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Zoning In on the Swedish Bidding Zone Review

Stockholm, 20th February

Introducing the speakers

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Agenda

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I. Introduction

II. Zoning in on the proposed Swedish Bidding Zone Review

III. Splitting the German bidding zone

IV. Conclusions and next steps

The dynamics of the Nordic power grid have changed, and the current bidding zone borders no longer coincide with system constraints

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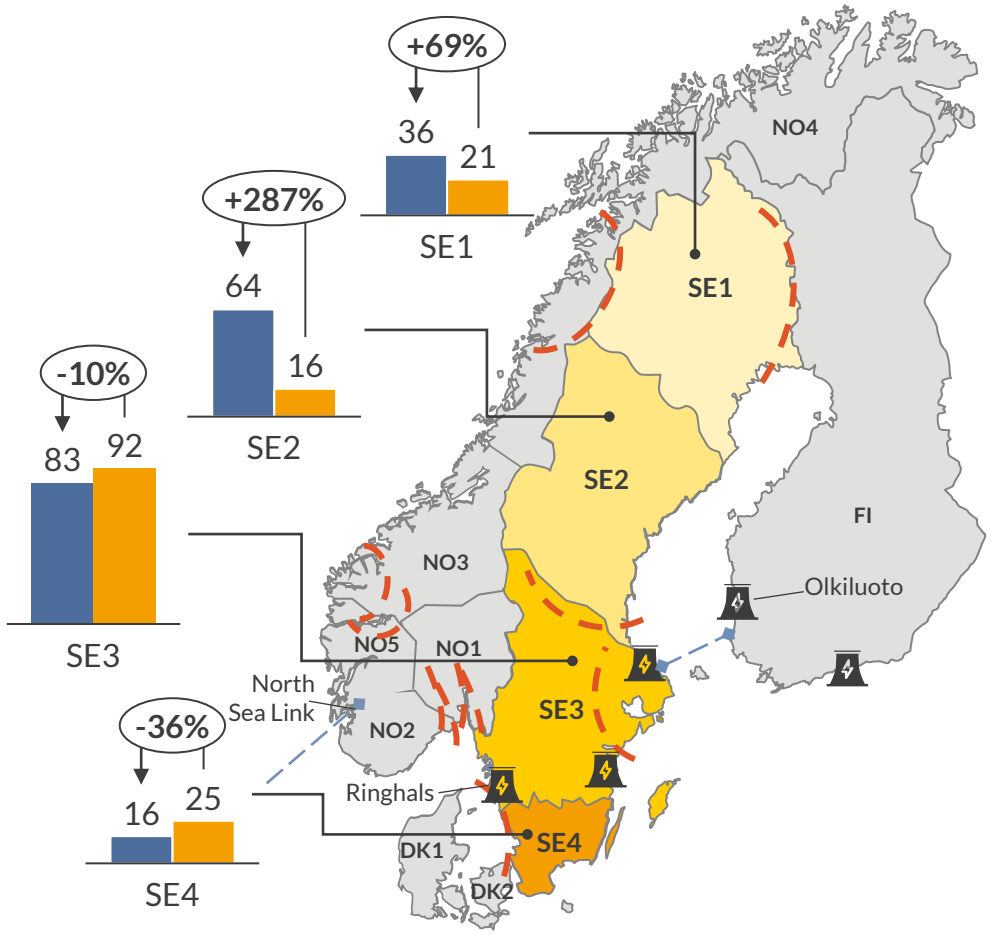
The Swedish zones including zonal net generation and base demand[1] in 2027

TWh



Background on the Swedish power grid

The current BZ configuration[2] is increasingly outdated and is no longer considered optimal as two major events have changed the dynamics of the Swedish power grid;

- the decommissioning of Swedish nuclear capacity[3] and,
- the commissioning of North Sea Link[4].

These changes have resulted in new flow patterns in an already unstable and congested power grid, which spurred a Bidding Zone Review.

Congestions

- Identified congestions in Sweden are north-southbound between SE2 and SE3 and east-westbound within the current SE3.
- Internal congestion within SE3 are due to east-west flows which occur about 15% of the time, mostly between March and May, and mainly in the case of imports from Finland and export to Denmark/Norway.
- Given these limitations, SE3 is often setting the boundaries for available capacities given to the market.

Corrective measures

- Non-sufficient transmission capacity has resulted in costly counter-trades and redirections of power, reducing the efficiency of the grid.

Market efficiency

- Unrepresentative market signals, as prices within the zones don't reflect the actual costs of transfer.

1) Base demand excludes demand from EVs, and electricity used in electrolysis; 2) Sweden implemented its current Bidding Zone (BZ) configuration in 2011; 3) Ringhals 1 & Ringhals 2 were decommissioned on 31 December in 2020 and 2019, respectively; 3) A 1,400 MW undersea cable connecting NO2 and the UK, commissioned in October 2021.
Sources: Aurora Energy Research, ENTSO-E, ACER

Implementation of bidding zones is seen as a solution to structural power grid congestion in Europe and contributes to increased renewables implementation

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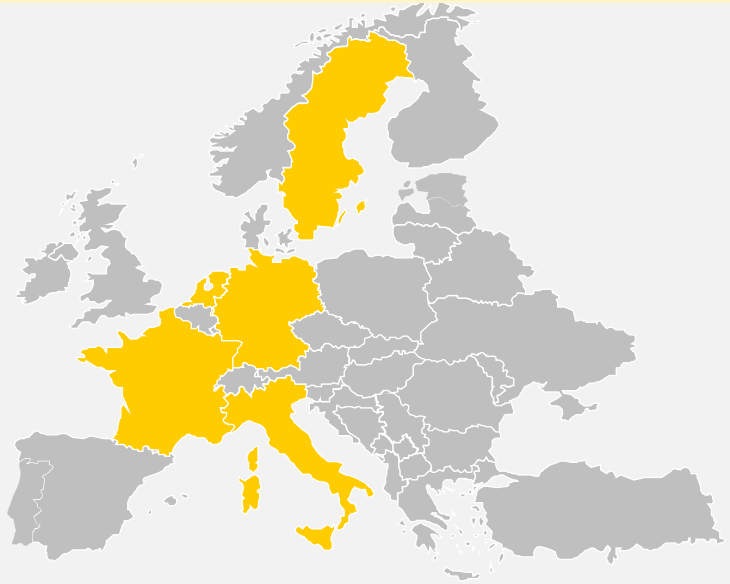
Bidding Zone Reviews on the European level

