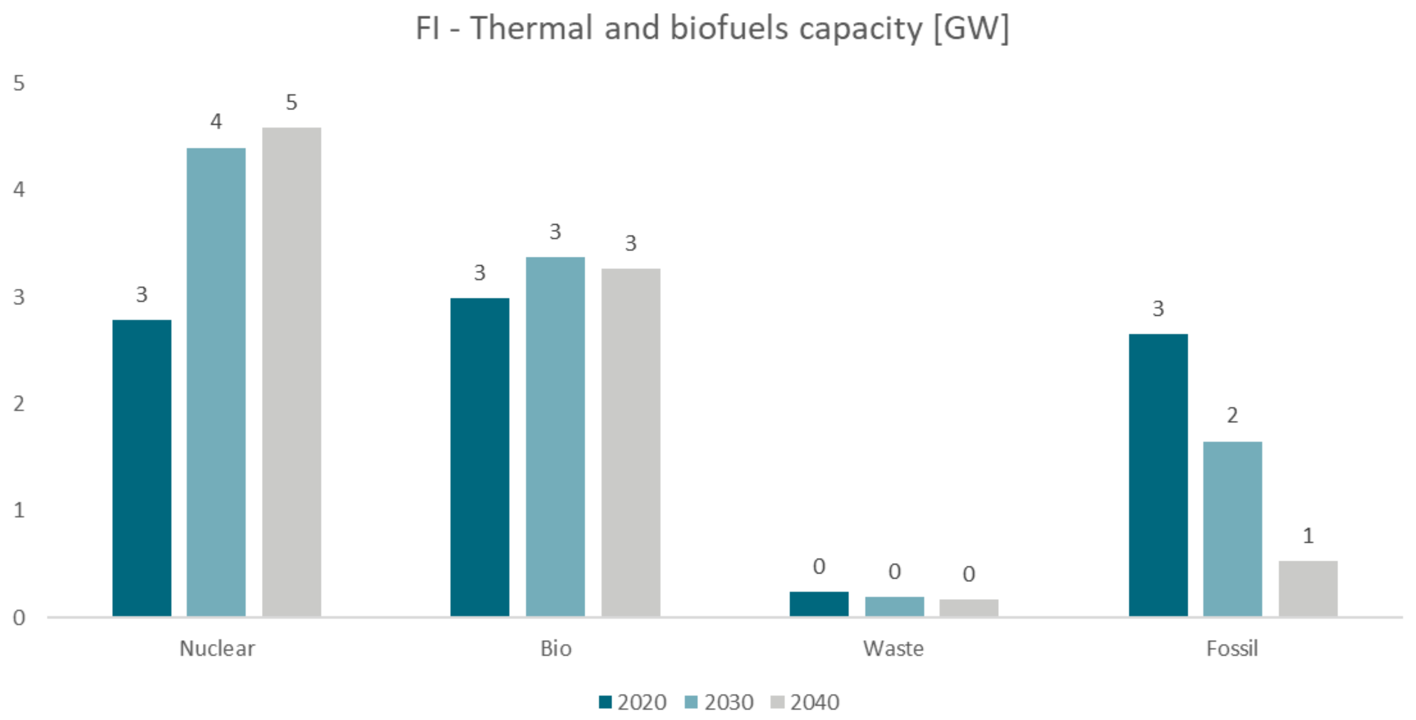
Finland - Thermal and biofuels capacity by year



