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ENERGY RESEARCH

Nordic Power Markets in Flux: Green Hydrogen Opportunities and Market Reform Challenges

4 April 2023

Stockholm

Agenda

I. **Introduction**

II. **Outlook on Nordic power**

1. Nordic power prices
2. Nordic power generation and demand

III. **Emergency measures and proposed market reforms**

1. Short-term emergency measures
2. Electricity market reform proposals

IV. **Conclusions and next steps**

Power prices in Europe have fallen 75% from the peak in 2022 but remain significantly higher than pre-COVID levels

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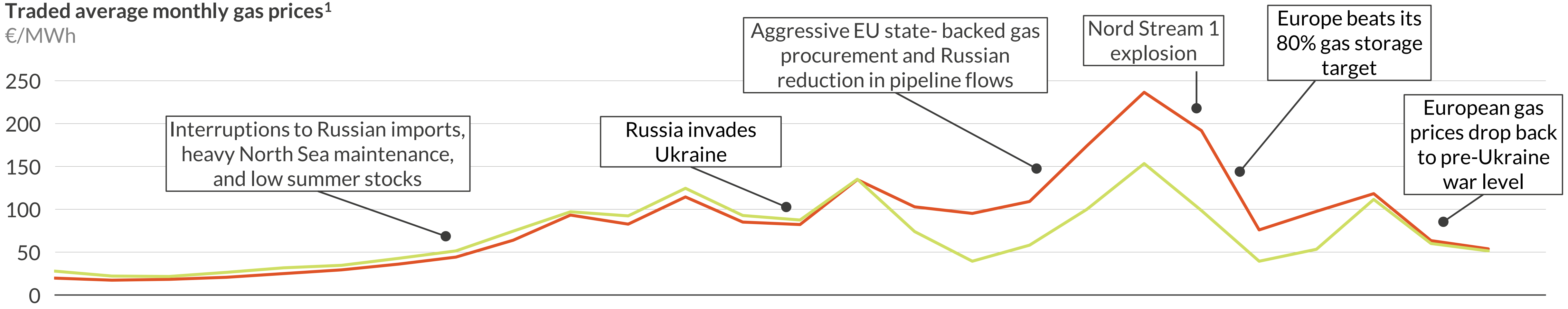
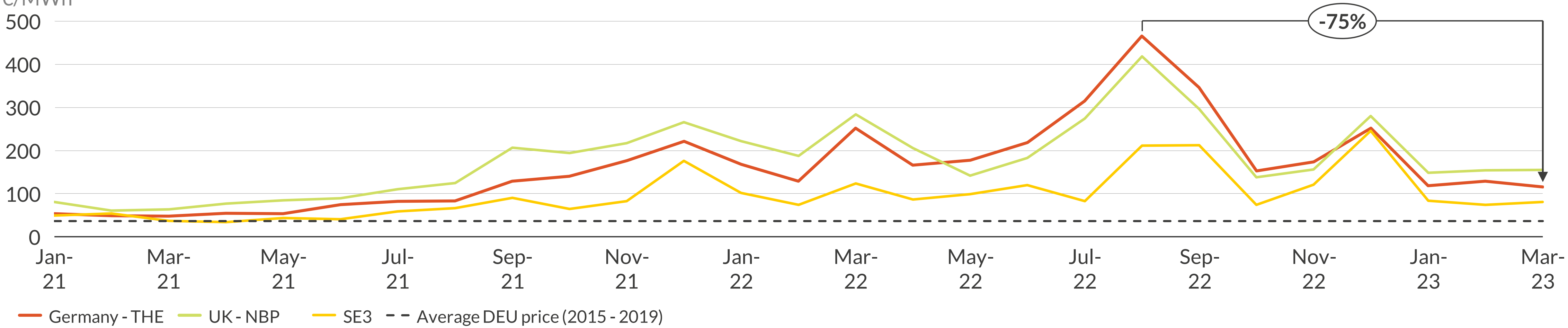
Traded average monthly gas prices[1]
€/MWh



Average monthly power prices for select countries[1]
€/MWh

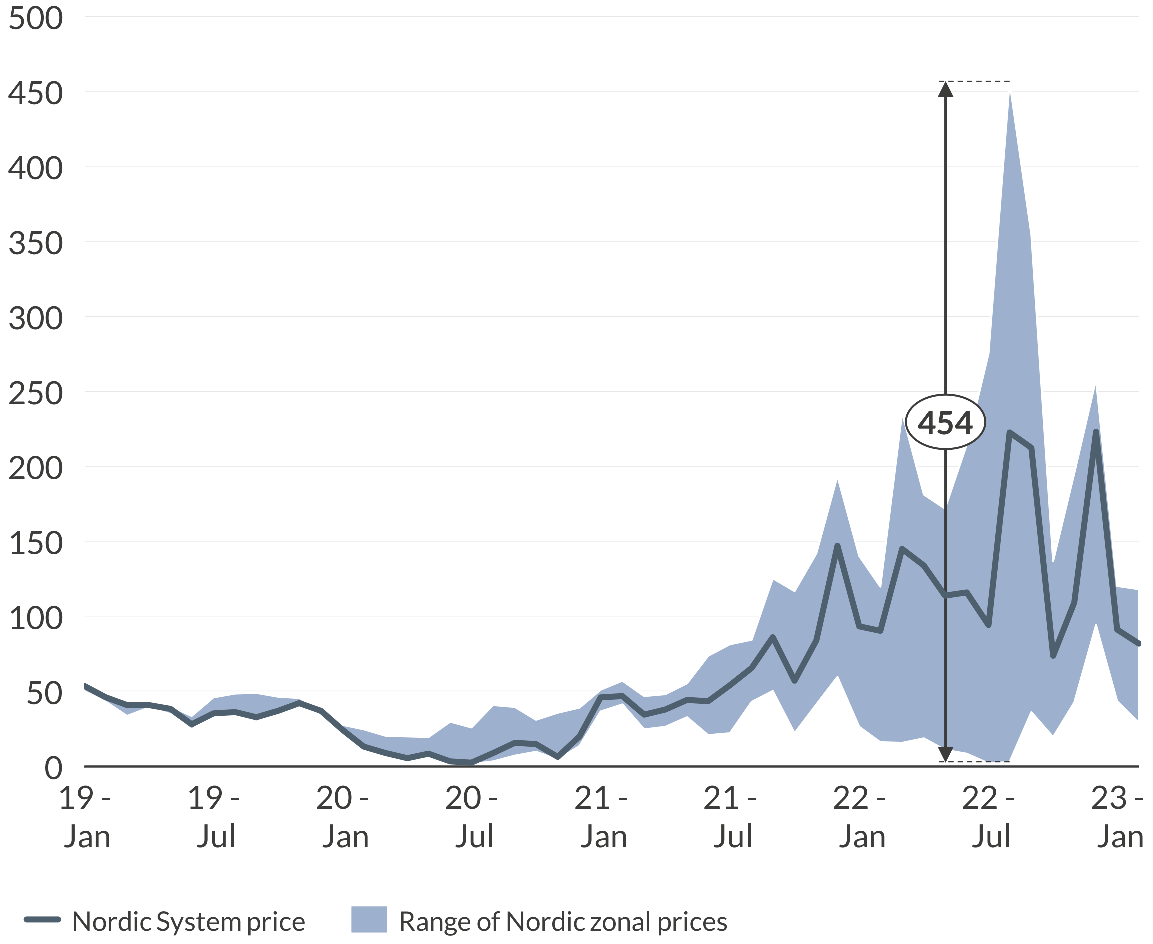


1) Monthly average of daily day-ahead prices as of 16 March 2023

Sources: Aurora Energy Research, Refinitiv

The Nordic power prices diverged more than ever before, as power in the south followed the gas price and the north remained at low levels

Monthly average of Nordic power prices
€/MWh (nominal)



Record breaking price divergence

- During 2015-2019 the average zonal price range was 4.3 €/MWh, and the maximum for the period was at 26.8 €/MWh
- Since the outbreak of the war in February 2022, the Nordic zonal price spread has drastically increased to 206 €/MWh on average[1]
- As a consequence of the diverge, the Nordic System price[2] becomes less representative of the price zones, which adds risk to financial hedging as the Nordic EPADs[3] suffer from low liquidity

Bottlenecks in the transmission grid and more renewables

- Lower availability on key transmission lines in Sweden, together with large scale onshore wind buildout in Northern Sweden, has caused more frequent decoupling of Swedish price zones
- The situation has been exacerbated by the spike of continental power prices
- New interconnectors in southern Norway to Germany and the UK have further increased south Norwegian power prices

1) Until 30 March 2023, 2) The unconstrained market clearing reference price for the Nordic region, 3) Electricity Price Area Differential

Sources: Aurora Energy Research, Nordpool, ENTSO-E

As a consequence of a turbulent 2022, the Commission identified four key areas in which it perceived the current market design not fit for purpose

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1 Making power bills more independent of short-term markets

- Consumers are exposed to fluctuations in fossil fuels, and do not benefit sufficiently from renewables
- Inframarginal generators (esp. renewables and nuclear) achieve returns way above their costs, capturing the high prices set by fossil generation

2 Alternatives to gas to keep the power system in balance

- There are insufficient low-carbon alternatives that can keep the power system in balance (e.g. demand response, energy storage, nuclear)
- It is unclear whether investment in firm capacity is made at a sufficient scale to ensure security of supply in crises or in absence of fossil generators

3 Better consumer empowerment and protection

- Consumers have been exposed to energy costs that have lowered the standard of living of EU citizens
- Energy-intensive industry has faced soaring energy costs, giving rise to cuts in production and temporary or permanent closures and lay-offs

4 Enhance integrity and transparency of energy market

- Entities could engage in illegal trading practices in times of very high price volatility to extract higher profits
- Transparency, monitoring capacities and more effective investigation for cross-border cases need to be improved

Apr '22

29-Apr: ACER's final assessment to keep the current design

18-May: REPowerEU plan to reduce Russian dependence and fast forward the transition

22-Jul: Greek proposal to split the market between renewables and fossil fuels

Jan '23

11-Jan: Spanish non-paper, advocating a re-regulation, including central planification through state-backed CfDs

23-Jan: Consultation on EU market design until February 13

Feb '23

13-Feb: North/Central European joint letter, calling for a market preservation, emphasising PPAs and forward liquidity

Mar '23

14-Mar: Commission publishes its market reform proposal, largely siding with the North/Central European letter

?