- The EU Clean Energy Package requires ACER to assess energy market efficiency and to review current bidding zone configurations **every three years.**
  - In case of inefficiencies, ACER can request Transmission System Operators (TSOs) to evaluate and make proposals for an alternative BZ configuration.
- Five Bidding Zone Reviews (BZRs) are currently ongoing with the purpose to increase economic efficiency and cross-zonal trading.
- The countries undergoing a BZR are:
  - **France, Germany, Italy, the Netherlands and Sweden.**



Bidding zone reconfiguration decision on national level

- The Swedish BZR is a part of a coordinated Pan-European BZR.
- The modelling and the evaluation is performed at a regional level (i.e., the Nordics) while some aspects, e.g. the impact on market liquidity and transition costs, are evaluated within the Pan-European study.
- Svenska Kraftnät (Svk), together with the other Nordic TSOs, are **aiming to present results and recommendations for the bidding zone reconfiguration by May 2024.**

Sources: Aurora Energy Research, ACER, ENTSO-E, Svenska Kraftnät

A Swedish bidding zone reconfiguration could decrease price spreads between SE2 and SE4 by 7 €/MWh in the late 2020s

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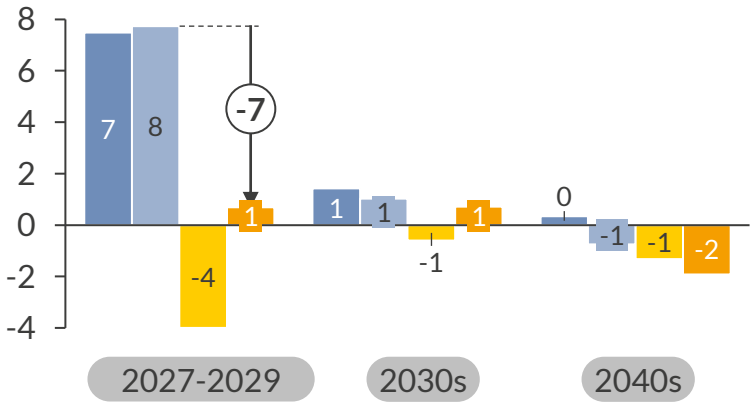
1 From 2027, a bidding zone reconfiguration will increase prices in the north, mainly due to higher availability of the north-south transmission.

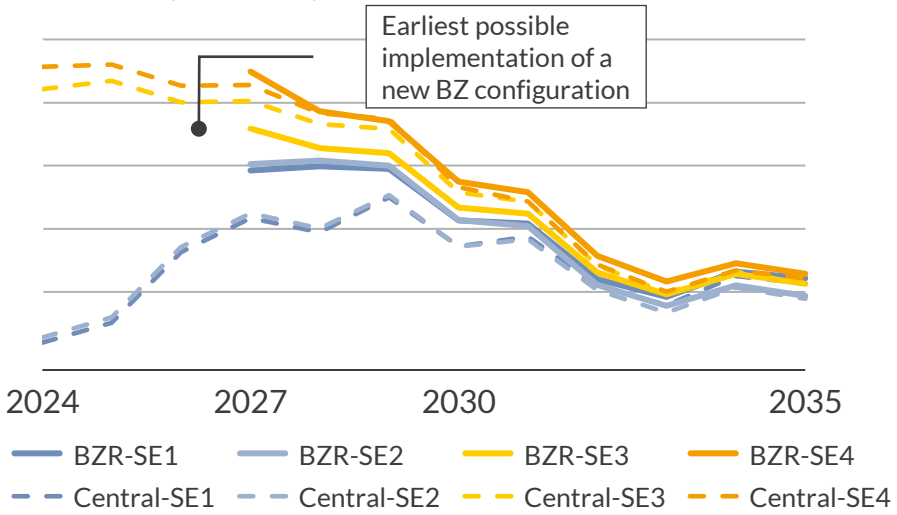
Average price difference per zone[1]
€/MWh (2022 real)



- The spread between the north (SE2) and the south (SE4) decreases, as the price in the north increases more than in the more expensive south.
- Wholesale prices in the smaller SE3 area are lower due to low transmission capacity between SE3 and SE4, while simultaneously having a high connectivity to SE2.

2 The price spreads between the north and the south converge ahead of the completion of the NordSyd Package due to contiguity between SE2 and SE4.

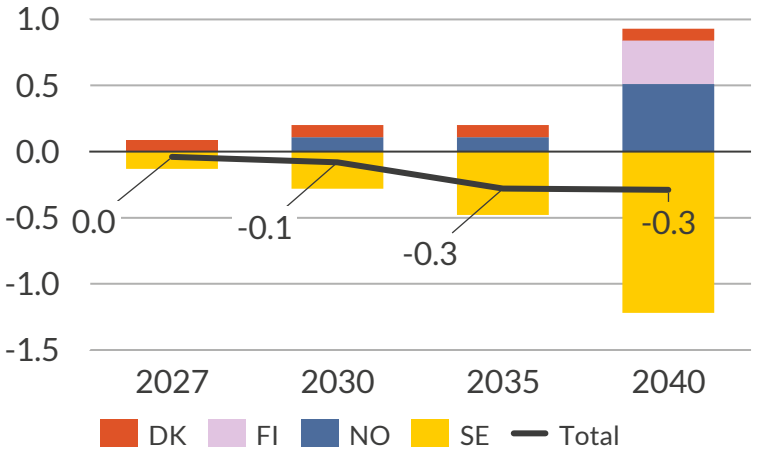
Power price per price zone
€/MWh (2022 real)



- Pricing the congestion within SE3 leads to a decoupling of the region containing Stockholm and the western parts of SE3, where Stockholm and Uppland see reduced wholesale prices while the western parts (containing Gothenburg) see an increase.
- The impact of the newly gained contiguity between SE2 and SE4 decreases spreads between the zones, pushing the prices in the northern zones higher.

3 Renewables deployment in Sweden is reduced due to lower long-term capture prices and increased onshore wind deployment in neighbouring regions.

Delta installed capacity in the Nordics
GW



- Exports are lower as neighbouring zones (such as the DK1 and NO1) are connected to the more expensive SE4 instead of SE3.
- The total impact on renewable buildout in the Nordics following a bidding zone reconfiguration is low, limited to less than 1% of the total Nordic onshore wind fleet.

1) The bidding zone configuration referred to is alternative D on page 13.