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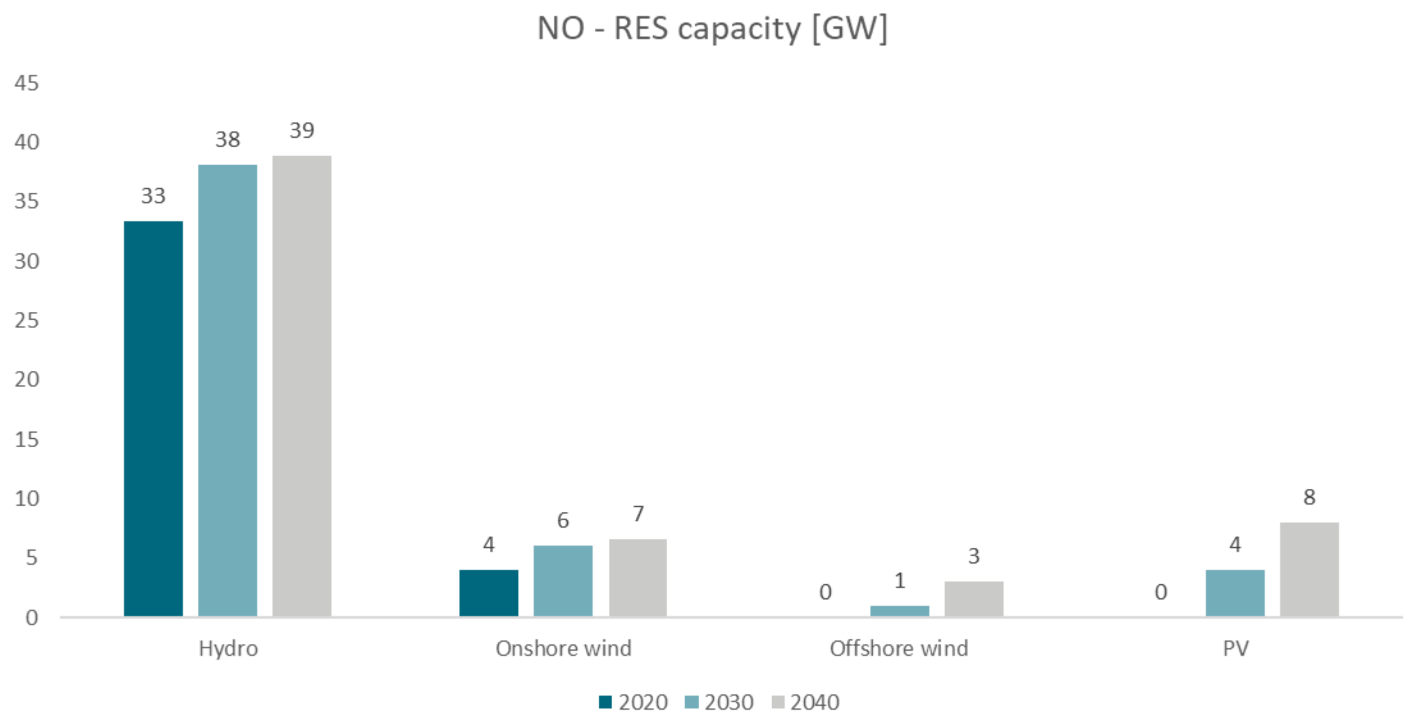
Norway - RES capacity by year