The proposal is negotiated by Parliament and Council. EC is confident that the reform will be prioritised

Sources: ACER; European Commission; Aurora Energy Research

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Prices drop in most zones until the early 2030s, as gas prices rebalance and offshore wind comes online, and remain relatively stable thereafter

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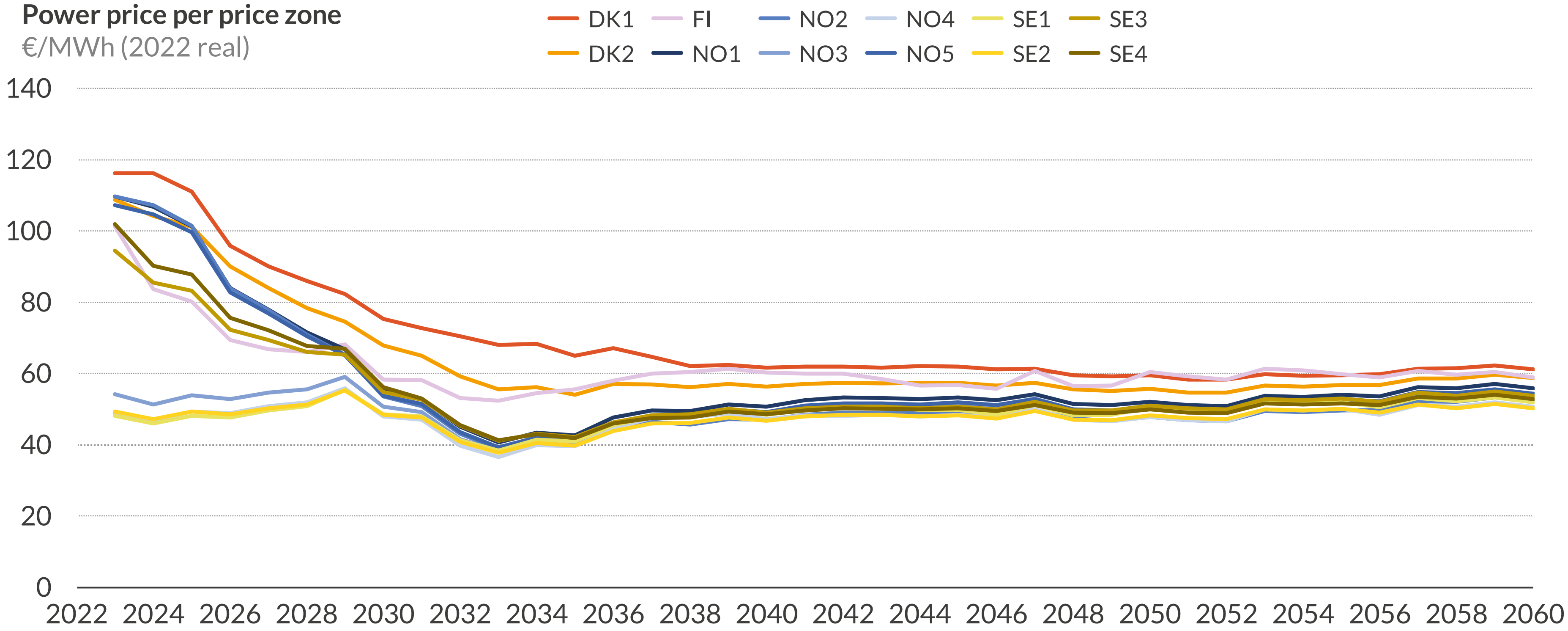
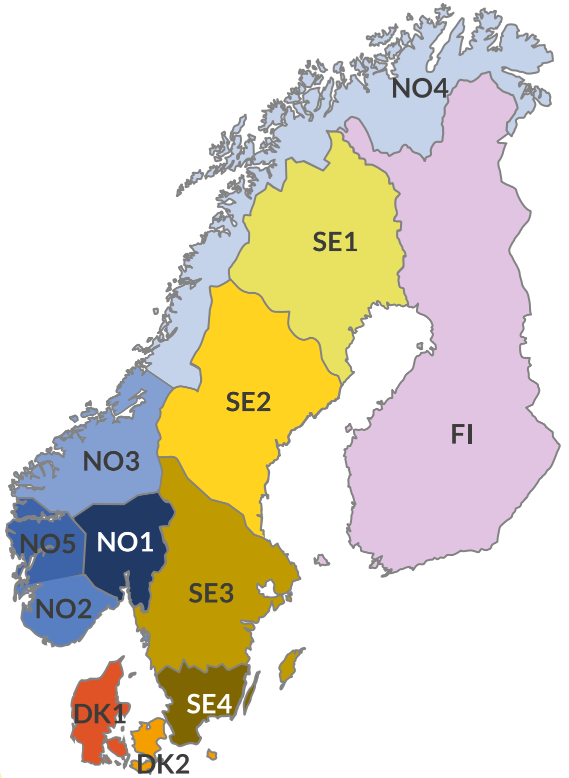
Power price per price zone
€/MWh (2022 real)





Phases of forecast

- Prices drop as gas markets rebalance while more
- Grid buildout and increased demand lead to convergence of Northern and Southern zonal prices

- Most price areas become more expensive with rising demand, gas and CO_2 prices
- Large offshore wind entry decreases Danish prices to further: +7.5 GW in 2030-2050
- Increase to 16 GW export capacity to GB and the continent, exerting upwards price pressure
- Addition of Estlink 3 between Finland & Estonia in 2035 increases prices in Finland afterwards

- Large RES deployment counterbalances price rise in the face of rising power demand
- Slight discount of North Swedish prices given large wind buildout

Source: Aurora Energy Research

Gas prices rise from the mid 2020s to 2030 due to supply tightness, whilst the EU ETS rises as a result of increasingly ambitious emissions targets

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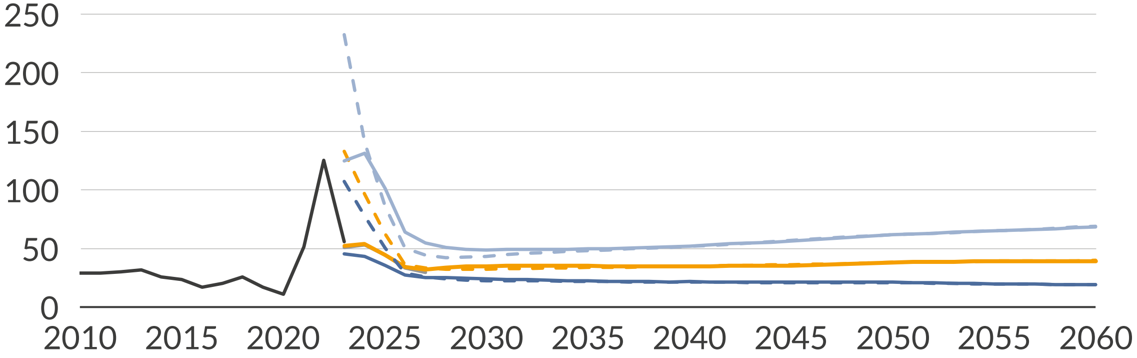
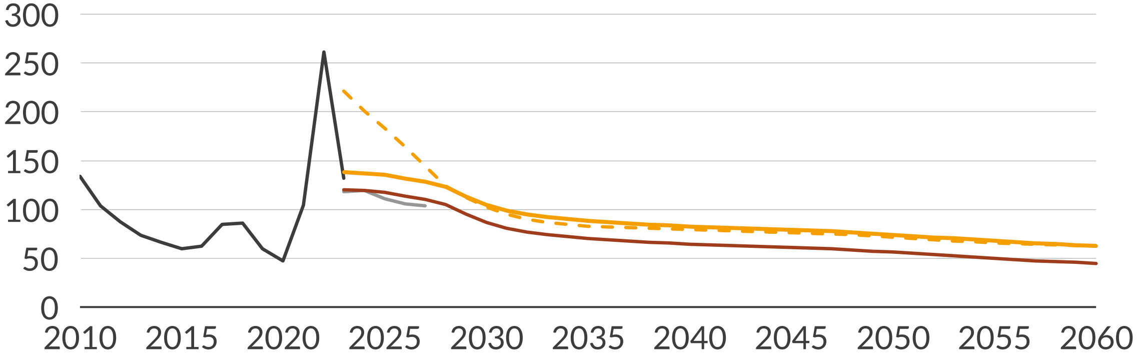
Danish/Swedish gas prices[1]

€/MWh (real 2022)[2]



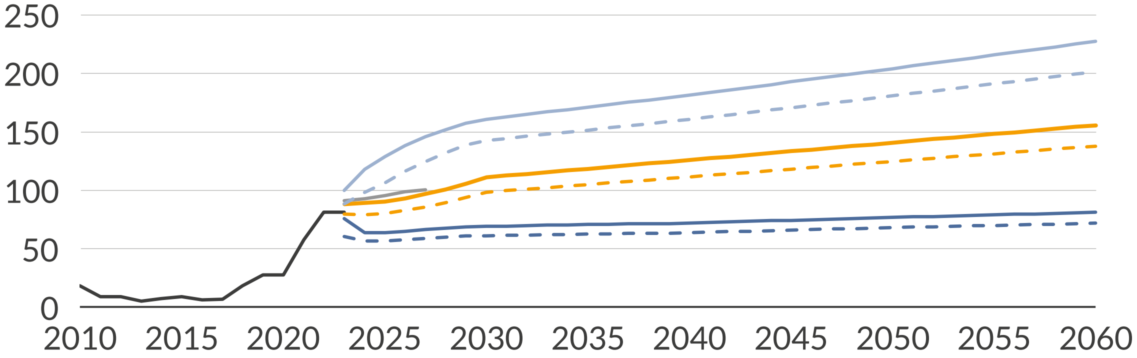
Finnish coal prices[3]

€/tonne (real 2022)[2]



Carbon prices

€/tCO_2 (real 2022)[2]



Key update for this quarter's commodity price forecast include:

- **Short term (2023-2027)** – The **gas price** is expected to average 43.3 €/MWh seeing a 40% decrease relative to our previous forecast. The EU reaching its gas storage targets ahead of schedule and gas saving efforts amid a mild winter season have pushed gas prices lower. Prices are expected to ease further by 2026 as several new LNG liquefaction/regasification facilities become available worldwide. The **carbon price** is forecast to average 91.3 €/tCO2, an increase of 12% relative to our previous forecast, as increased compliance buying and a delay in REPowerEU auction frontloading past April compliance deadline.
- **Long term (2028 – 2060)** – **Gas prices** average 36.2 €/MWh in the period, up by only 1% relative to our previous forecast, amid lower European production and a tightening global gas market, driven by increased Asian demand. The **carbon price** rises to 155.4 €/tCO2 by 2060, reflecting the required marginal abatement cost across most sectors to decarbonise.

Historical — Futures[4] — Q2 2023 Central — Q1 2023 Central — Q2 2023 High — Q1 2023 High — Q2 2023 Low — Q1 2023 Low

1) THE hub historical and future prices are reported. 2) For years 2023-2028, the prices shown take into account latest futures prices for the years in question, with declining weights. 3) ARA hub coal prices historical and future prices are reported. Finnish coal prices include transport costs. 4) A rolling 14-day average as of 01/03/2023.