Source: Aurora Energy Research

Based on the identified congestions, four alternative configurations are presented after aggregating grid nodes to bidding zones

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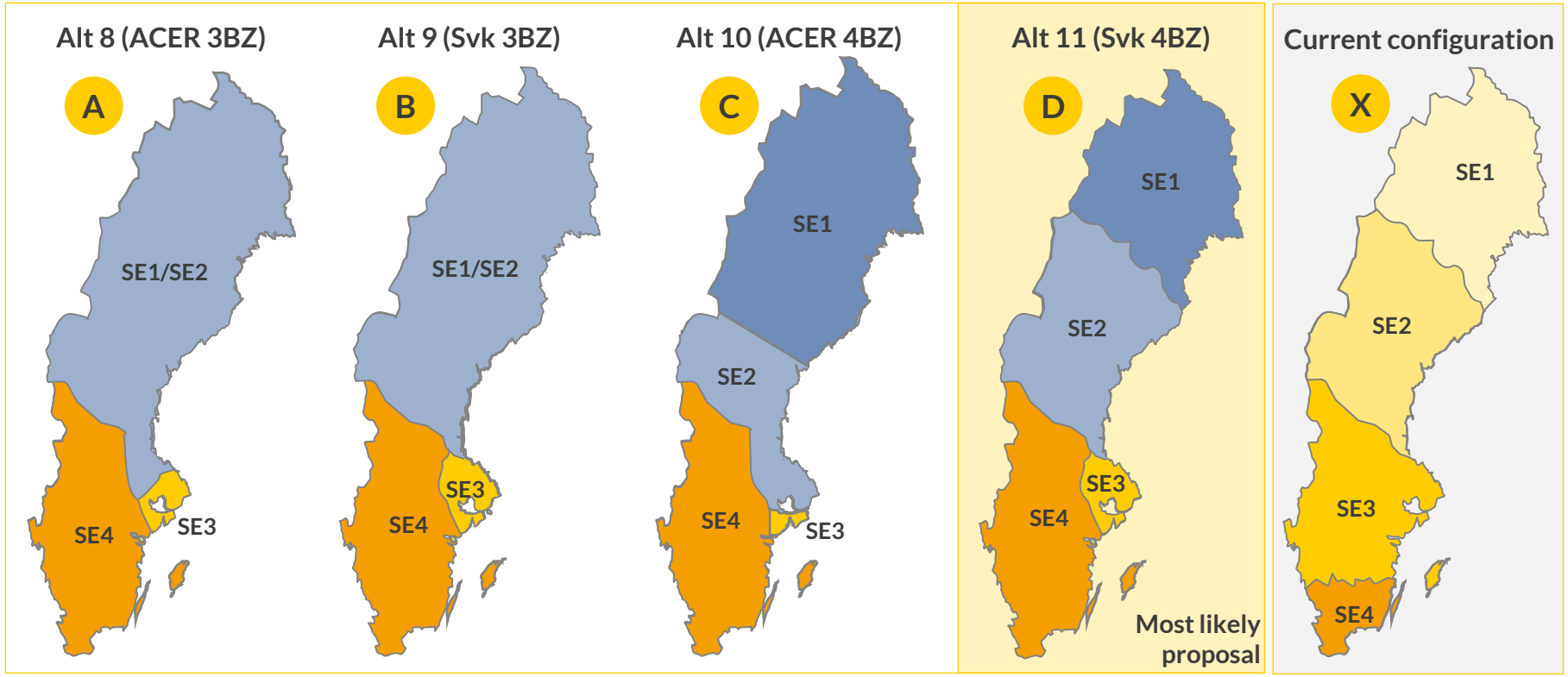
Bidding zones proposed by ACER



Method for determining alternative prize zone configurations

A. Each node[1] in the electricity system is modelled as an its own price area, and structural congestions are identified.
B. Socio-economic factors and security of supply are then considered, which may alter the configuration.

The preferred configuration in Sweden will be determined by assessing what **social economic impacts**[2] a reconfiguration **could have**, as well as evaluating **22 indicators**[3] **presented by ENTSO-E**

1) Power stations at nominal voltage level greater than or equal to 220 kV; 2) Estimated and analysed by Svk; 3) The 22 indicators, grouped into four categories (Network Security, Market Efficiency, Stability & Robustness of BZs and Energy Transition), needs to be assessed in the BZR.
Sources: Aurora Energy Research, ACER, Svenska Kraftnät

Comment

ACER and Svk has decided on four alternative bidding zone configurations that are to be assessed for Sweden.

- Two configurations with a three-zone split (3BZ), and
- Two configurations with a four-zone split (4BZ):

Main characteristics of the four alternatives are:

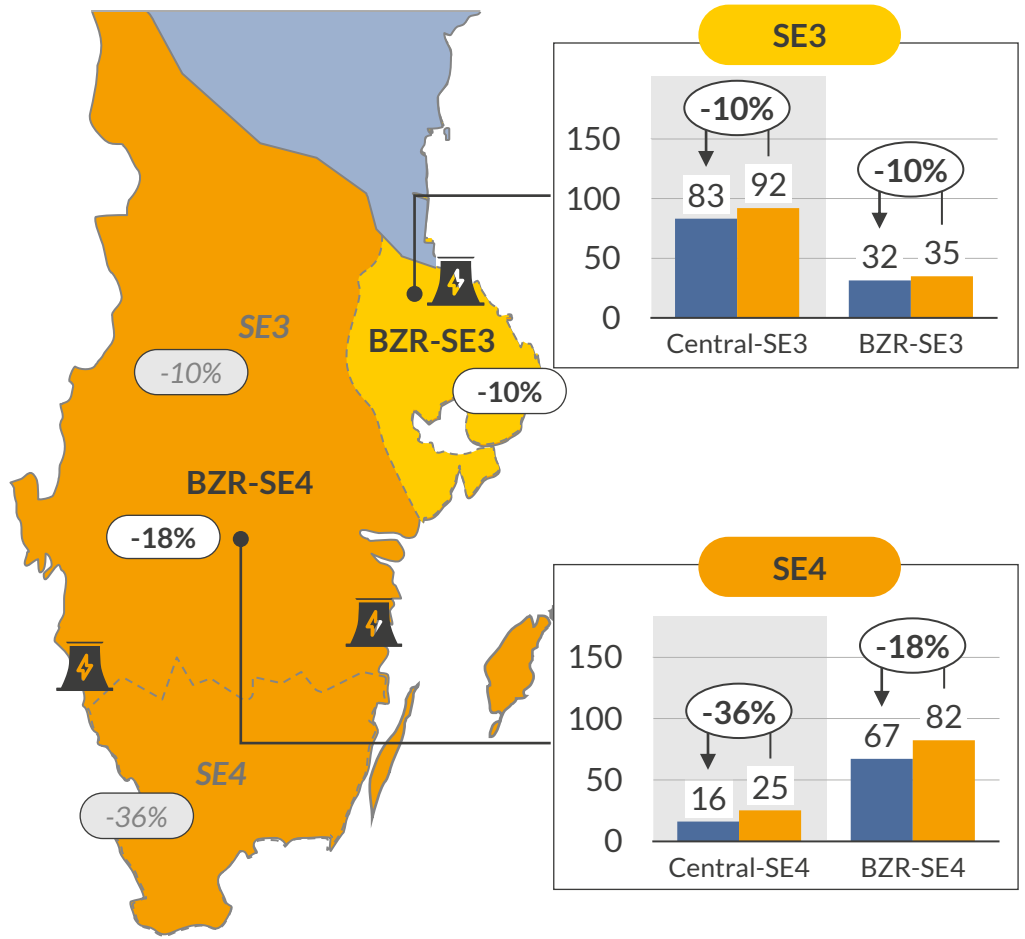
I. The northmost border SE1/SE2 is either merged or kept as is.
II. The north/south border, SE2/SE3, is either kept as is or is extended south-eastward into today's eastern parts of SE3.
III. The southern border SE3/SE4 is removed.
IV. The proposed "SE3 area" has two alternative configurations, mainly with or without the nuclear plant Forsmark.

