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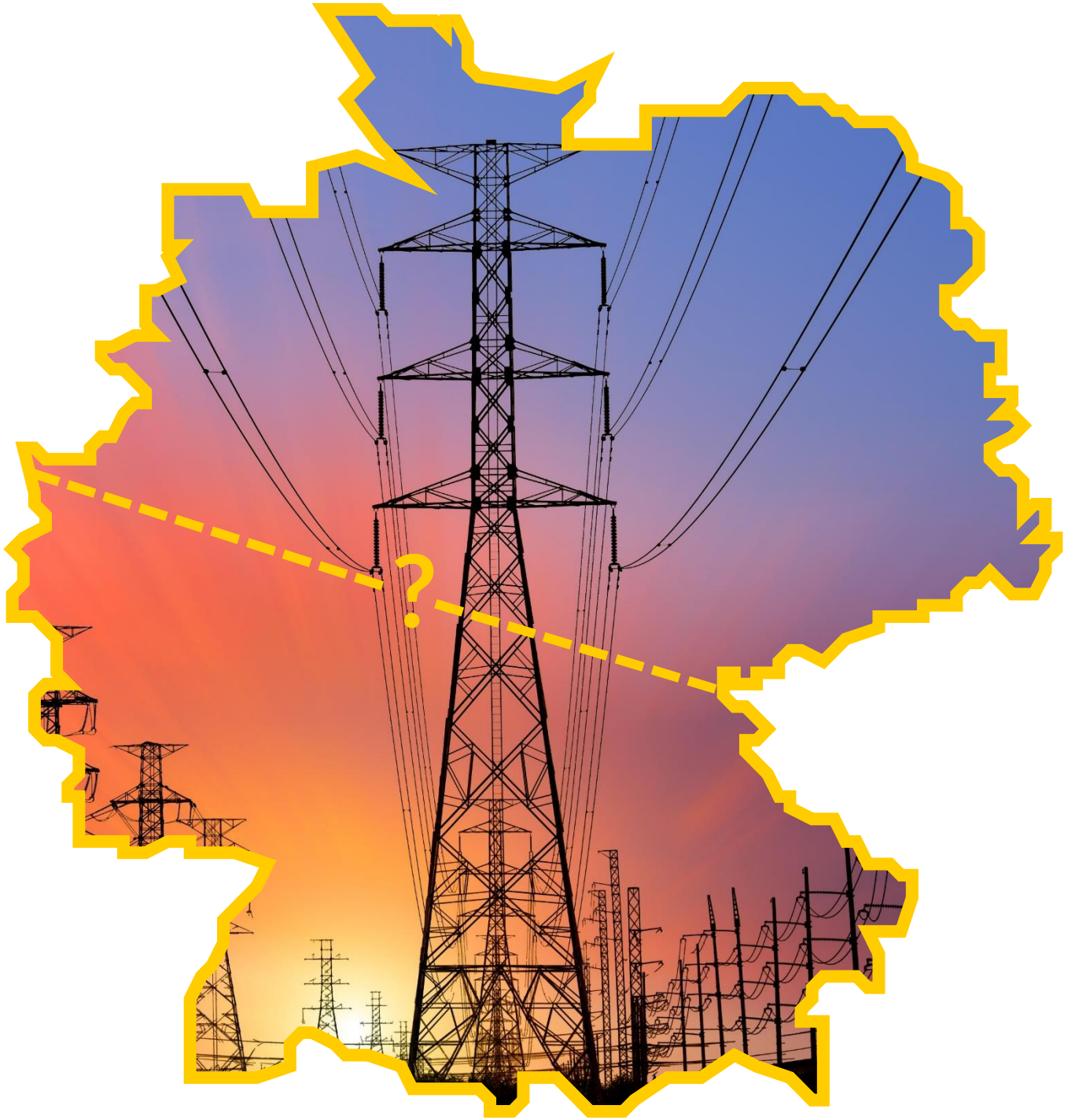
Power Market Impact of Splitting the German Bidding Zone