Sources: Aurora Energy Research, EIKON

Power demand rises by 349 TWh due to electrification of transport and industry, data centres, battery factories and hydrogen production

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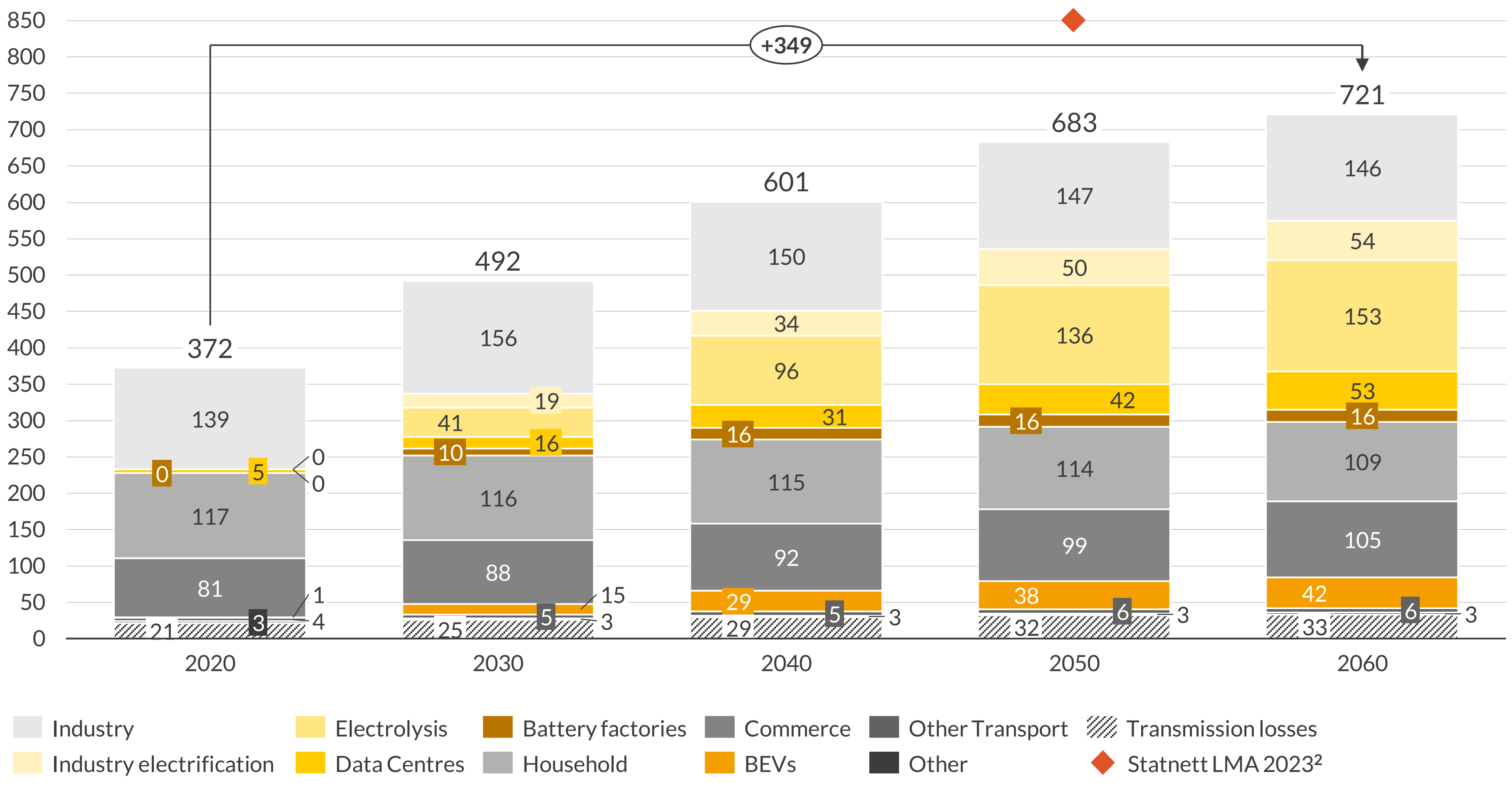
Electricity consumption forecast for the Nordics,
TWh



1) Battery electric vehicles; light and heavy transport; 2) Long-term market analysis (LMA), March 15, 2023

Sources: Aurora Energy Research; Nordic Grid Development Perspective 2021; Statnett

Comments

- Industry demand increases in line with GDP growth until 2030s before it decreases due to efficiency gains
- An increasing part of currently gas fired industry processes get electrified
- Demand from data centres grow in line with computing demand, energy demand per server and favourable geographical conditions
- Hydrogen electrolysis experiences a massive uptake in demand starting in the late 2020s
- Battery factory demand increase based on projects announced until 2030 after which it increases in line with BEV sales in Europe

European H_2 demand is expected to increase five-fold by 2060; we assume half of the e-fuel demand is met by domestic production

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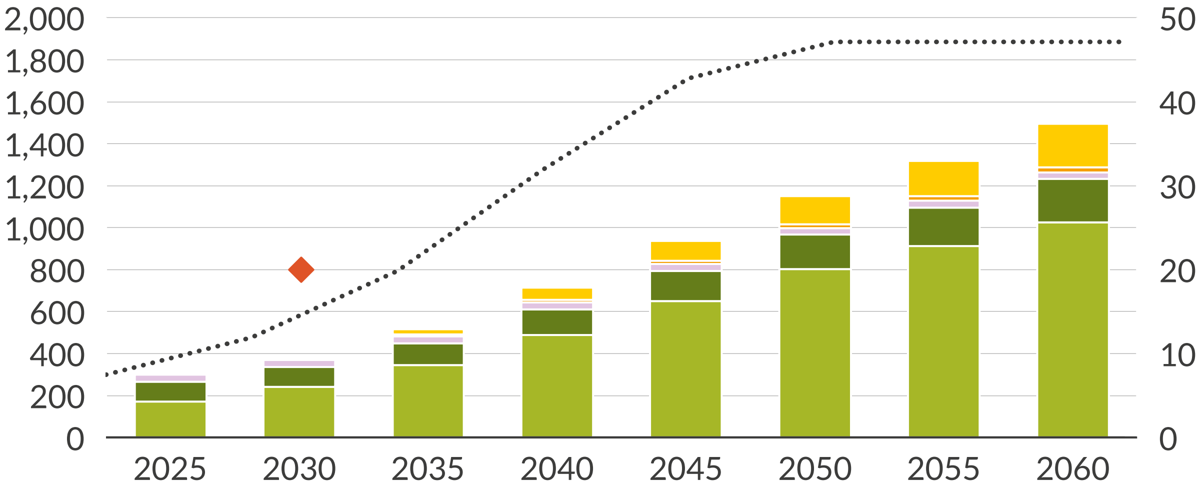
Demand assumptions for H_2 in Europe[1] (excl. demand for gas to power generation)

TWh, final energy consumption

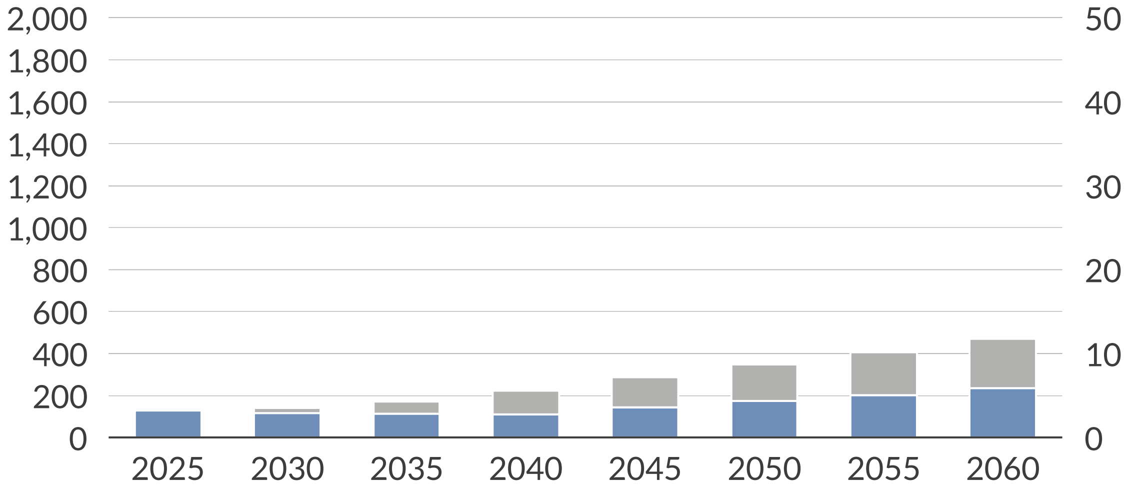


- Aurora's Central scenario expects a more conservative uptake of H_2 and e-fuels in Europe, but this would still increase demand five-fold by 2060, mainly from the fertiliser and steel industries, as well as long-distance transports
- Less demand will come from passenger vehicles and space heating, as electrification is both cheaper and more suitable
- EU's REPower strategy aims to achieve a demand of 20 MtH_2 by 2030, which we believe to be very challenging to achieve given the current market status

Synthetic Kerosene | Ammonia | Synthetic Diesel | Hydrogen | Methanol | Aurora's Net Zero scenario | REPowerEU target (all EU)

E-fuel[2] demand assumptions

TWh, final energy consumption



- We assume that in the long-term Europe will only rely on domestic production of e-fuels for 50% of its demand, the rest will be imported from outside Europe
- Although importing e-fuels is more economically attractive than domestic e-fuel production via imported H_2 into Europe, ensuring a certain level of domestic security of supply can be an important factor beyond the economics

Imported e-fuels from outside Europe | E-fuels produced domestically in Europe

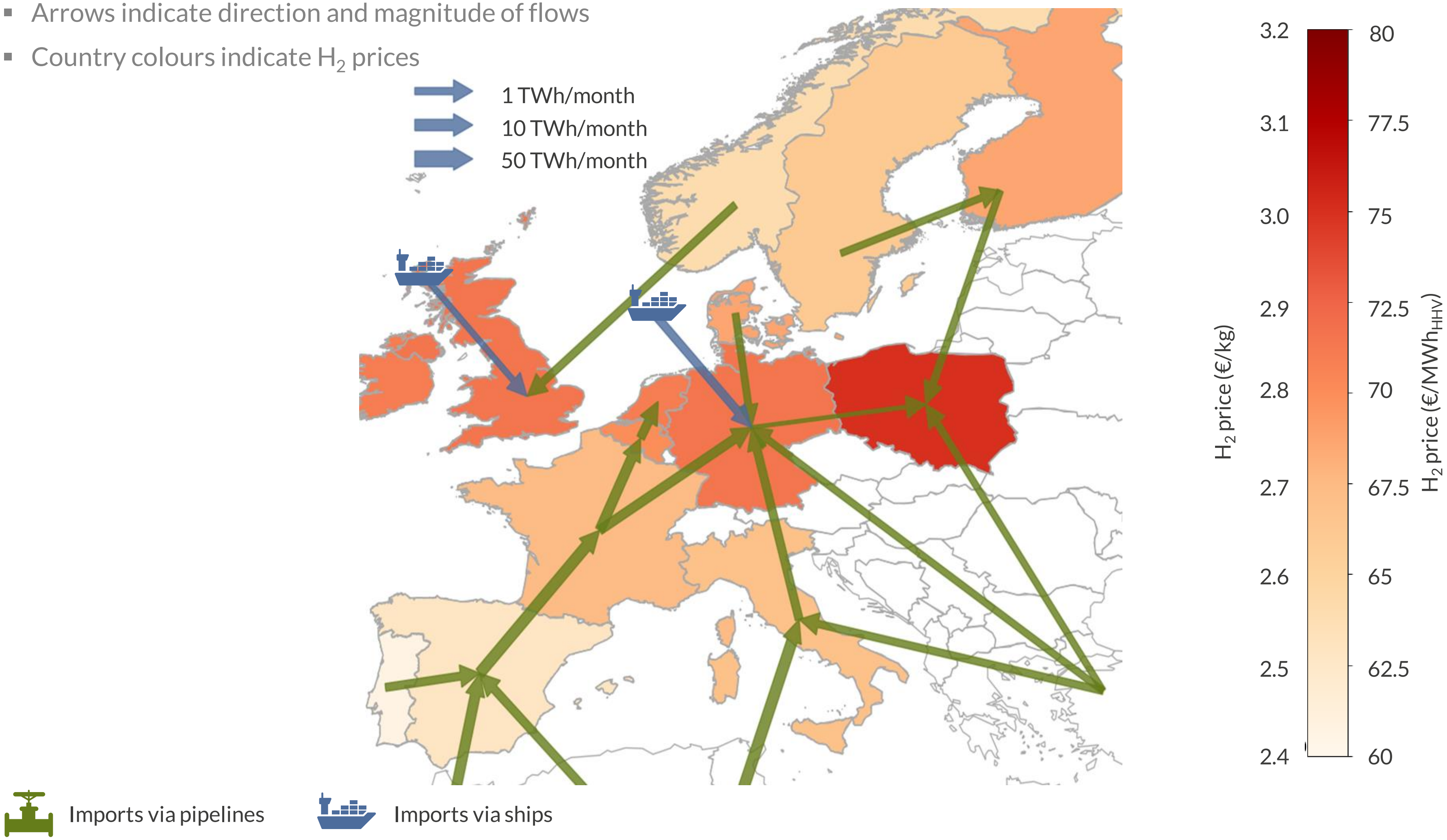
1) European countries include 15 HyMAR countries analysed by the European Hydrogen Service, the demand is estimated for BEL, DNK, DEU, ESP, FIN, FRA, GBR, IRL, ITA, NLD, NOR, POL, PRT, ROU, and SWE. 2) E-fuels considered in this analysis cover ammonia, methanol, synthetic diesel, and synthetic kerosene.