- Another consideration, although no longer an option, is to merge today's southern areas, SE3 and SE4 into a combined area.

In alternative D, the balance in SE4 improves significantly while not negatively impacting the other Swedish bidding zones

Map of Swedish zones including net generation and base demand[1] per zone in 2027

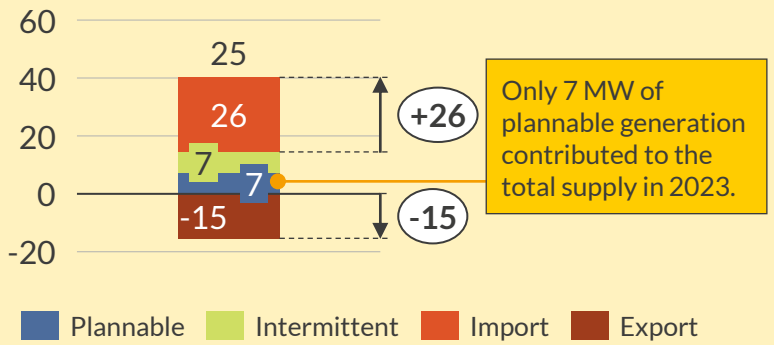
TWh



Over-/undersupply in 2027 (+/-) | Nuclear plant | Generation | Demand

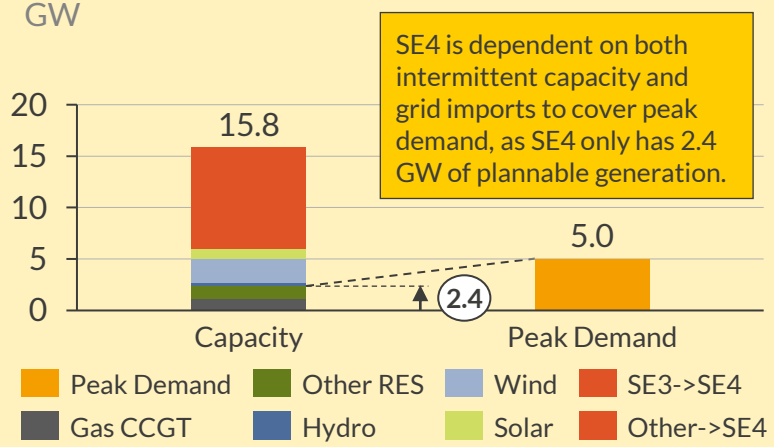
SE4 Generation and Import/Export in 2023,

TWh



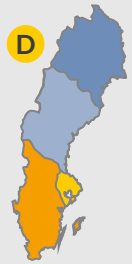
SE4 Generation and import capacity in 2023,

GW



1) Base demand excludes demand from EVs, and electricity used in electrolysis; 2) Carbon intensity incl. co-generated heat

Sources: Aurora Energy Research, ENTSO-E, Region Skåne



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Central

- The northern price zones are currently oversupplied with more generation than internal demand, with SE2 being the most imbalanced area.
- SE4 has a capacity-to-peak demand ratio where the plannable capacity can cover less than half of the peak demand.
- The southern zones are currently undersupplied and rely on imports from SE2.

BZR

- The energy balance in the southern zones is more evenly distributed as nuclear generation is moved from SE3 to SE4.

Onshore wind capture prices increase in both the north and in SE4 by 7 €/MWh and the prices converge ahead of the Nord-Syd package

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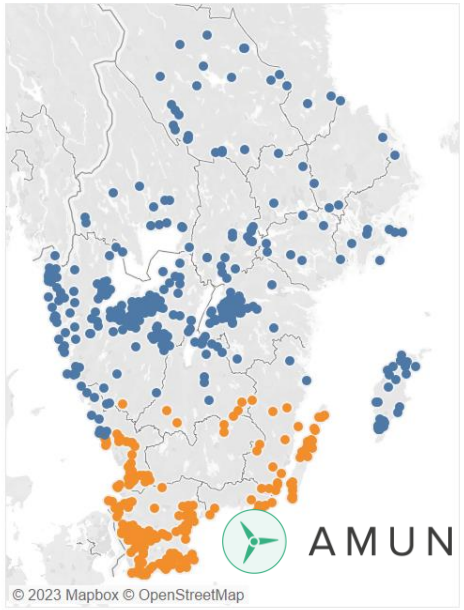
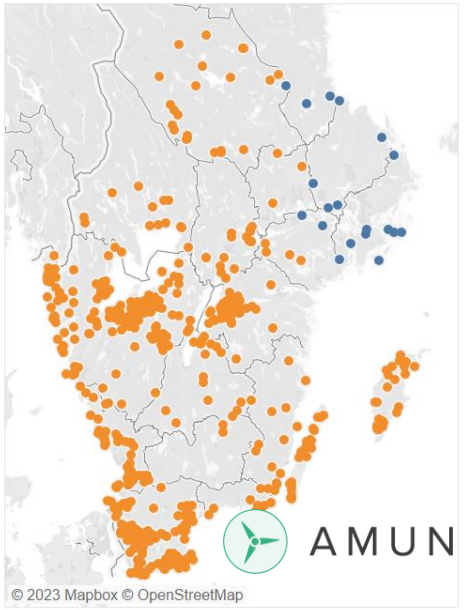
1 Current BZ configuration[1]



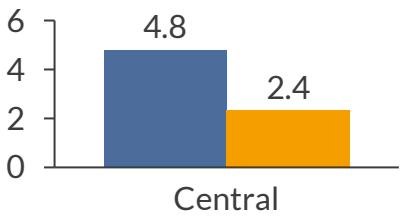
2 Alternative D[1]



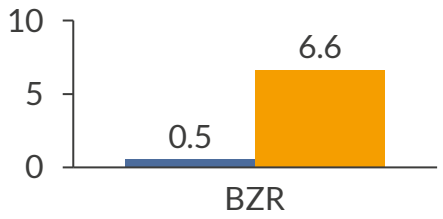
Changes for onshore wind between alternative D and the current configuration

- In the current configuration, roughly 3 GW of wind turbines are clustered In the West- and East Gothland (western SE3), which in alternative D will be in the new SE4.
- Due to the contiguity of the new SE4 and SE2, capture prices in SE2 increase in the medium term. Simultaneously, the capture price spread between the areas narrows in 2027 by 2 €/MWh.