Public Report



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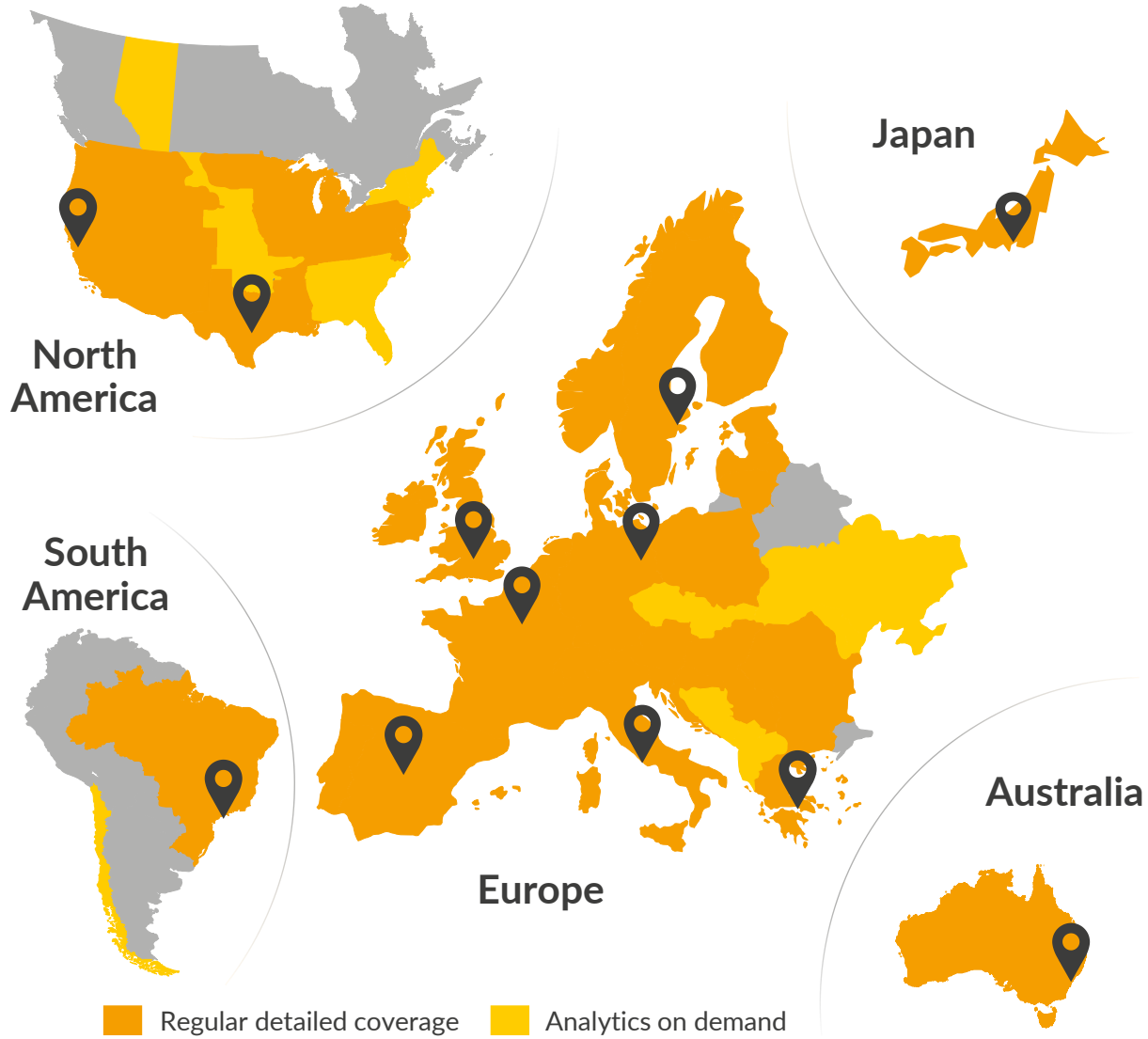

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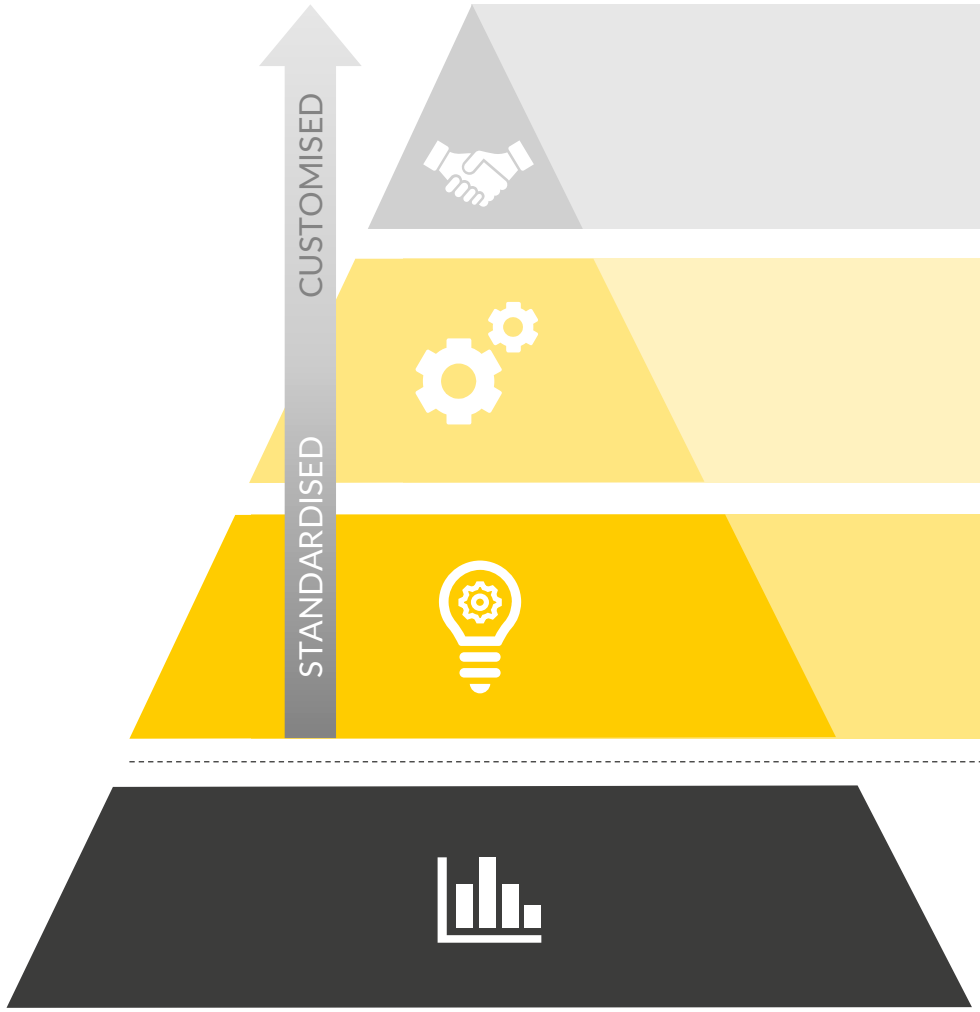