Source: Aurora Energy Research

A H_2 pipeline network will play a key role reducing the need for more expensive shipping imports, and making H_2 price in Europe converge

Hydrogen prices and flows across Europe, example for April 2053

- Arrows indicate direction and magnitude of flows
- Country colours indicate H_2 prices



1) This follows the outlook from European Hydrogen Backbone.

Source: Aurora Energy Research

Key trends observed in the results

In the 2030s:

- We already see some price convergence as regions with cheaper H_2 production can export H_2 at scale
- From outside Europe, only one pipeline is operational in this decade (Tunisia to Italy)[1]. Shipping imports are required to supply H_2 in some European countries

Beyond 2040:

- There is a high degree of price convergence across regions
- Pipeline imports from outside Europe flow into central Europe displacing other sources. Imports via ships are only needed when pipeline imports in combination with domestic production are not enough to satisfy demand

By 2030, the Nordics are expected to become a green hydrogen hub, exporting to emerging industry applications in Germany, GB and Poland

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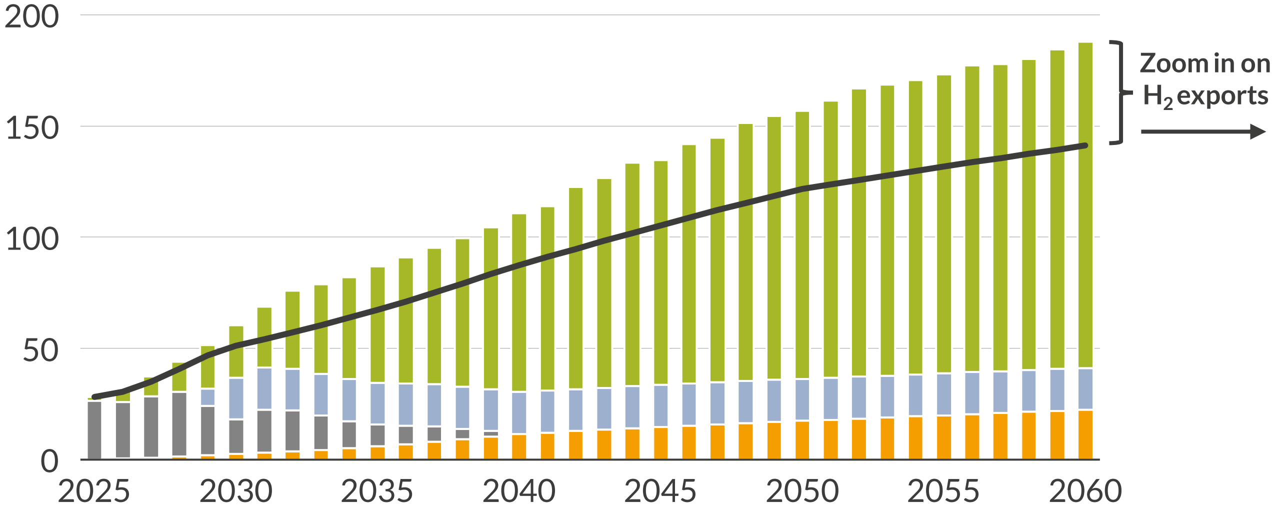
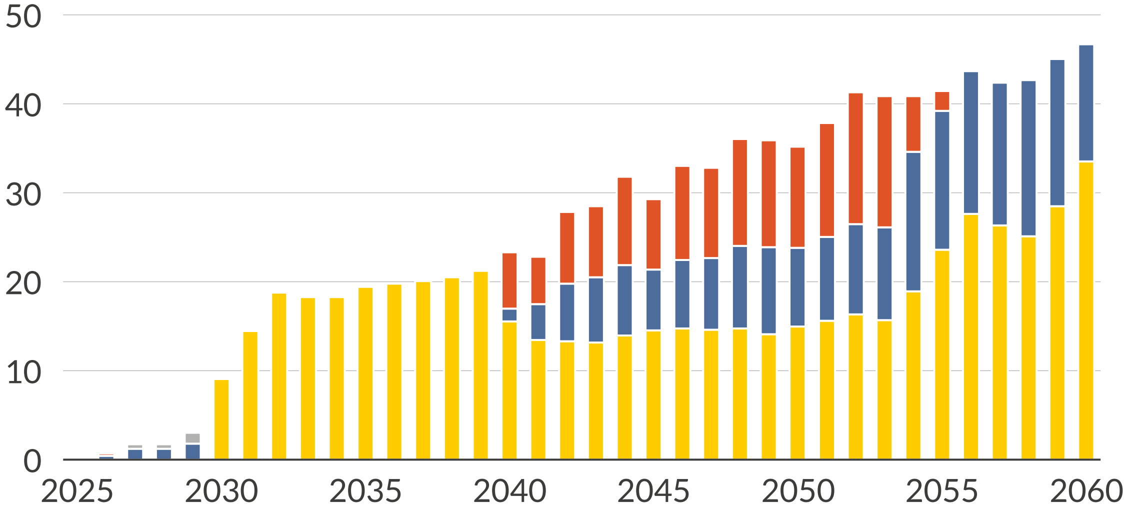
Supply balance of H_2 and e-fuels in the Nordics
TWh, final energy consumption



- The Nordic hydrogen supply will reach 188 TWh at the end of the forecast horizon, amounting to almost 13% of European demand, and exceeding regional demand by 33%
- While Norway will supply almost all (84%) of the blue hydrogen, Sweden will provide close to half (44%) of the green hydrogen, as its electrolyser capacity will ramp up faster to supply the massive production of carbon-free steel
- Norway will account for roughly half (46%) of the region's e-fuel imports

Demand　Electrolysers　Blue H_2　Grey H_2　E-fuel imports

Net exports from the Nordics
TWh, final energy consumption



- The Nordic region is a net exporter of hydrogen across the forecast horizon, initially to Germany. From 2040, the Nordic-Baltic corridor supplies Poland
- Finland will export 6% of their hydrogen, while Sweden, Denmark and Norway export 25-37% of their production in 2060
- Exports to Germany reduce as North African imports are available and more cost competitive. In the 2050s, Nordic exports to Poland are displaced by cheaper pipeline exports from Southeast Europe

Germany　Great Britain　Poland　Other EU countries

Source: Aurora Energy Research

The 5 GW Nordic electrolyser capacity by 2040 can support renewables' capture prices by being much more flexible than traditional demand

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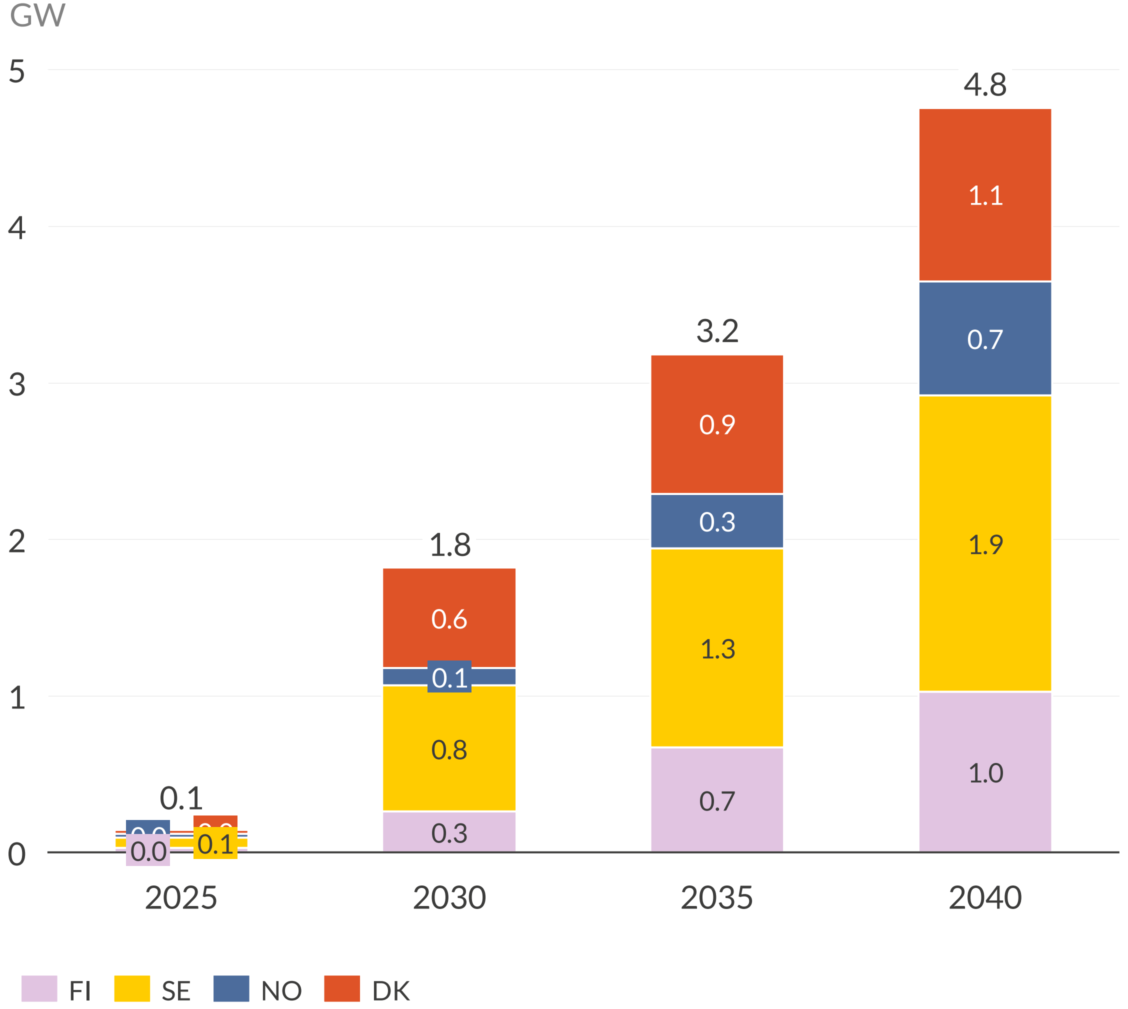
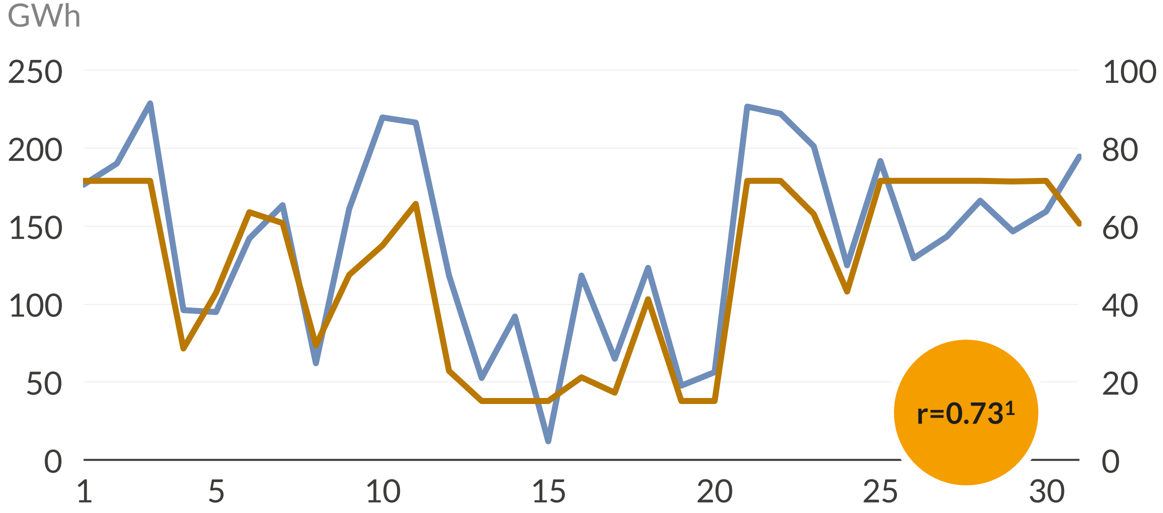
Electrolyser capacity in the Nordics