Capacity installed in 2027
GW

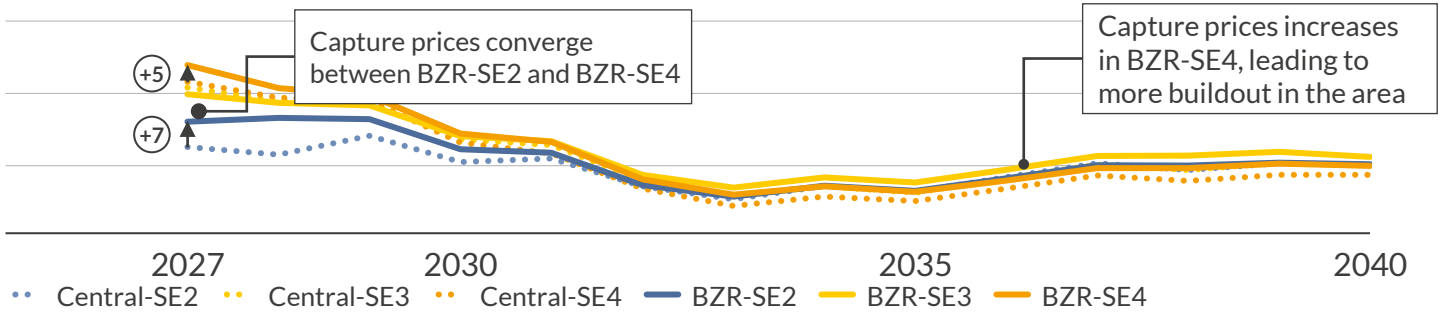


Capacity installed in 2027
GW

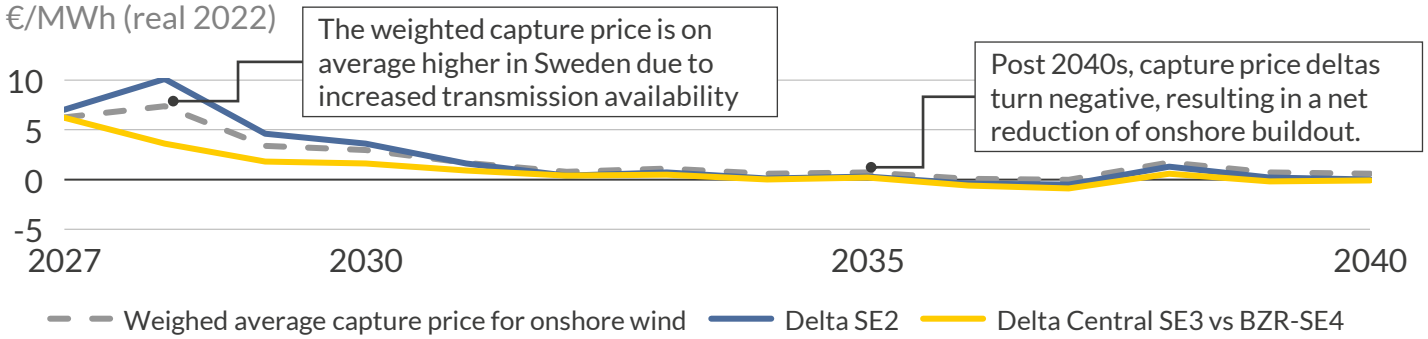


Central-SE3 Central-SE4 BZR-SE3 BZR-SE4

Uncurtailed onshore wind capture price
€/MWh (real 2022)



Delta Central vs BZR, uncurtailed onshore wind capture prices
€/MWh (real 2022)



1) Modelled wind power plants in the current (1) and in the alternative 11 (2) Bidding Zone configuration

Sources: Aurora Energy Research

Negligible impacts on BESS investments despite arbitrage being less profitable due to lower volatility

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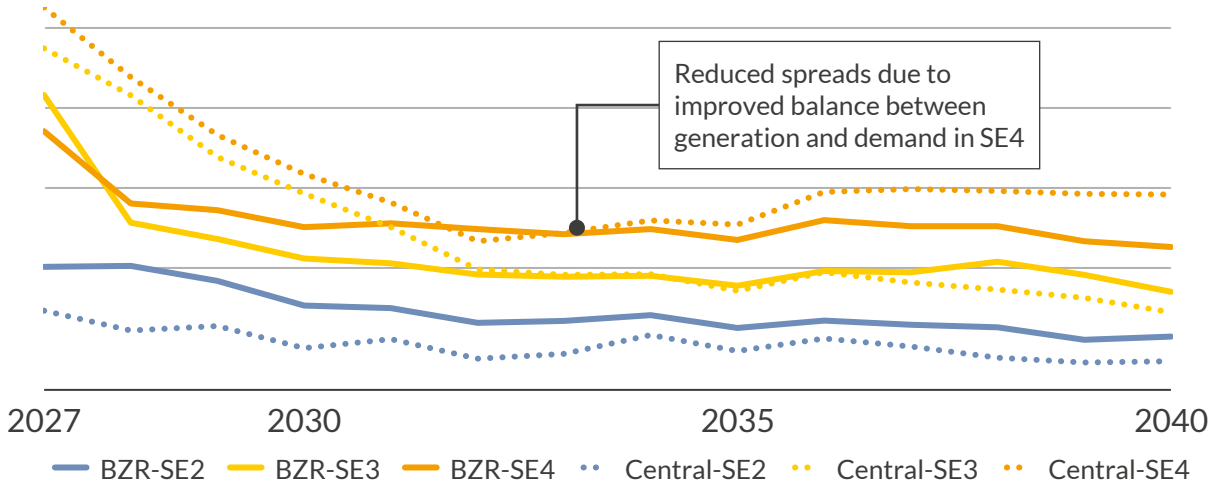
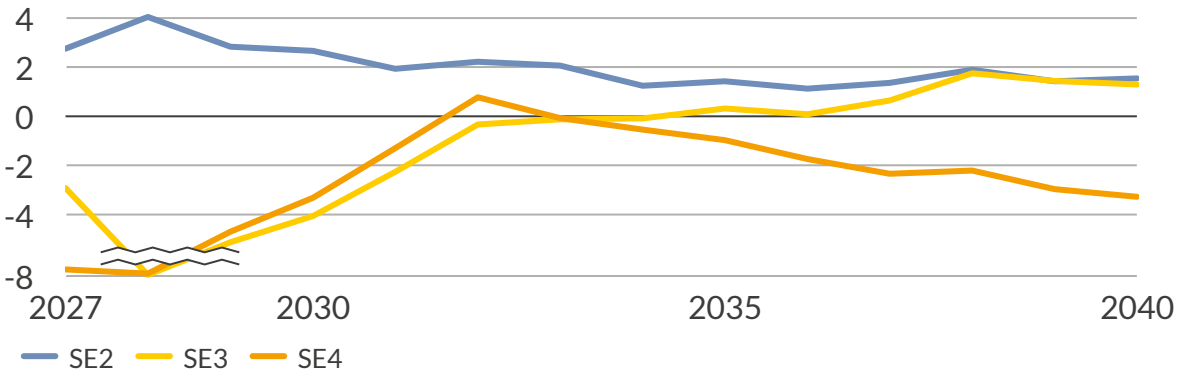
Average daily spread 2h