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>
> **Ben van Beurden, CEO, Shell**

> *"Aurora analysis and the provision of reliance was crucial for our debt funding. Their ability to explain market logics and revenue streams was vital for this successful financing."*
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Source: Aurora Energy Research

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Aurora's offerings

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To discuss speaking partnership opportunities with our team experts, please contact **Lucy Sovetova, Marketing Coordinator**

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Source: Aurora Energy Research

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I. Political process and scope of analysis

II. Impact of bidding zone split on wholesale prices

III. Green hydrogen production in Germany

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V. Outlook and closing

Current load centres in the South do not match renewable generation in the North—without new local incentives this trend will persist

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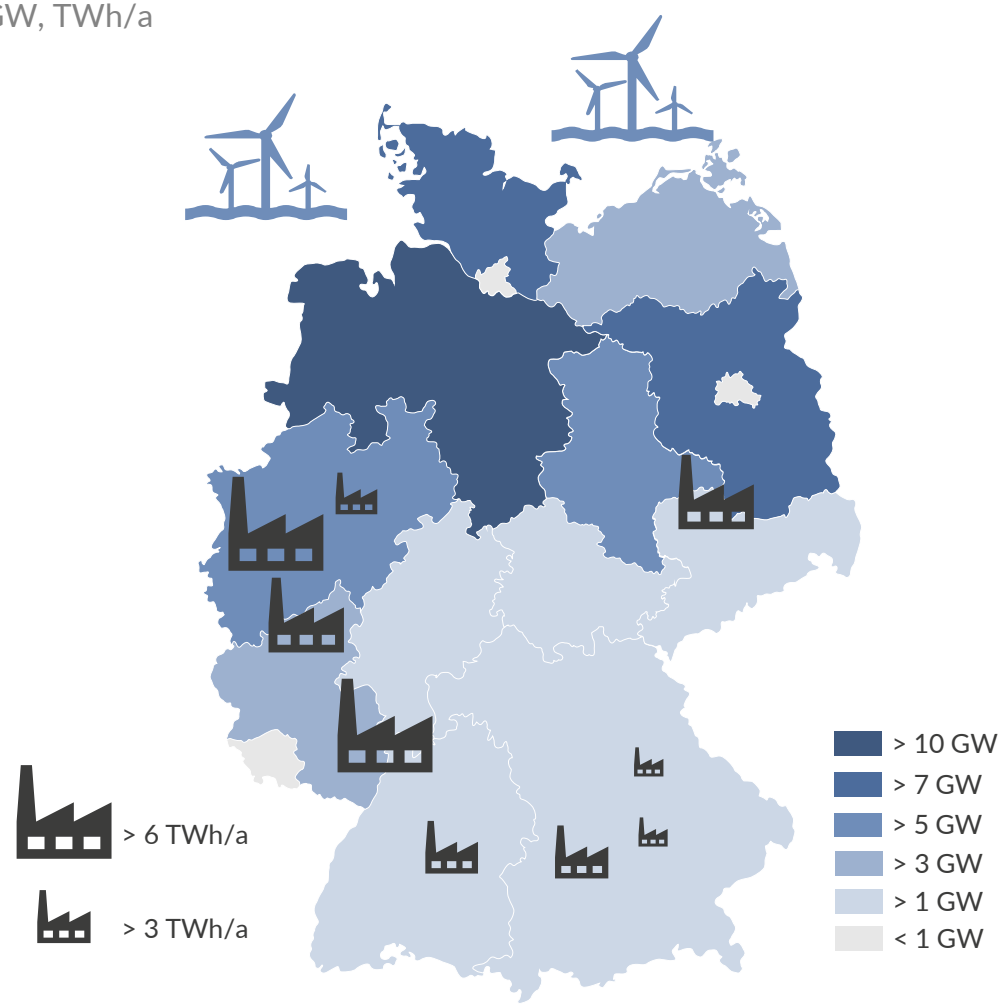
Installed wind capacity by federal state[1] and industrial consumption centres
GW, TWh/a



Resulting obstacles for the German energy transition

Generation demand mismatch

- Generators have no incentive to build close to consumption centres
- Settlement decisions of large consumers and flexible loads based on other criteria

Grid congestion

- Electricity cannot always be transported to load centres
- Resulting redispatch increases system costs, overhead, and CO_2 emissions

Curtailment of renewables

- Renewables generation is wasted
- Costly compensation of generators

Larger grid buildout requirements

- Due to inefficient location of consumers and generators, even larger grid buildout is needed
- Costs and complications increase

1) Includes onshore and offshore wind capacities (2021).