Modelled offshore generation and electrolyser demand in DK1, Oct-2040



Day of month

- Electrolysers' power demand is, due to their flexibility, highly correlated with the generation from wind
- On windier days, when power prices are low, electrolysers' demand maxes out. On calmer days when prices are high, electrolyser demand is low
- A pre-requisite for electrolyser flexibility is that the produced hydrogen can be stored, e.g. in caverns or overground fuel tanks
- Electrolyser flexibility can thereby redeem renewables' capture prices by ramping up demand in times of high power generation

Offshore wind production (LHS) — Electrolyser power demand (RHS)

1) Pearson correlation coefficient for full year 2040

Sources: Aurora Energy Research

The Nordic region will keep being a provider of clean electricity for the continent, as export capacity will increase by 3.6 GW until 2030

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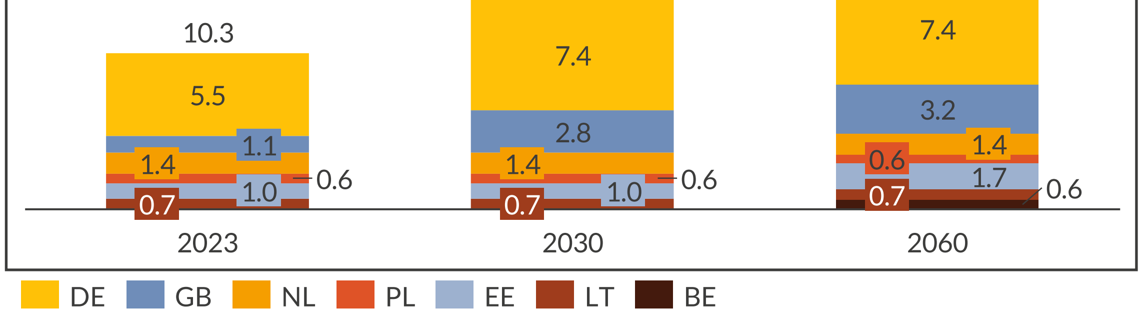
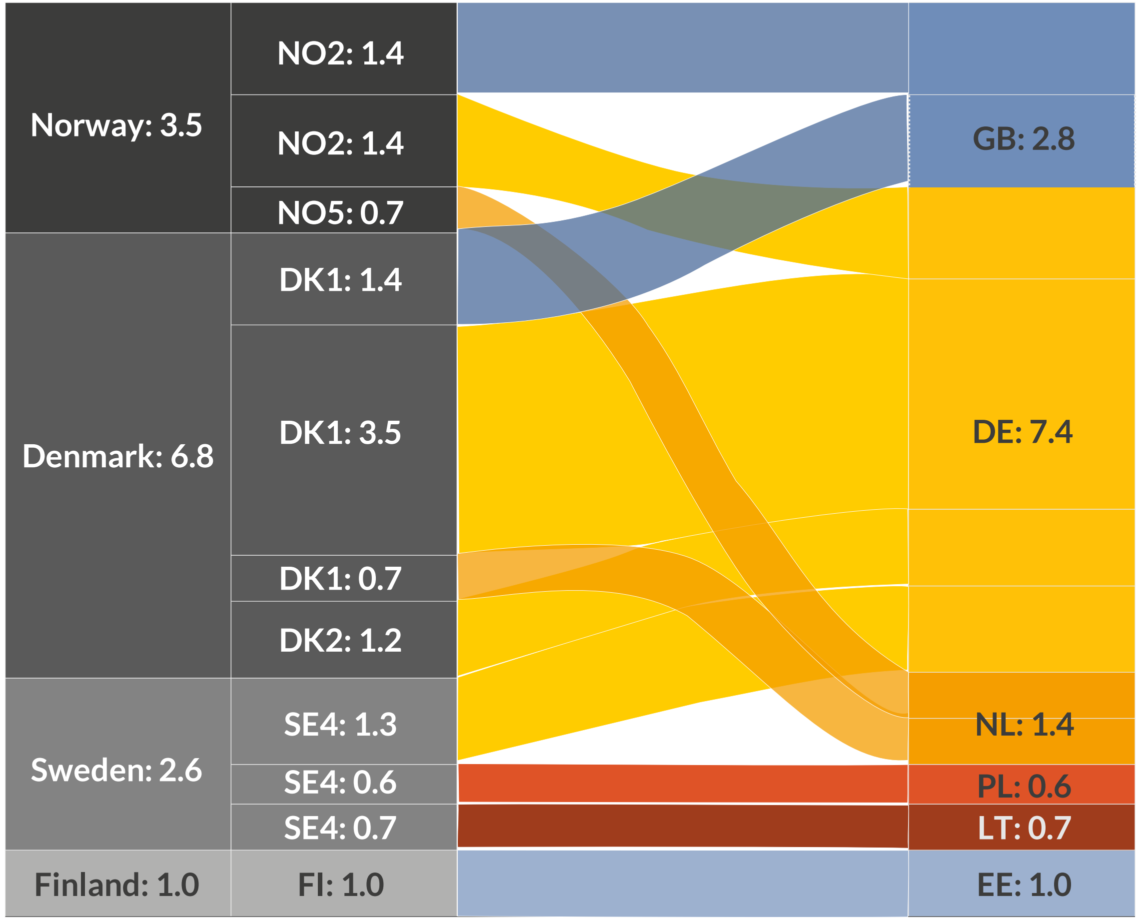
Major interconnector projects

Name	Zones	Add. Capacity, MW	Projected start	Status
Westcoast line	DK1 -> DE	1,000	2024	Under construction
Viking Link	DK1 -> GB	1,400	2024	Under construction
Hansa PowerBridge I	SE4 -> DE	700	2029	In permitting[1]
Aminth Energy	DK1 -> GB	1,400	2032	Under consideration[2]
Kontek 2	DK2 -> DE	600	2030	Under consideration
NorthConnect	NO5 -> GB	0	2030	Licence rejected
Estlink 3	FI -> EE	700 – 1,000	2035	Signed letter of intent
TritonLink	DK1-BE	1,400 – 2,000	2032	Under consideration

Nordic export capacity
GW



Exporting interconnector capacity in 2030
GW



1) Projects in permitting aiming to come online after 2025 are discounted by 30%; 2) Projects under consideration are discounted by 70%

Sources: Aurora Energy Research; Nordpool; TSO reports; TYNDP

Electricity production grows across the Nordics, driven by wind and solar buildout; Denmark is doubling its production and exports

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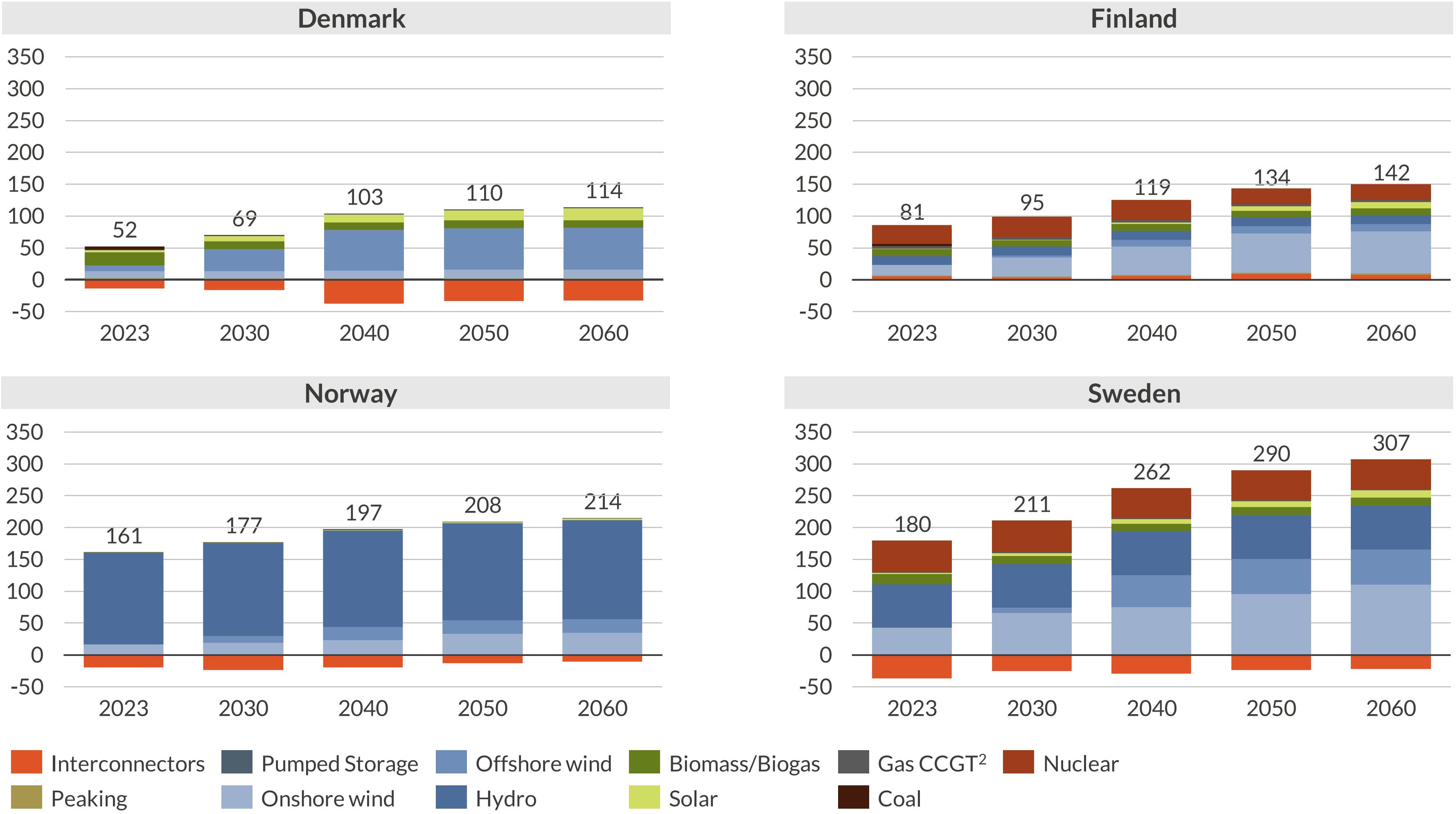
Electricity production and net imports by country[1],
TWh



1) Note: net imports are excluded from sums in diagrams; 2) Including gas OCGT, oil peakers, and hydrogen peakers

Source: Aurora Energy Research

Assumptions and model results

Baseload

- Nuclear remains the only thermal baseload technology with significant production volumes (in Finland and Sweden) after coal is phased out
- Gas is continued to be relied upon to provide peak flexibility

Wind

- Annual production from onshore wind more than doubles between 2023 and 2060
- Offshore wind production increase rapidly with the Danish energy islands coming online

Solar

- Annual Nordic production from solar increases from about 6 TWh in 2023 to 42 TWh in 2060
- Strong increases in all countries apart from Norway