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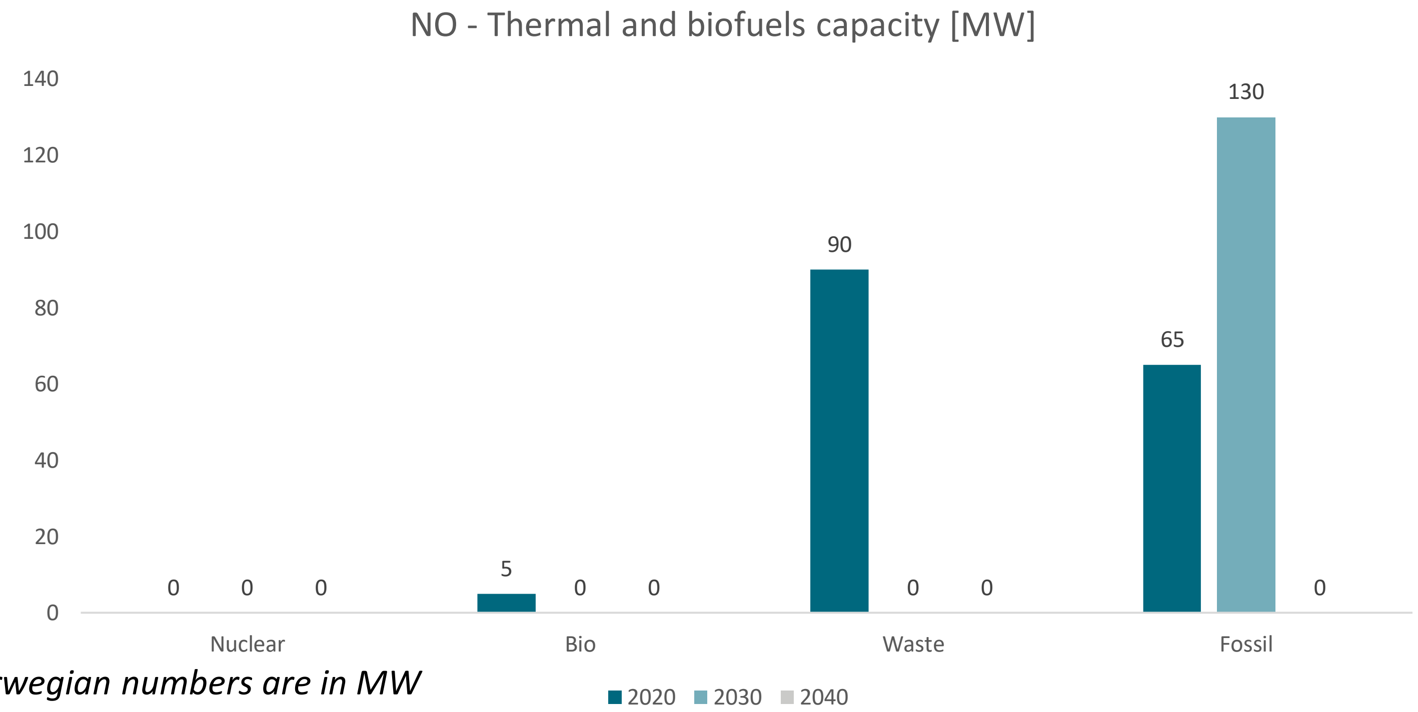
Norway - Thermal and biofuels capacity by year



Notice the Norwegian numbers are in MW

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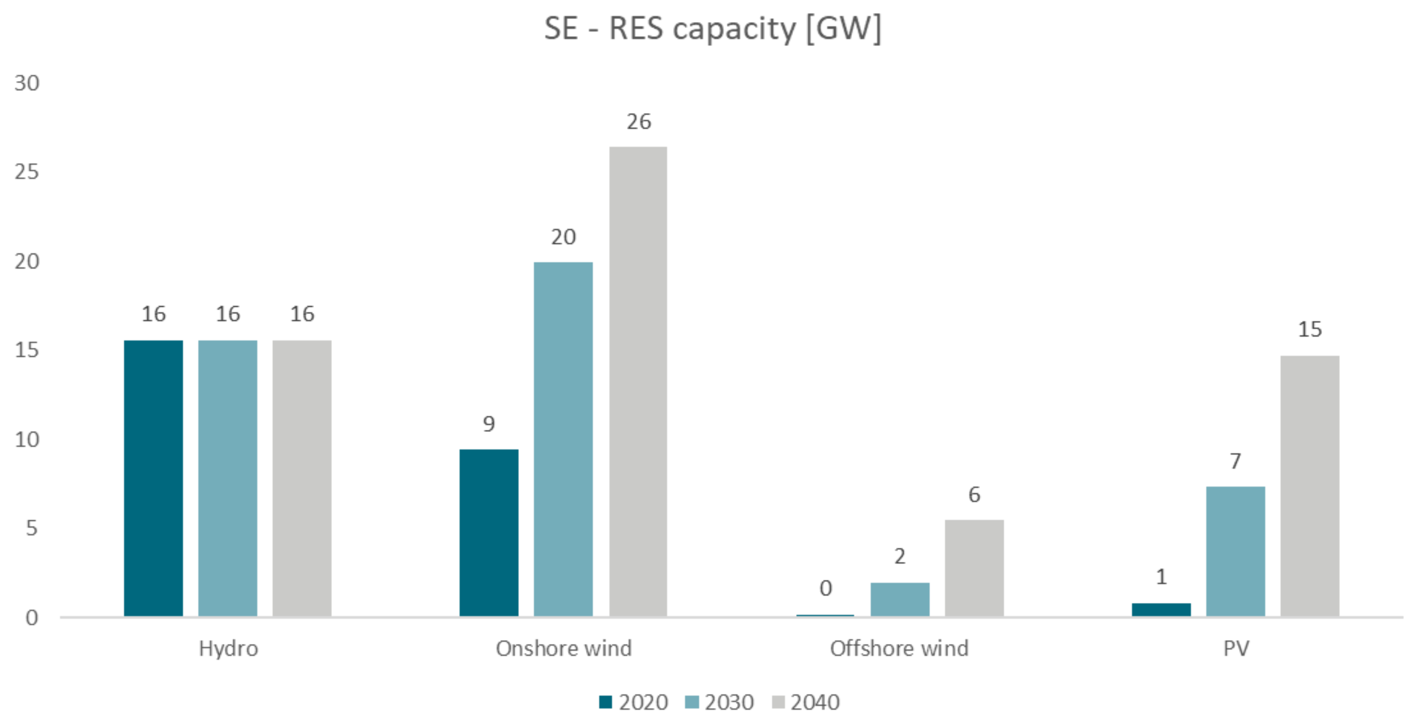
Sweden - RES capacity by year