Sources: Aurora Energy Research, BWE

A bidding zone split is currently discussed both on the European and on the German level

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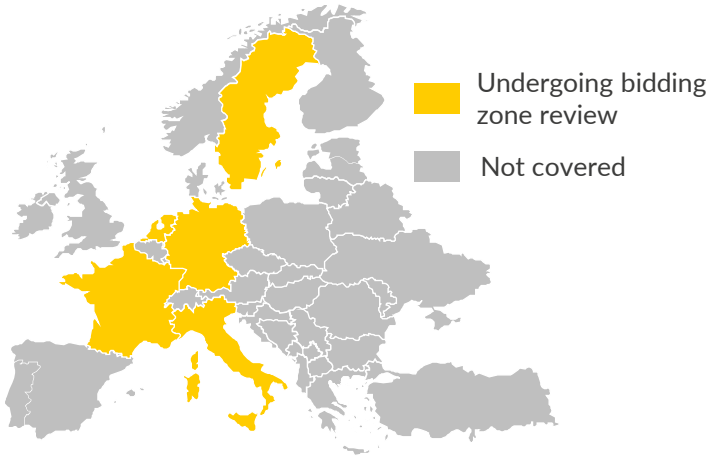
Current political processes

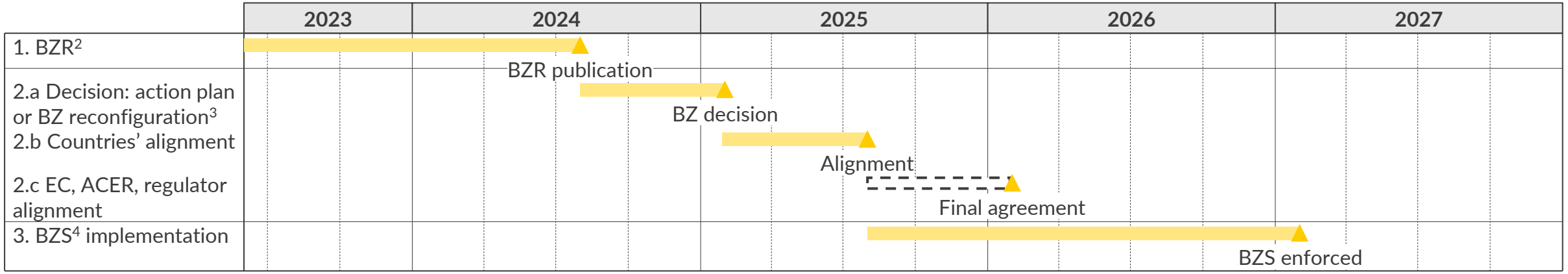
- ACER needs to assess the efficiency of the current bidding zone configuration every three years
  - ENTSO-E drafted a technical report on the current configuration and a market report on market efficiency
  - With inefficiencies in current bidding zone configuration, ACER requested TSOs to launch a review of existing bidding zones

- **Plattform Klimaneutrales Stromsystem (PKNS)** launched as stakeholder forum to tackle challenges of German power system. One working group discusses **how the power market can reflect restrictions of the grid's topology**
- **Increasing support for price zone split** from Northern German state governments



If Germany achieves 70% available interconnection capacity (minRAM) by 2025, it cannot be forced to split its bidding zone.

Potential timeline of bidding zone split analysed for this study[1]



1) 2027 is the earliest, feasible start year of the bidding zone split However, it is likely that the bidding zone split starts later e.g., in case member states fail to decide on the bidding zone configurations; 2) Bidding Zone Review; 3) If countries opt for action plan, BZS could also be triggered if countries fail to achieve minimum capacity share of 70%; 4) Bidding Zone Split

Sources: Aurora Energy Research, ENTSO-E

We focus our analysis on the impact of a bidding zone split on the day-ahead market, but it will also affect the grid and hedging opportunities

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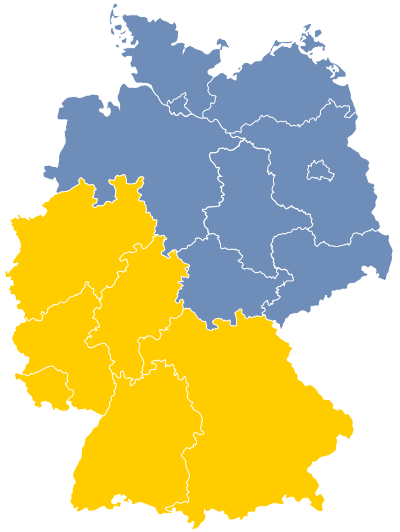
Impact on[1]	Description	Potential impact
Grid stability	Grid use and congestion as well as generation adequacy	+
Market liquidity	Degree to which any party can quickly source or sell any volume of energy	−
Hedging	Ability of consumers and producers to hedge against price risks	−
Competition	Capability of certain parties to profitably manipulate market prices (market power)	−
Prices	Market prices, asset economics and wholesale market dynamics (e.g. hydrogen)	+ / −
Balancing mechanisms	Impact on the efficiency of balancing mechanisms and imbalance settlement	−
System costs	Total system costs, including benefits for redispatch and grid buildout	+ / −