In recent years, buildout of onshore wind in Norway and Denmark has come to a halt; Finland has become the most attractive onshore market

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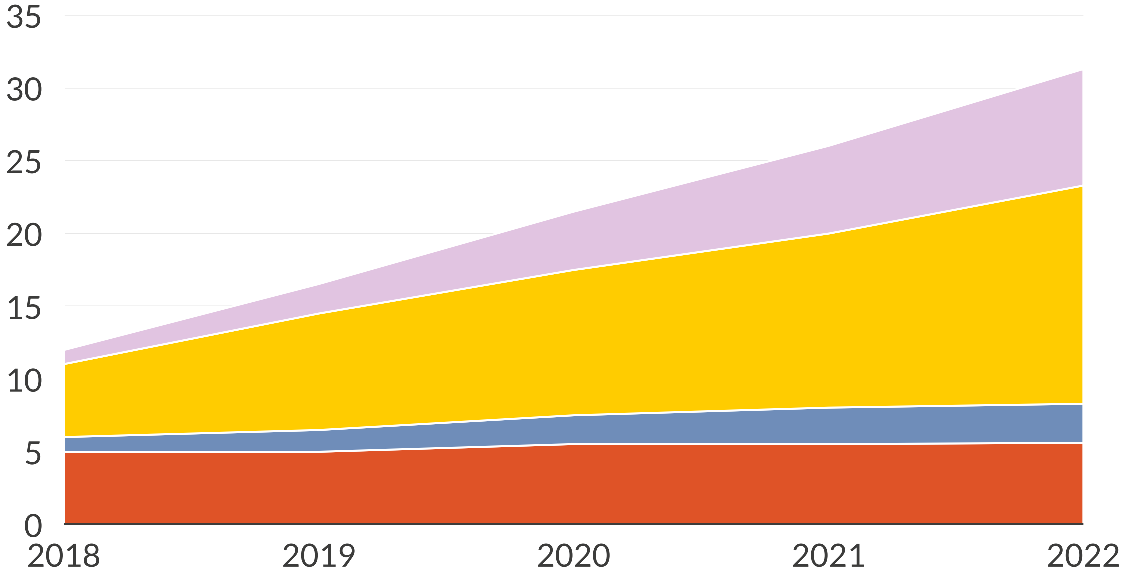
Installed onshore wind capacity
GW



- Onshore capacity buildout has stagnated in Denmark and Norway over the last few years, partially caused by unfavorable government policies
- Sweden has had the largest onshore buildout in absolute terms, but permitting sluggishness and disapproval rates hamper investment
- More spatial availability, faster permitting and less public resistance contribute to making Finland the most attractive Nordic market for onshore

FI SE NO DK

Onshore buildout faces several hurdles in the Nordics

Permitting in Sweden is a slow process ...

- Onshore permit-granting processes can take up to 10 years. In 2021, a record low 22% of the onshore buildout applications were given permit

... while development in Denmark encounters several obstacles

- Including land restrictions, municipal planning responsibility, noise limits and site restrictions, as well as grid connection costs borne by developers

Norway has proposed a tax specifically targeting onshore ...

- From 2023 onwards, onshore wind farms with capacities exceeding 1 MW pay a resource rent tax at an effective income tax rate of 40%

... and public acceptance remains an issue

- Public perception, spatial conflicts with armed forces, and NIMBY resistance restrict onshore wind buildout

Sources: Aurora Energy Research

While Finland and Sweden go merchant, Denmark and Norway provide support, with the Danish offshore pipeline being the greatest

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We expect Denmark and Norway to provide governmental support, while Finland and Sweden will go fully merchant

Denmark

- Offshore buildout follows an open-door scheme[1], which was on the rocks in February over worries of breaching EU state aid rules but resumed in March, or a tendering procedure awarding support through a CfD format
- The **13 GW energy islands** are currently planned, with subsidies expected

Norway

- The government has an ambitious target to allocate **30 GW** of capacity by 2040. Two offshore farms comprising 4.5 GW are now being planned
- **Sørlige Nordsjø II**, a 3 GW fixed farm, will be auctioned and receive public support through a two-sided CfDs. Application due date is Aug. 4, 2023
- **Utsira Nord**, a 1.5 GW floating farm, will receive public support either in the form of investment aid or CfDs. Application due date is Sep. 1, 2023

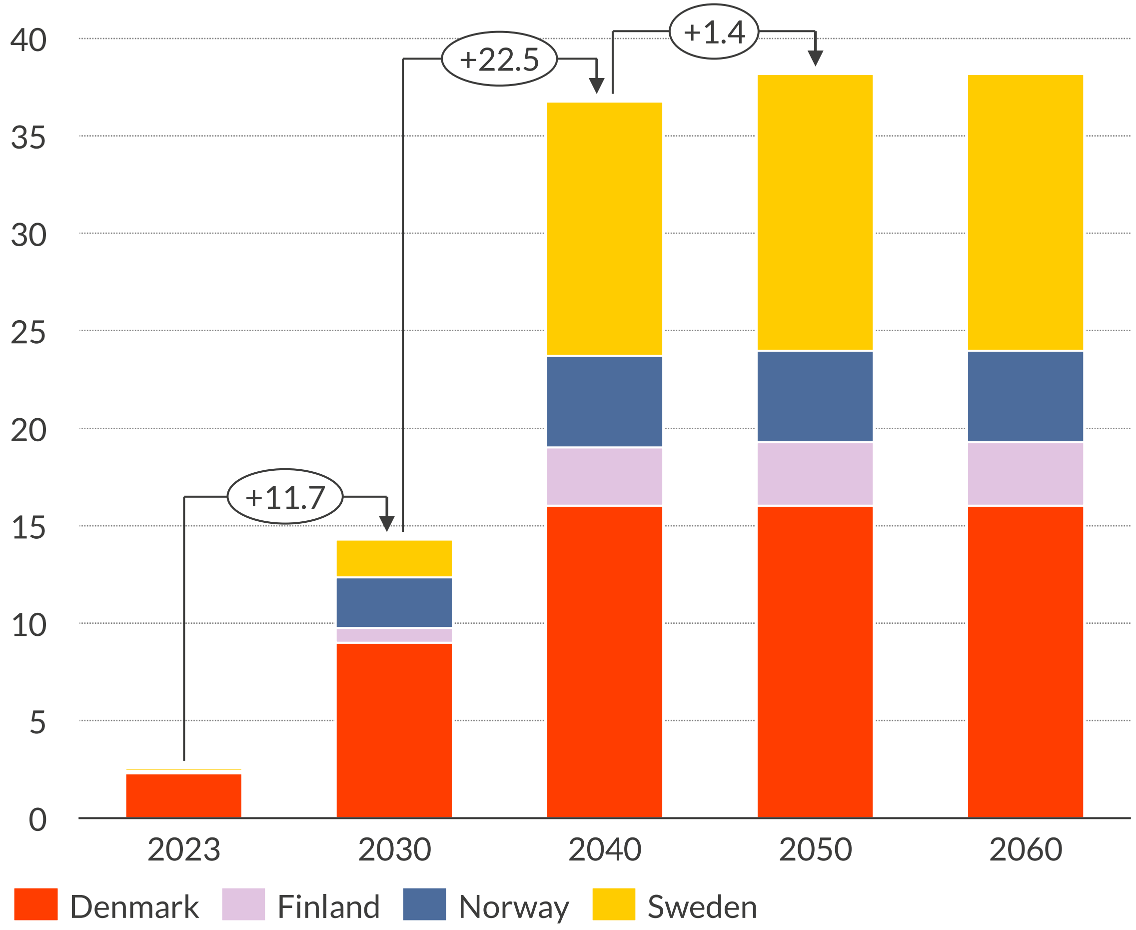
Finland

- Investment support has been given on a case-by-case basis given specific qualitative criteria, but no formal generation-based support

Sweden

- The governing coalition has declared that support to renewables, including offshore, will be scrapped, promoting market-based competition

Assumed installed offshore capacity
GW



1) The scheme permits developers to submit an unsolicited project application to a municipality, as opposed to the municipality tendering a project.

Sources: Aurora Energy Research; ENS; Norwegian Ministry of Petroleum and Energy; Administrative Board of Skåne County; OX2; RWE; Vattenfall; CPH Post; Energistyrelsen

Although costs for offshore wind are significantly higher, it jumps many of the hurdles that onshore currently faces in the Nordics

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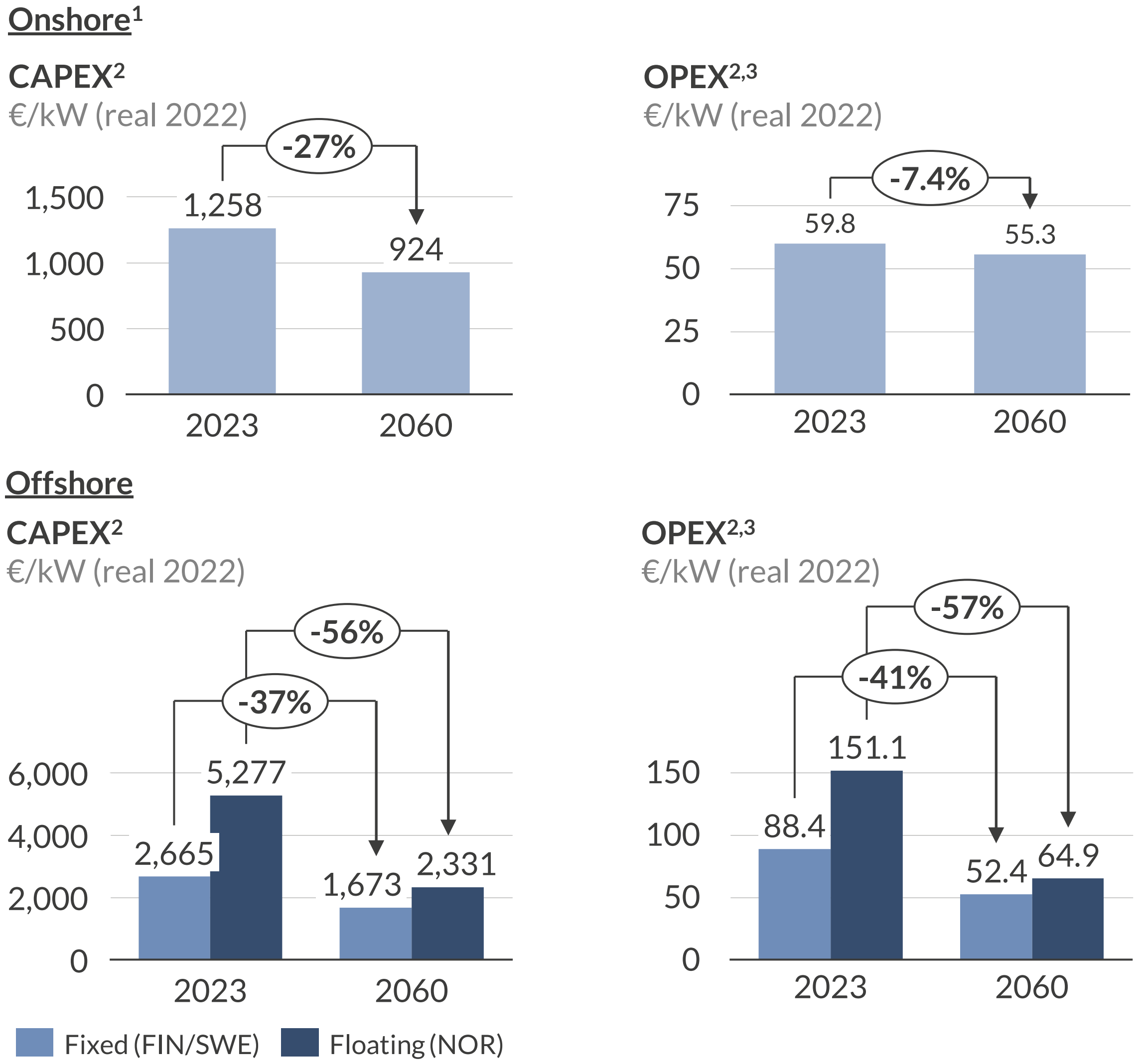