€/MWh (real 2022)



Delta average daily spread 2h, Central vs BZR

€/MWh (real 2022)



Effects on BESS business case from a bidding zone reconfiguration

Volatility

- Increased price stability due to high transmission availability reduces arbitrage opportunities.

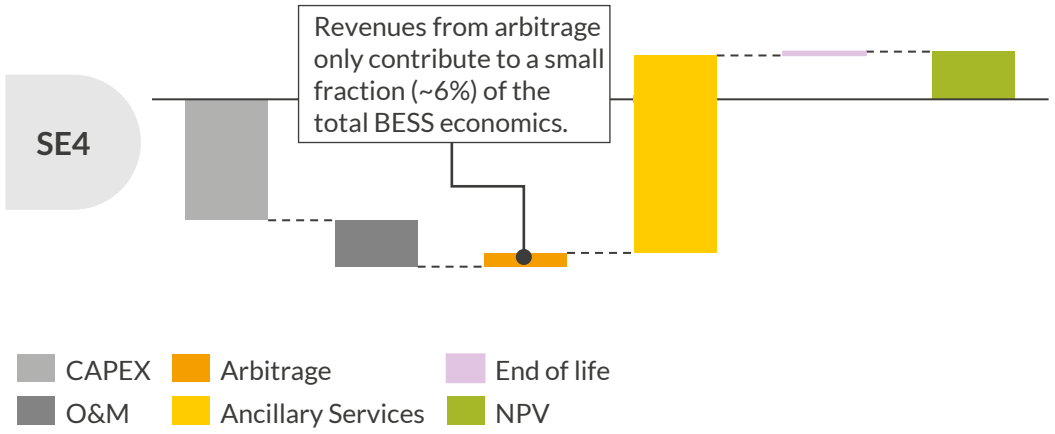
Ancillary services

- Underlying fundamentals of the power grid are unchanged and ancillary market prices are not directly related to bidding zones.

The impact on BESS business cases is negligible as the main revenues are from ancillary services, which are independent of bidding zones.

Economics for new-build battery (2hr duration, 2024 entry year)

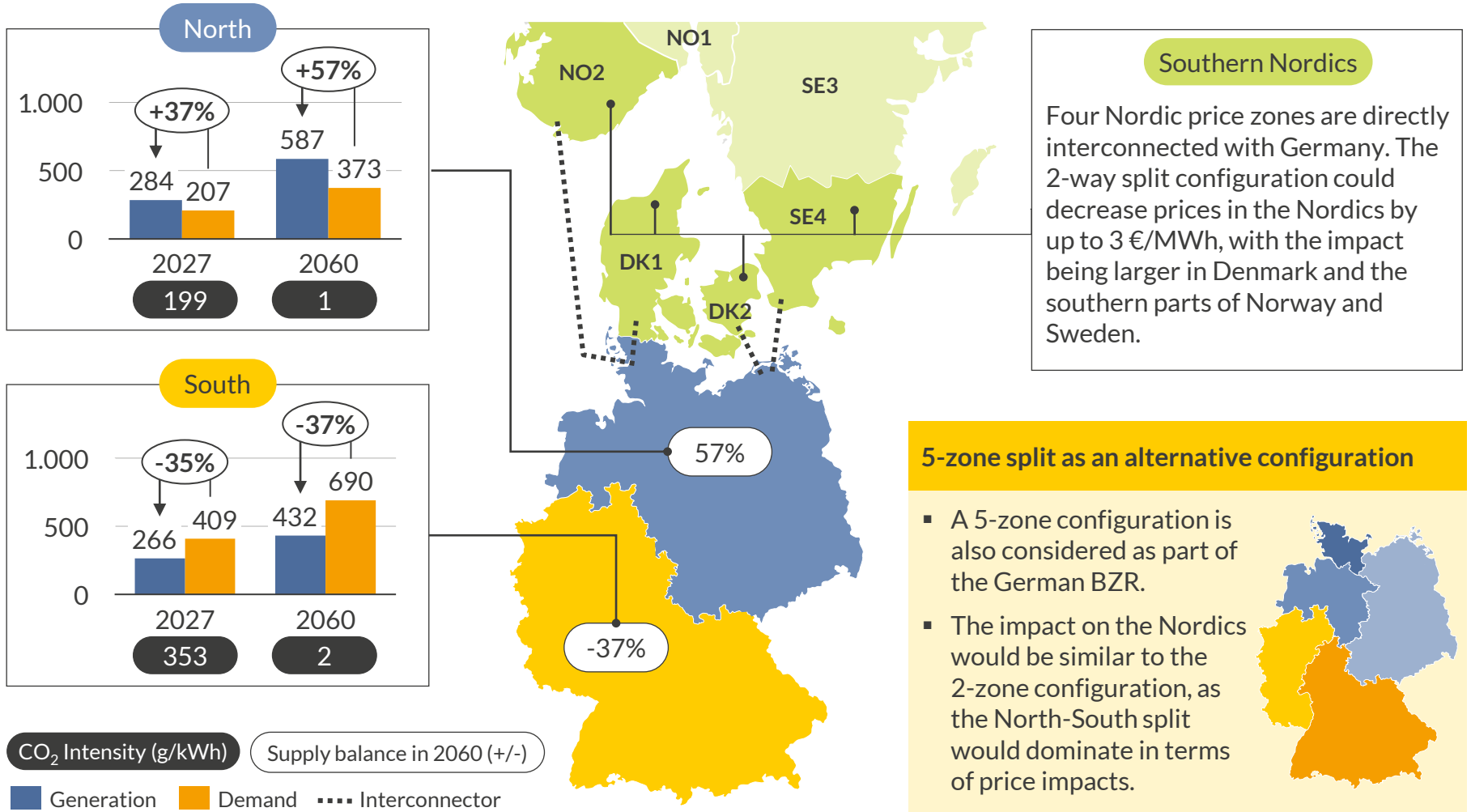
Present value[1] €/kW, real 2022



Sources: Aurora Energy Research

A 2-zone split in Germany decreases power prices in North Germany, which impacts the Nordics due to the direct interconnectivity