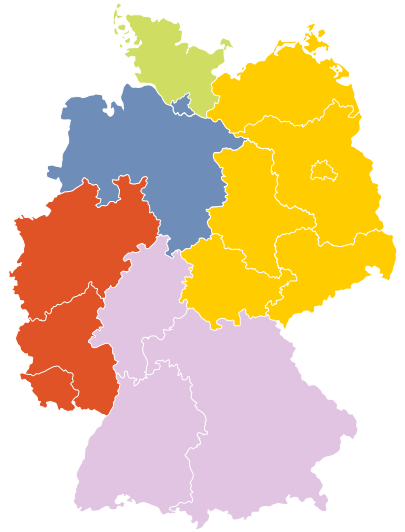
Bidding zone configurations analysed by Aurora

Focus of this report

1 **2-zone split: DE2 (TSOs)[2]**



2 **5-zone split: DE5[2]**



Focus of the Aurora quantitative analysis is the impact of a potential bidding zone split on the power market and wholesale prices. No conclusions about the total costs and benefits of a bidding zone split can be drawn.

1) Note: List non-exhaustive. Other effects could be regarding sector coupling or social acceptance of the energy transition; 2) ACER uses a different naming convention

Sources: Aurora Energy Research, ENTSO-E

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The northern zone shows an oversupply of 57% by 2060, NDP foresees large interconnection capacity available to transport to South

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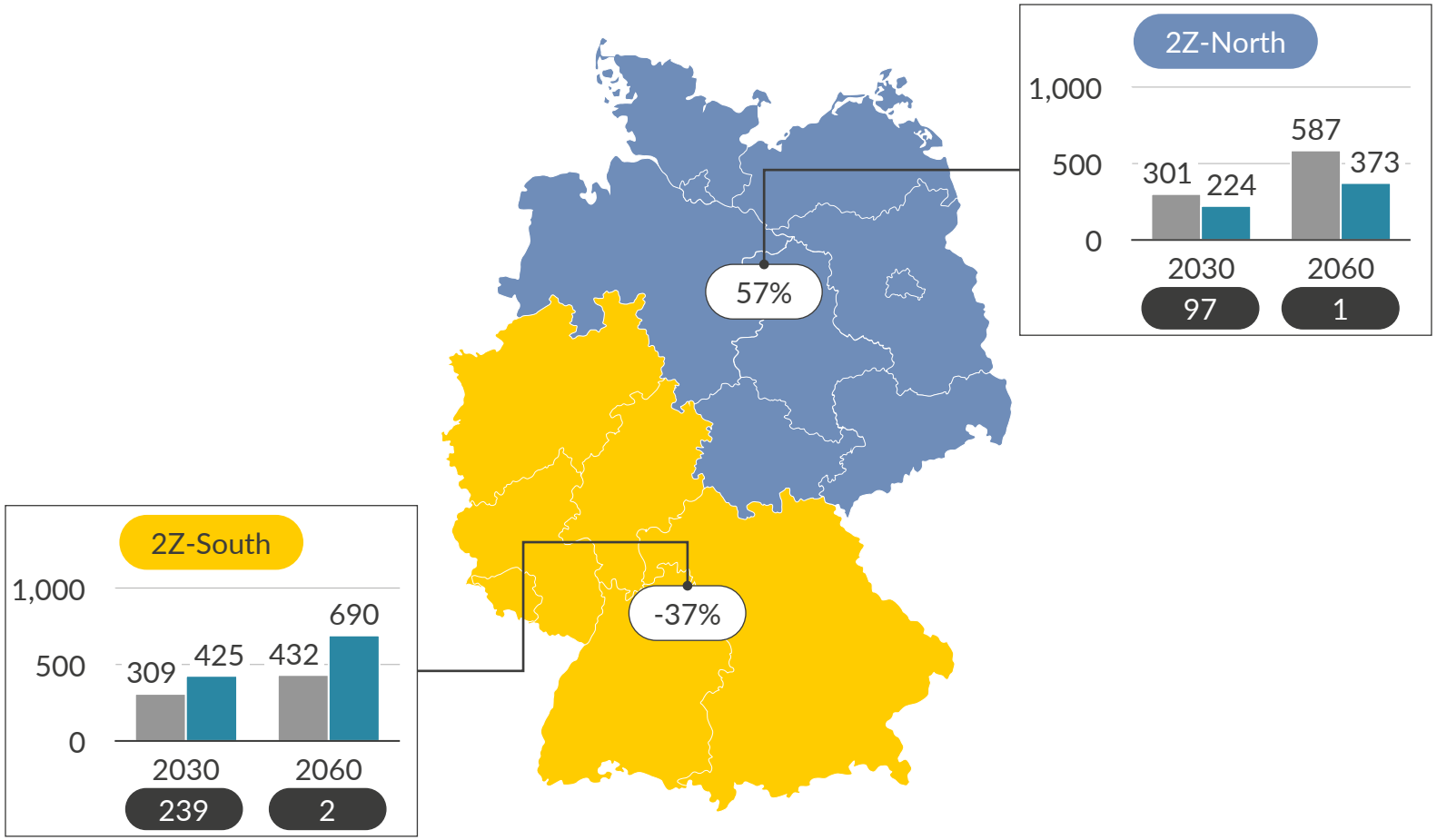
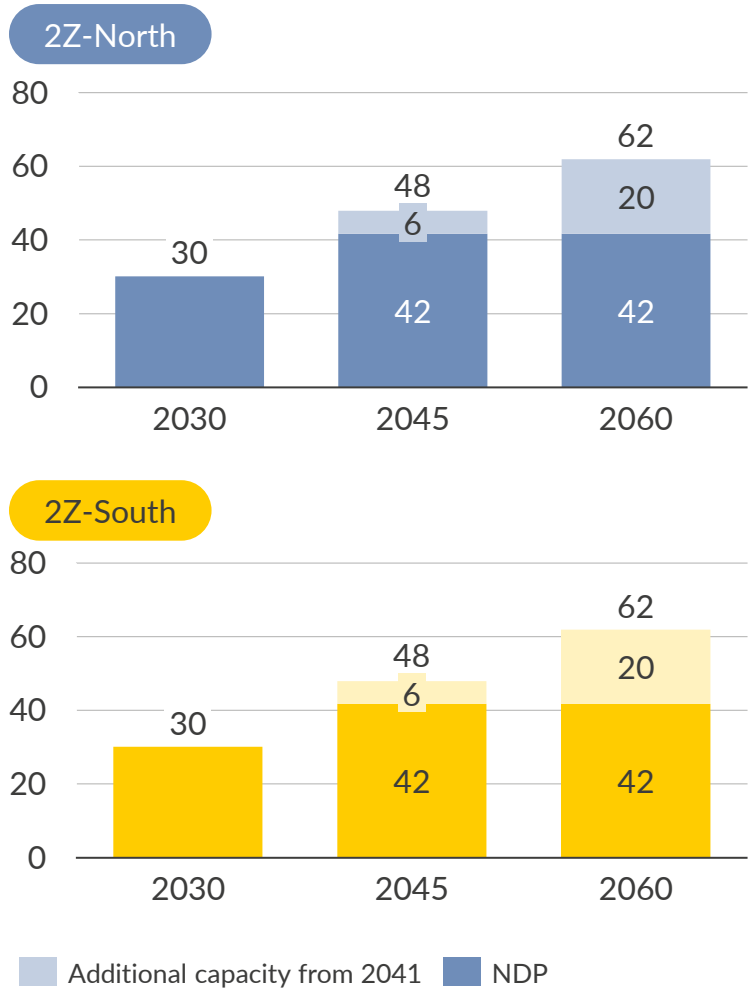
Map of zones including generation and demand per zone