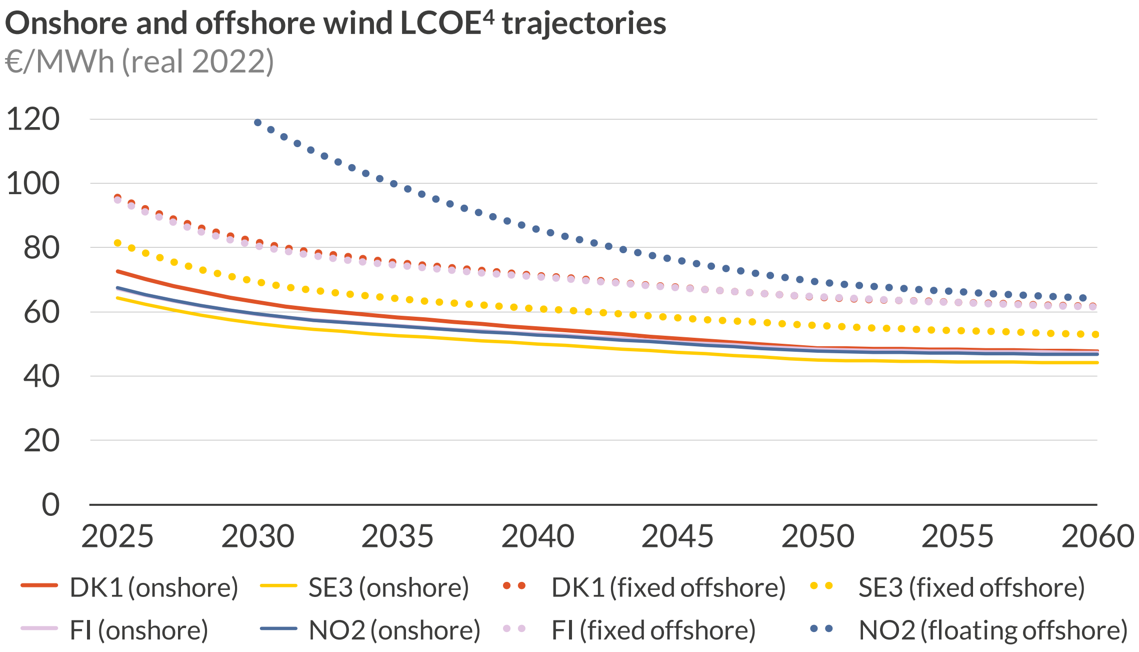

Offshore wind jumps many of the hurdles that onshore wind faces

- Spatial availability for offshore is greater in Denmark, and economic policy favours offshore in Norway
- Governments, not municipalities, are responsible for offshore planning, resulting in faster permit-granting processes and decreased political risk
- Offshore farms often sit far out from the shore, limiting NIMBY resistance
- The scale of offshore sites brings down costs and attracts international utilities and oil majors as developers

1) Refers to onshore in Denmark, Finland and Sweden; 2) Values represent the year asset begins construction; 3) OPEX costs include fixed costs but exclude network charges and imbalance charges; 4) LCOEs shown for a representative location before curtailment. Includes effects of recent movements in commodity and raw materials prices. For Norwegian offshore we consider the technology specifications of floating offshore.

Sources: Aurora Energy Research

Offshore costs are falling rapidly in the next decades, but will not reach the levels of onshore without additional support

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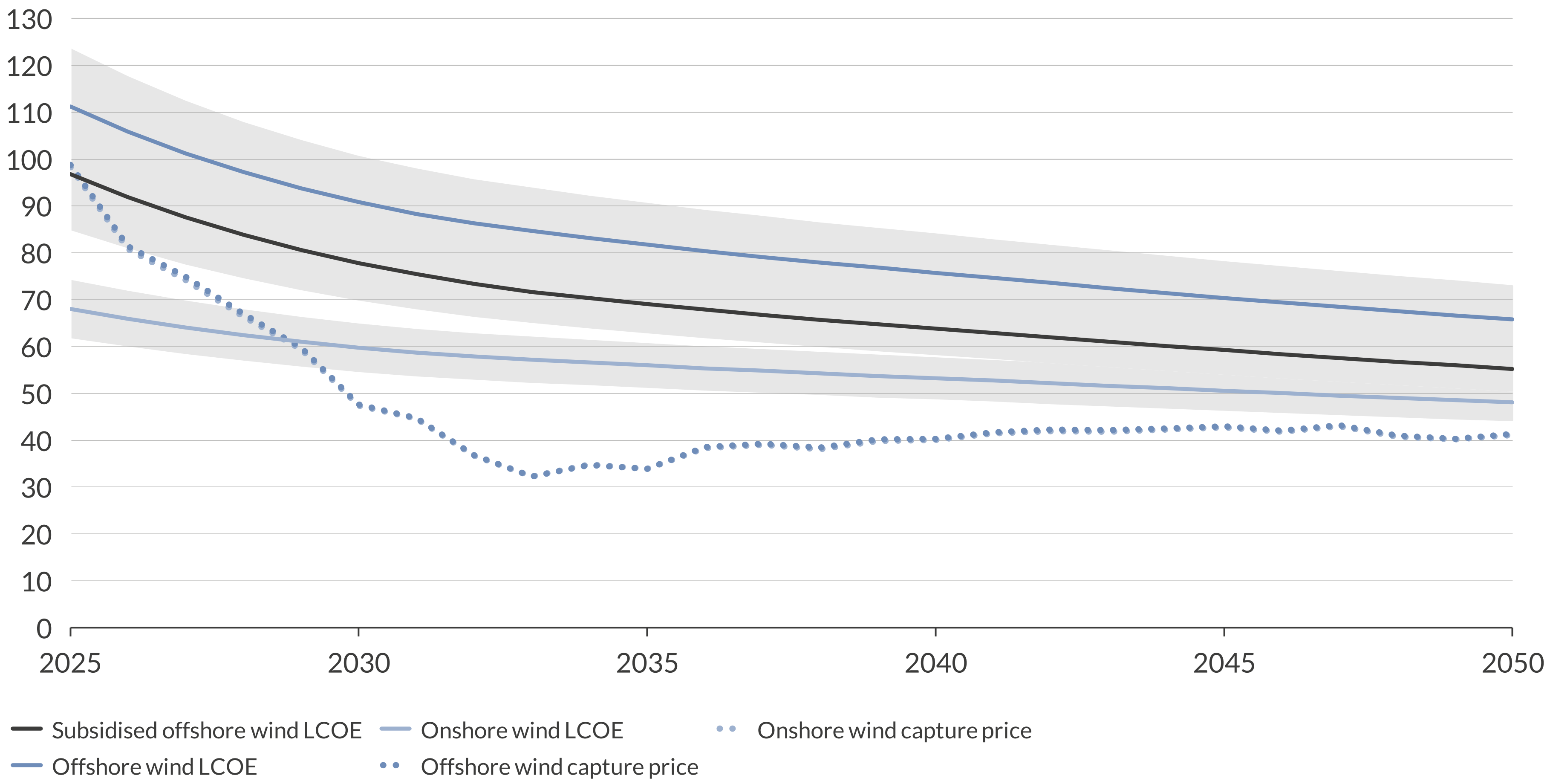
Onshore and offshore wind capture prices and LCOEs in NO2[1]

€/MWh (real 2022)



1) Levelized cost of energy, assuming a merchant model with a 7.5% discount rate (WACC). Shaded ranges represent site-varying LCOEs.

Sources: Aurora Energy Research

Capture prices and LCOEs

- While offshore wind LCOEs are falling rapidly in the next decade, they flatten in the 2040s, and never converge with onshore LCOE
- Even though higher yield and marginally higher capture prices they do not offset the higher LCOEs stemming from greater capital costs
- CfDs, used by the Norwegian government for supporting Sørlige Nordsjø II, lower the WACC, and in turn the LCOE

Several factors can make Nordic offshore as profitable as onshore, such as faster costs declines, new revenue streams, and subsidies

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Lower costs from more deployment and larger turbines

- More rapidly declining costs than expected, stemming from offshore being a less mature market, and economies of scale if more is deployed
- Turbine technologies and sizes improve faster than anticipated, leading to greater power generation per unit, fewer turbines needed to be installed and serviced, and lower LCOEs

Additional revenue streams

- Offshore wind islands, such as those developed in Denmark and Norway, can share grid connection with interconnectors to several markets, adding to the share of bottleneck revenues
- Added on-site hydrogen production can counterbalance cannibalisation and diversify route-to-market

Guaranteed revenues from support schemes

- Subsidy schemes may remove the upside to revenues in times of higher prices, but provide income certainty and can lower capital costs
- Although the Nordics have phased out subsidies for onshore wind, new support schemes for offshore wind route-to-market are considered in Norway and Denmark, and any new government support to renewables in the EU may have to be structured as two-sided CfDs

Restrictions to onshore wind buildout

- Continued politically driven restrictions to onshore buildout at the national and local level can benefit the deployment of other renewables, including offshore wind
- Less overall capacity, and especially less onshore wind, whose production is correlated with offshore wind's production, can improve offshore's capture prices and profitability

Sources: Aurora Energy Research

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The EU introduced an inframarginal revenue cap, which Denmark and Sweden followed. Finland and Norway adopted alternative tax schemes

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	Electricity market interventions	Status
EU	Imposes a cap on inframarginal producers' windfall revenues at 180 €/MWh, effective from Dec. 1, 2022, until Jun. 30, 2023. The cap applies to realised market revenues, including power producers with existing or new PPAs, for plants with an installed capacity of more than 1 MW. The regulation has proven difficult to implement nationally, and member countries are allowed to marginally diverge from the details.	Implemented/approved
Sweden	Taxes inframarginal producers' realised revenues above 1,957 SEK/MWh (c. 180 €/MWh at the time of the proposal) at 90 % from Mar. 1 to Jun. 30, 2023. The tax is temporary and can not be applied retroactively from Dec 1. 2022, according to Swedish legislation.	Implemented/approved
Finland	Introduces, in lieu of a revenue cap, an additional 30% temporary income tax, on top of the statutory corporate income tax of 20%, on companies within electricity generation, wholesale and partly retail, for the 2023 income year. The tax is applied retroactively from Jan 1. 2023, on profits exceeding 10% of the company's capital tied to the electricity operations.	Implemented/approved
Norway	Increases the resource rent tax from 37% to 45%, effective from the income year 2022, for hydro plants with a capacity of 1 MW or more.	Implemented/approved
Norway	Proposes a resource rent tax at an effective rate of 40% on onshore wind energy, on top of the corporate income tax of 22%. The tax is proposed to have effect from Jan. 1, 2023, and will apply to power from plants with more than five turbines or an output of 1 MW or more.	Proposed/on referral
Norway	Imposes a windfall tax of 23% on onshore wind and hydro power on prices exceeding 700 NOK/MWh (≈61 €/MWh) on a monthly average. The tax applies from Sep. 28, 2022, for hydropower plants with a total rated output of 10,000 kVA or more, and from Jan. 1, 2023, for wind farms and other hydropower plants. PPAs entered prior to Sep. 28, 2022, will be exempt.	Implemented/approved
Denmark	Proposes a revenue cap like the EU regulation, which was on consultation until Feb. 24, 2023.	Proposed/on referral