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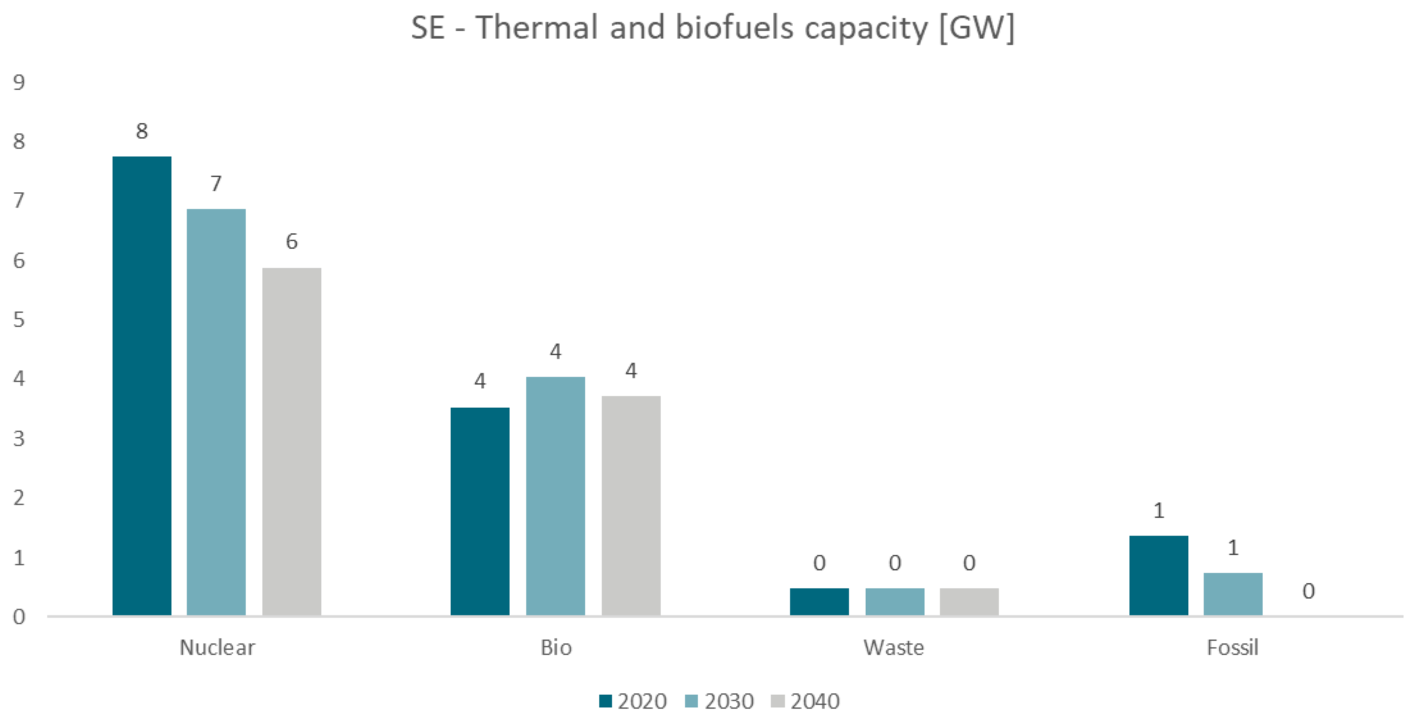
Sweden - Thermal and biofuels capacity by year