TWh



Intra-German NTC in Base Case

GW



Note: NDP is the Network Development Plan.

Sources: Aurora Energy Research

Baseload prices in the 2Z-North are up to 9 €/MWh below the South, with the gap widening in the 2040s

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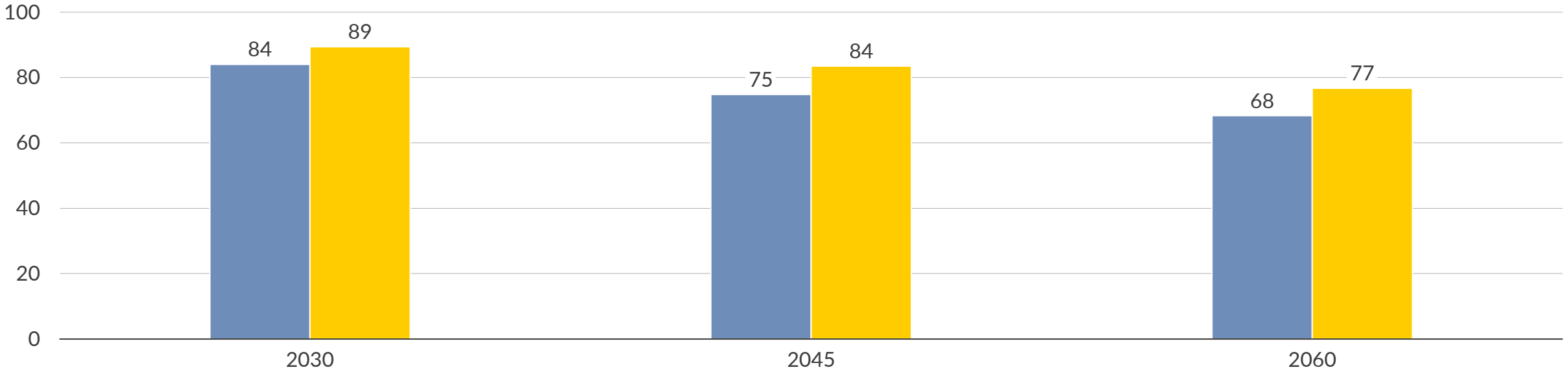
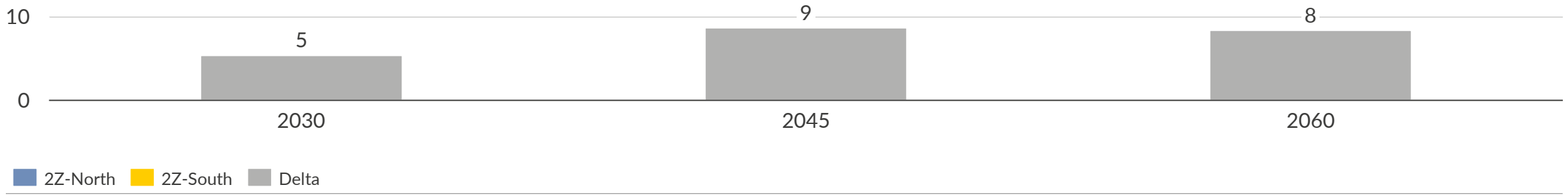
Baseload wholesale electricity price
€/MWh (real 2022)