● Implemented/approved ● Proposed/on referral

Sources: European Council; KPMG; Montel Group; Norwegian Tax Authority; Statkraft; Swedenergy; the Nordic Governments and Parliaments; Aurora Energy Research

Danish and Swedish hedges and PPAs are unaffected by the revenue cap, while Finnish and Norwegian generators can forego some profit

Hedges and PPAs are contracted at levels far below the revenue cap, thus leaving Danish and Swedish utilities' revenues largely unaffected

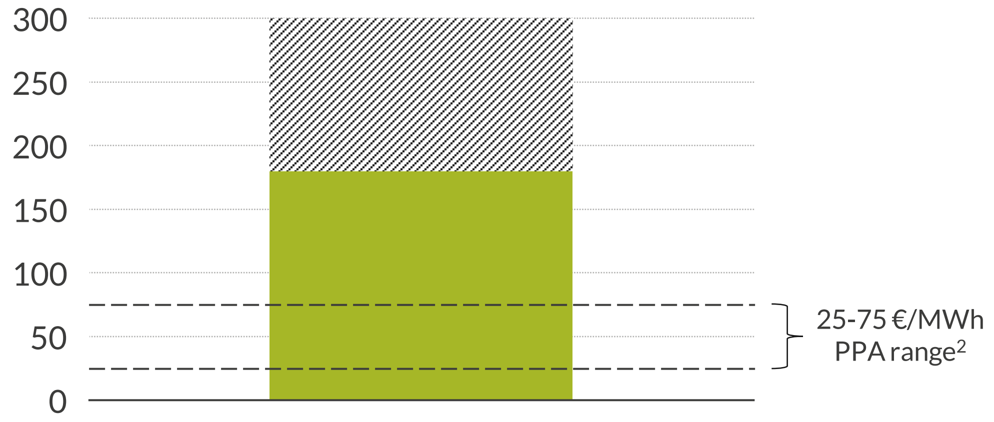
- Although profits from both futures and PPAs are affected by the revenue cap, the actual financial impact is deemed small to non-existent
- First, the tax is only applied in Sweden from March 1 to June 30, 2023, and is yet to be implemented in Denmark
- Second, the largest utilities in Denmark and Sweden have hedged up to 70% of their projected 2023 generation at price levels below the cap

All Finnish generation, including hedged volumes and PPAs, are subject to the Finnish tax. In Norway, some fixed-price output may be affected

- The Finnish 30% tax applies to all new and existing output, and not only output sold above a certain price threshold, for the whole of 2023
- The Norwegian 23% tax is also likely to impact some hedged volumes and PPAs, as it applies from Sep. 28, 2022, to generation sold above c. 61 €/MWh
- However, as in the other Nordic countries, hedging and PPA prices generally fall below that level

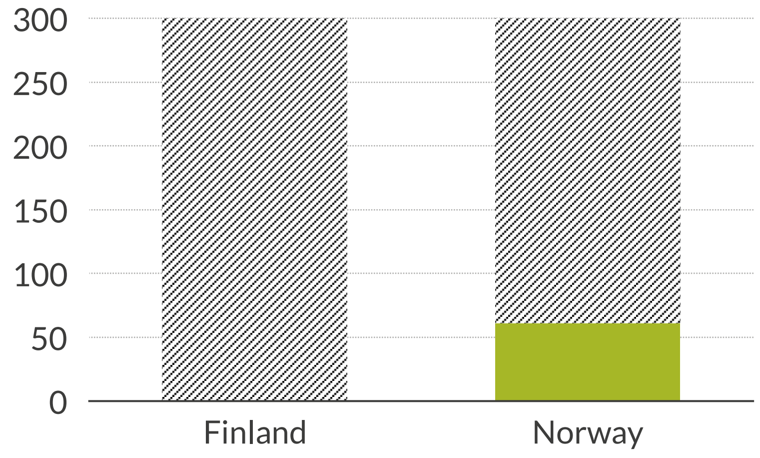
Danish and Swedish revenue cap regulations

€/MWh[1]



Finnish and Norwegian revenue cap regulations

€/MWh[1]



Output subject to taxation Output not subject to taxation

1) Euro approximations for local currencies; 2) PPA quotes for Sweden and Denmark available to Aurora

Sources: Companies' annual reports; Aurora Energy Research

The short-term measures turned into a discussion about reforming the European power markets, and contrasting proposals were made in the EU

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Jan '23 — Feb '23 — Mar '23

22-Jul: Greek root-and-branch proposal to **split the market** between renewables and fossil fuels

11-Jan: The Spanish non-paper advocates a **re-regulation** of the power sector, including **central planification** through **state-backed CfDs** to overhaul the pricing mechanism

13-Feb: The joint letter from the North/Central Europeans counterbalances the Spanish proposal, calling for a **preservation of the current design**, with an emphasis on **PPAs** and **forward market liquidity**

14-Mar: Commission publishes their market reform proposal

Topic	Spanish non-paper	North/Central European joint letter[1]
Long-term contracts	▪ **Voluntary CfDs** between new and existing renewables generators and the regulator	▪ Reduced barriers to incentivise **market-based PPAs**. Improved liquidity in **forward markets**
	▪ Regulated prices through **forced CfDs** for hydropower and nuclear generation	▪ **Voluntary, auction-based CfDs** for new renewables, but not for dispatchable generation, as that could counteract system needs
Security of supply	▪ **Central capacity market** for combined-cycle gas plants, energy storage and demand-side management to support flexibility	▪ Advocates **safeguarding current dispatch signals** to reflect flex demand, improved by strengthened EU internal cross-border flows
Revenue limitations	▪ As inframarginal generation will be contracted at fixed prices reflecting average costs, **windfall profits are prevented**	▪ Not in favour of making temporary caps permanent in order not to erode investor confidence

1) Joint letter from Denmark, Estonia, Finland, Germany, Latvia, Luxemburg and the Netherlands.

Sources: Spanish non-paper; North/Central European joint letter; Aurora Energy Research

The Commission's final proposal leans more towards the North/Central European's joint letter, and avoids extreme reforms to the current design

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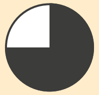
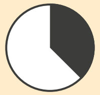
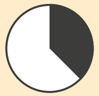
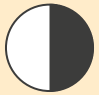
Topic	Trade-off			European Commission Proposal
1 Renewables revenue risk	Market-based renewables buildout with PPAs	Supply and demand-side stimulation for PPA market; Promoting two-sided CfDs	State-backed RES buildout with CfDs	▪ Mandating two-way CfDs for all new renewables and nuclear subsidies ▪ Facilitating PPAs through guarantees and integration with subsidy schemes
2 Role of government	Protecting consumers from high costs	Regulated prices for consumers during crises	Investor confidence in regulatory regime	▪ Access to regulated prices for households/SMEs during crises, limit at 80% of median consumption[1] ▪ Establish supplier of last resort regime
3 Consumer flexibility	Consumer demand response	New demand response products; Mandate fixed retail tariffs	Long-term consumer hedging	▪ Consumer access to fixed tariffs ▪ Enable TSOs to roll out "peak shaving" products and storage support schemes ▪ Establish national flexibility targets ▪ Reinforce local energy sharing
4 Role of utilities	Regulation of hedging activities	Mandate minimum level of hedging; Enhanced cross-border futures trading	Futures markets integration	▪ ACER to create "virtual hubs" enabling cross-border forwards sale for up to three years ▪ Member States able to mandate utilities' minimum level of hedging

◆ Type of measure proposed by European Commission

1) 70% for small and medium sized enterprises.

Sources: European Commission, Aurora Energy Research

For the Nordics, the proposals can entice nuclear buildout and make the PPA market liquid, but risk distorting price and dispatch signals

	European Commission Proposal	Positive contributions	Potential limitations	Impact on the Nordics
1	**A. Mandating 2-way CfDs for new renewables and nuclear subsidies** **B. Facilitating PPAs with credit guarantees**	✓ Confirms CfDs in Denmark (and non-EU Norway) ✓ CfDs can reduce nuclear capital cost and entice investment, especially in Sweden and Finland ✓ PPA guarantees can make the PPA market more liquid again after a halt in 2022, by supporting lower-credit entities, such as start-ups, to sign PPAs	× CfDs may distort price signals and reduce the flexibility potential of nuclear power × Guarantees may shift the risk from investors to governments	
2	**A. Access to regulated prices[1]** **B. Establishing supplier of last resort regime**	✓ Price regulations protect consumers from the highest price peaks ✓ Supplier of last resort reduces cut-off risks	× Regulated prices partially distort price signal to reduce consumption, which is especially important in the Nordics due to high power consumption × Price crisis reforms risk undermining investor confidence and curb renewables buildout	
3	**A. Peak shaving & support schemes for flexibility**	✓ Peak shaving and flexibility support schemes can lower day ahead and intraday prices	× Splitting peak shaving into a separate product could divert resources from functioning market structures	
4	**A. Virtual trading hubs for forward sales** **B. Mandating utilities minimum hedging levels**	✓ Properly designed and implemented, trading hubs can improve liquidity on forward markets	× Creation of hubs may take years, foster uncertainty and reduce current forward market liquidity × Mandating specific hedging levels is a step away from deregulation × EPAD like contracts, which can suffer from low liquidity, are still needed to be fully hedged	

1) If a) wholesale prices are at least 2.5 times above the previous 5-year average and are expected to be there for at least 6 months, b) retail prices increase at least 70% and are expected to last for 6 months, and c) the wider economy is negatively affected by the electricity prices. Exactly how the regulated prices will be implemented remains unspecified but will likely be something the member states do individually.

Sources: Aurora Energy Research, European Commission, EEB, Valtioneuvosto, Reuters

Agenda

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I. Introduction

II. Outlook on Nordic power

1. Nordic power prices
2. Nordic power generation and demand

III. Emergency measures and proposed market reforms

1. Short-term emergency measures
2. Electricity market reform proposals

IV. Conclusions and next steps

Key takeaways

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1 There is great potential for the Nordic region, with its cheap and green electricity, to become an export hub of green hydrogen as Europe will need to decarbonize industry. However, the deployment speed and costs of pipeline infrastructure remain as key questions

2 The number of Nordic offshore wind projects has rapidly increased in the last few years. However, there is a need for either faster cost declines, new revenue streams or subsidies, for the offshore project economics to make sense. In Aurora's central case, onshore wind continues to dominate the buildout

3 The inframarginal revenue cap, introduced by the EU at the height of the energy crisis, will have limited effects in Denmark and Sweden, as hedges and PPAs are contracted at levels far below the cap, and wholesale prices have come down substantially from record-highs. Still, the sudden implementation and the risk of it occurring again during next crisis create uncertainties for investors

4 Despite initial fears, the EU market reform proposal is more evolution than revolution, abstaining from extending the inframarginal revenue cap or making changes to the marginal pricing mechanism. However, it shows a strong move towards a larger role of the state, which can distort price signals and have a lasting impact on investor confidence

Sources: Aurora Energy Research

Explore upcoming Group Meetings and publications as part of the Nordic Power and Renewables Market Service

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Impact of the Russian war on the Nordic power system

June 2022

November 2022

The impact of weather on renewables economics

Outlook on Nordic power markets and the announced market interventions

4 April 2023

Mid-April: **Nordic Power & Renewables Market Report**

Late May: **Nordic Flexibility Market Report** with forecasts for frequency service markets and BESS valuations

13 June 2023

Nordic PPA market

Dimensioning of co-located solar and storage assets

21 Nov 2023

Details and disclaimer

Publication
Nordic Power Markets in Flux: Green Hydrogen Opportunities and Market Reform Challenges

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