Map of zones in 2-zone split including generation and demand per zone
TWh



Southern Nordics

Four Nordic price zones are directly interconnected with Germany. The 2-way split configuration could decrease prices in the Nordics by up to 3 €/MWh, with the impact being larger in Denmark and the southern parts of Norway and Sweden.

5-zone split as an alternative configuration

- A 5-zone configuration is also considered as part of the German BZR.
- The impact on the Nordics would be similar to the 2-zone configuration, as the North-South split would dominate in terms of price impacts.

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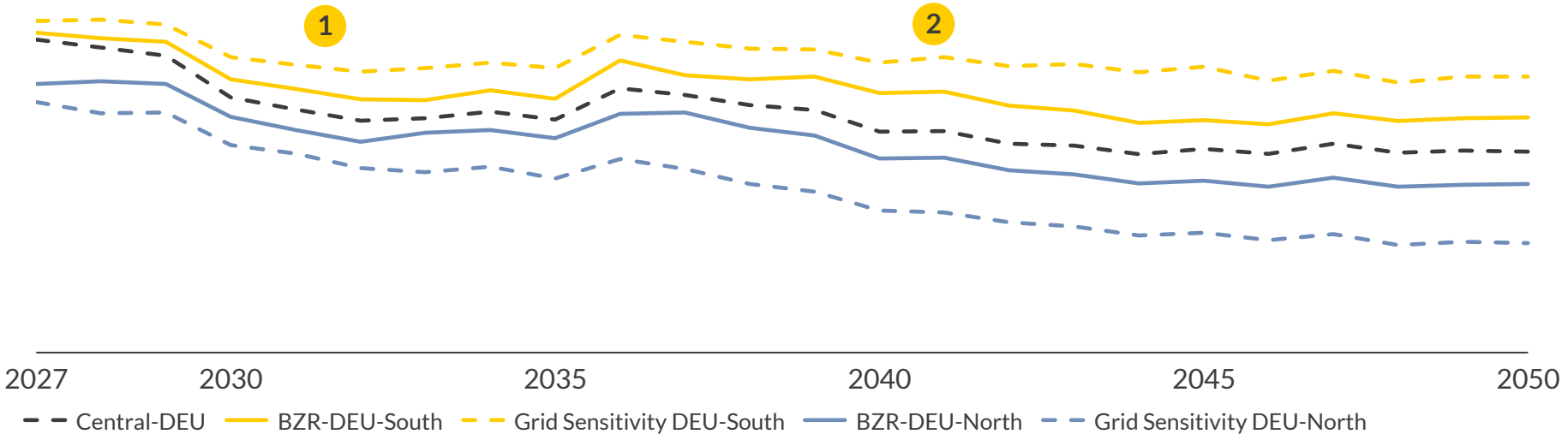
- The current oversupply of 37% in North Germany is due to a lower population density, a smaller industrial demand and high renewables potential, especially for onshore and offshore wind.
- In South Germany, there is average undersupply of 35% as:
  - Industrial centres have historically been located in the South and the West.
  - There is lower technical and economic potential for higher load factor technologies such as onshore and offshore wind.
- Due to higher share of gas and coal generation in the South, the emission intensity is 1.8x higher compared to the North in 2027.

Sources: Aurora Energy Research

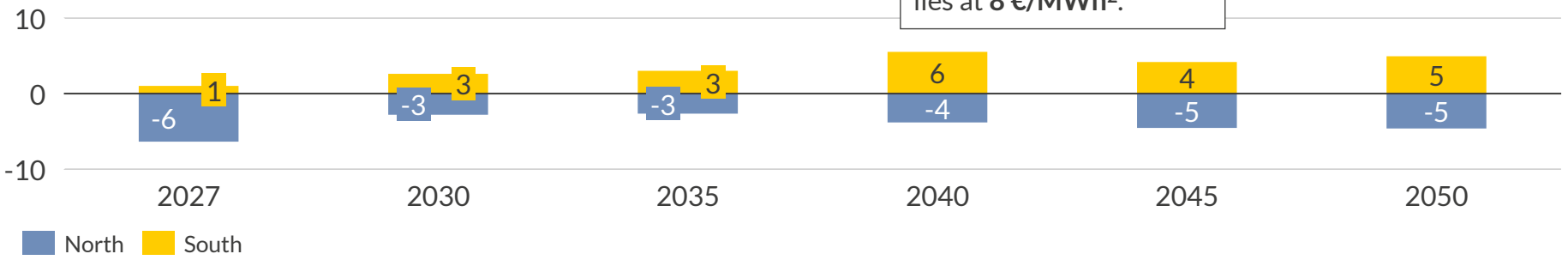
While a split would lead on average to 4 €/MWh lower prices in the North, slower grid buildout would more than double that value

German baseload wholesale electricity price for a two-zone split and Aurora Central[1]
€/MWh (real 2022)



Price impact of a two-zone split for the respective region
€/MWh (real 2022)

The average German North-South price delta lies at **8 €/MWh[2]**.



1) German Power and Renewables Market Forecast October 2023; 2) Average between 2027 and 2060; 3) Network Development Plan.

Source: Aurora Energy Research

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Development of baseload prices

1. More abundant generation from renewables leads to a downward trend in both regions. Prices in the South are higher because of transmission constraints and higher power demand in the southern zone.
2. The price delta between the two zones is increasing as the grid extension cannot keep up with the growing generation share of renewables in the North - maximum transmission capacities are reached more frequently.

i Hence the largest sensitivity lies in the grid buildout, which is following the TSOs' NDP[3] in the base scenario. It can lead to up to 8 EUR/MWh lower baseload prices in the North zone compared to the base case if delayed by 20 years.