Delta between Zones – 2Z-South vs. 2Z-North
€/MWh (real 2022)



Sources: Aurora Energy Research

The southern price zone is characterised by fewer low-price hours, while the price zones are similar for high-price hours

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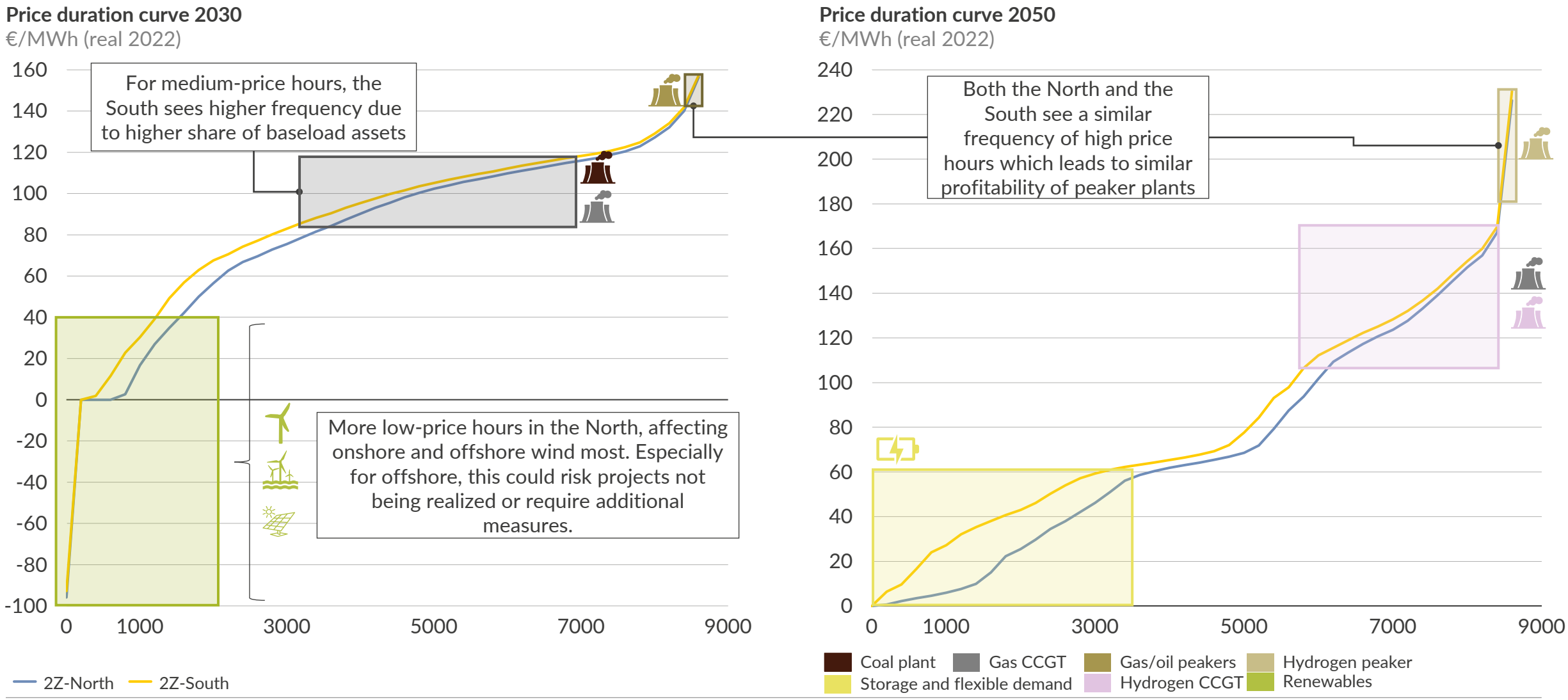

Sources: Aurora Energy Research

We model four sensitivities reflecting uncertainties regarding build-out of renewables and the grid, electrolyser location and weather years

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Sensitivities analysed by Aurora