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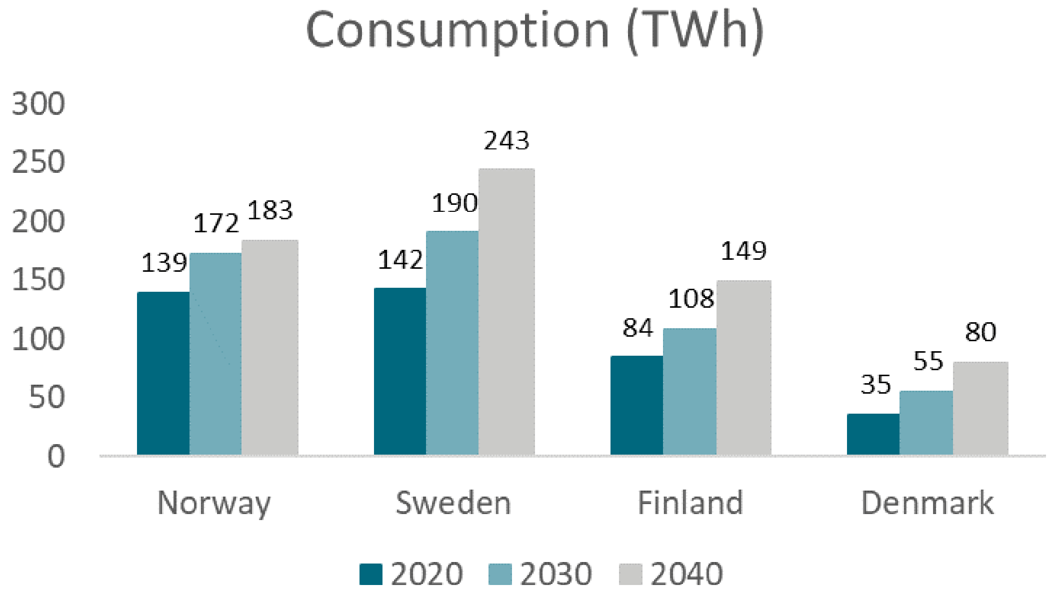
Consumption at country level

Nordic – Total consumption distributed on countries



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Extra slides

Fuel prices used for the Nordic Scenario

- Fuel prices from Distributed Energy (TYNDP20)
- Addition of Biomass, Peat, LSFO and H2 prices (Nordic assumptions)

- Main points:
    - Increase in coal price from 2030 to 2040
    - Increase in oil price 2030 to 2040
    - Increasing CO_2 price 2030 to 2040
    - Decrease in H_2 price 2030 to 2040

		2030	2040
€/net MWh	Nuclear	2	2
	Hard coal	15	25
	Gas	25	26
	Heavy oil	53	62
	Biomass	4	4
	Peat	14	14
	H2	60	45
€/ton	CO2 price	53	100

Modelling dynamics for including PtX in the electricity market (Example DK1 2040)