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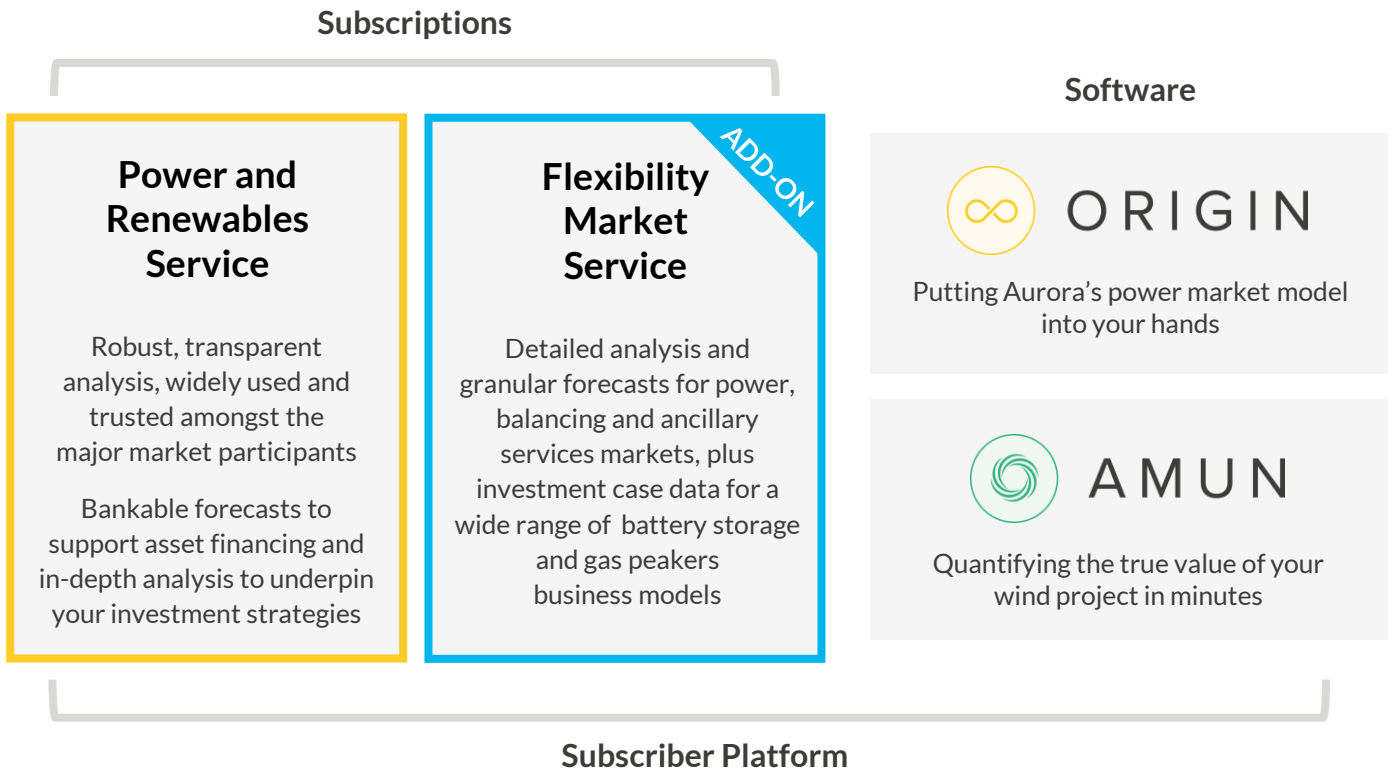

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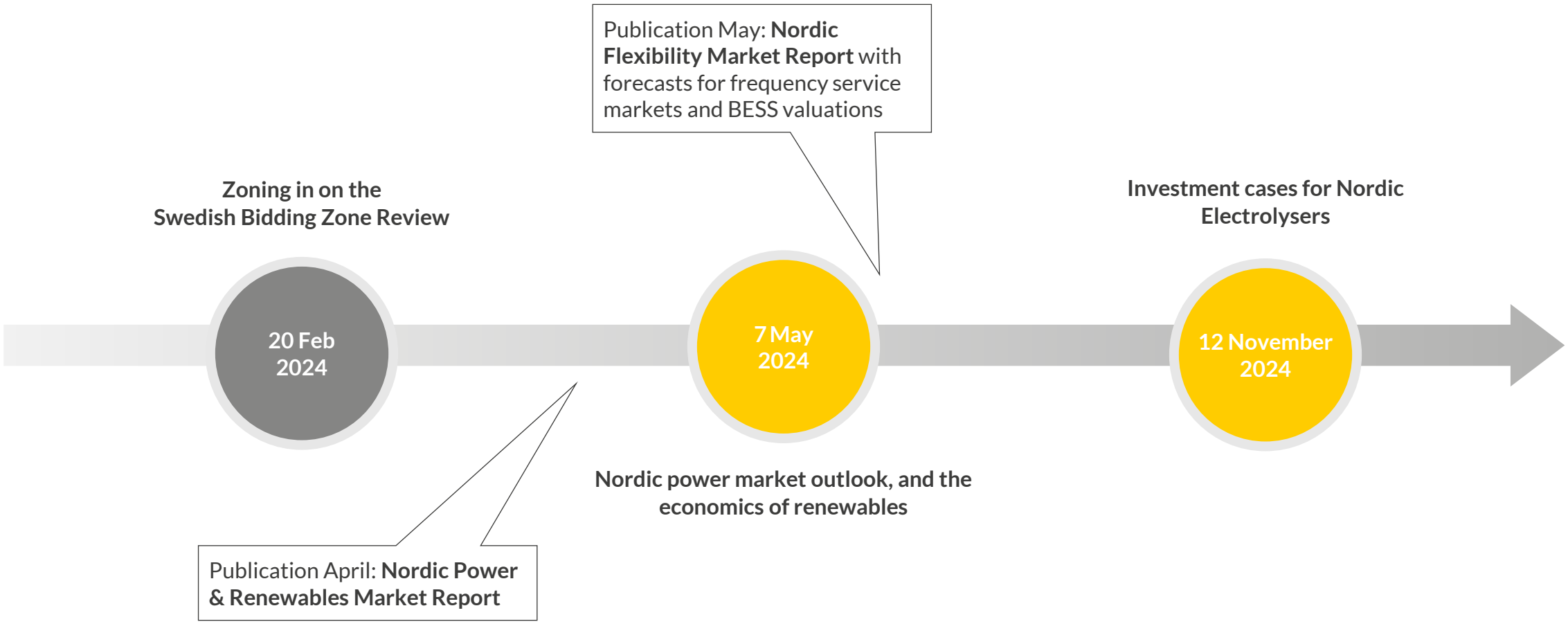


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