1 Net Zero scenario

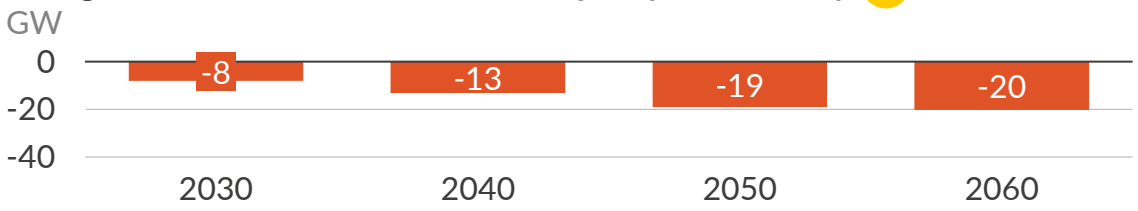
2 Weather years

3 Delay in grid build-out — *Focus of this report*

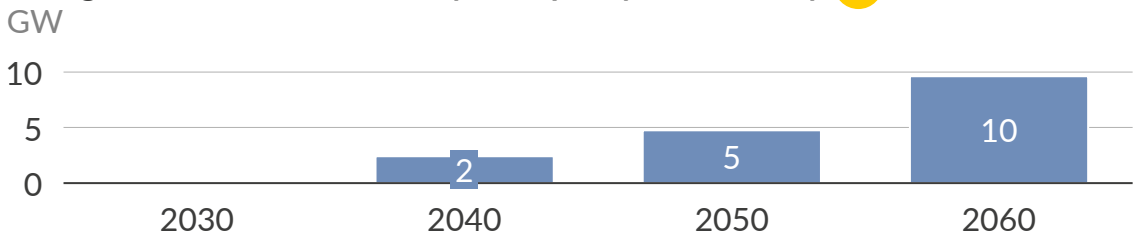
4 Electrolysers in North — *Focus of this report*

Key scenario parameters – sensitivity 3 & 4

Change to intra-German transmission capacity in sensitivity 3



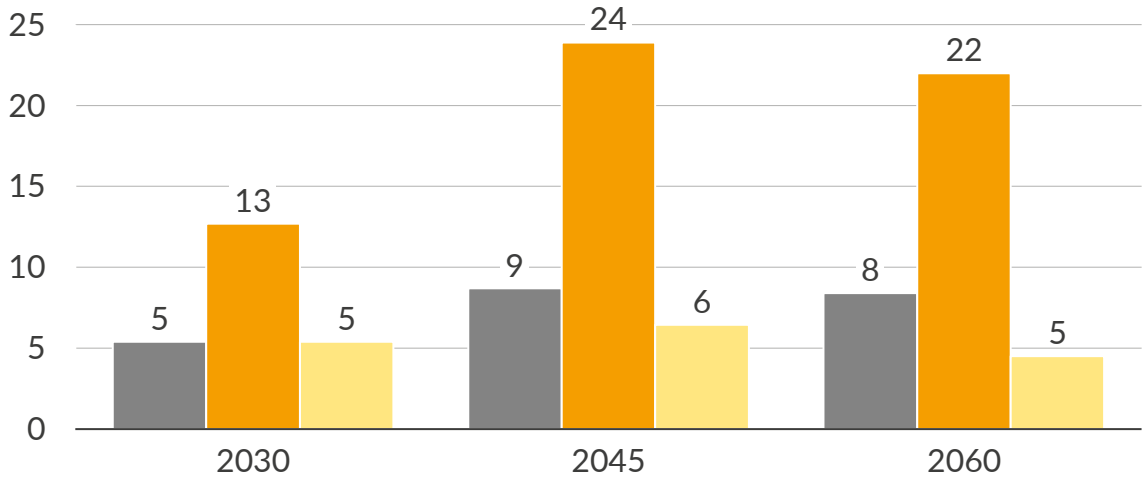
Change to allocation of electrolyser capacity in sensitivity 4



Shifted from South to North in Sensitivity

Price delta between prices zones – sensitivity 3 & 4

€/MWh (real 2022)



Base case | 3 Delayed grid buildout | 4 Different distribution electrolysers

Source: Aurora Energy Research

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The RED II delegated act (DA) describes multiple ways for producing green H_2 within a bidding zone, which is key for receiving support

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Required criteria for H_2 to be considered "green":

1 **Additionality**
Electricity used must come from a newly built renewables asset that came into operation max. 36 months before the electrolyser. The renewables asset must not receive subsidies.
- Additionality is compulsory for assets that start operation after 1st January 2028

2 **Geographic correlation**
Renewables asset and electrolyser must be located within the same bidding zone or neighbouring ones
- Price must be equal in neighbouring zones

3 **Temporal correlation**
The power generation and hydrogen production must match in a certain timeframe: This is monthly until 1st January 2030, and hourly afterwards.

Several exceptions provide partial compliance with RED II DA criteria

	H_2 production models			
Exceptions	**Additionality**	**Geography**	**Temporality**	**PPA**
A Electrolyser co-located with renewables asset[1]	Still required ✗	Considered fulfilled ✓	Considered fulfilled ✓	No
B Renewables share in electricity mix exceeds 90%[2]	✓	✗	✓	No
C Grid CO_2 intensity in bidding zone below 64.8 gCO_2/kWh[3]	✓	✗	✗	Yes
D Electrolyser using power that would have been curtailed otherwise	✓	✗	✓	No
E Power price below 20 €/MWh or 0.36x ETS price	✗	✗	✓	Yes

Production model: Co-located Grid-connected

1) However, if the renewables asset is connected to the grid, smart metering is necessary to provide evidence that no electricity is taken from the grid to produce hydrogen. 2) With the condition of electrolyser running less than the renewable mix (i.e. an electrolyser must not run more than 90% if the grid capacity mix has 90% renewables). 3) This only eliminates the additionality criteria; however, the electrolyser must use renewable power.

Sources: Aurora Energy Research, European Commission

Upon implementation of a zonal split, the production of green hydrogen from grid-based electrolysers would be possible in Northern Germany

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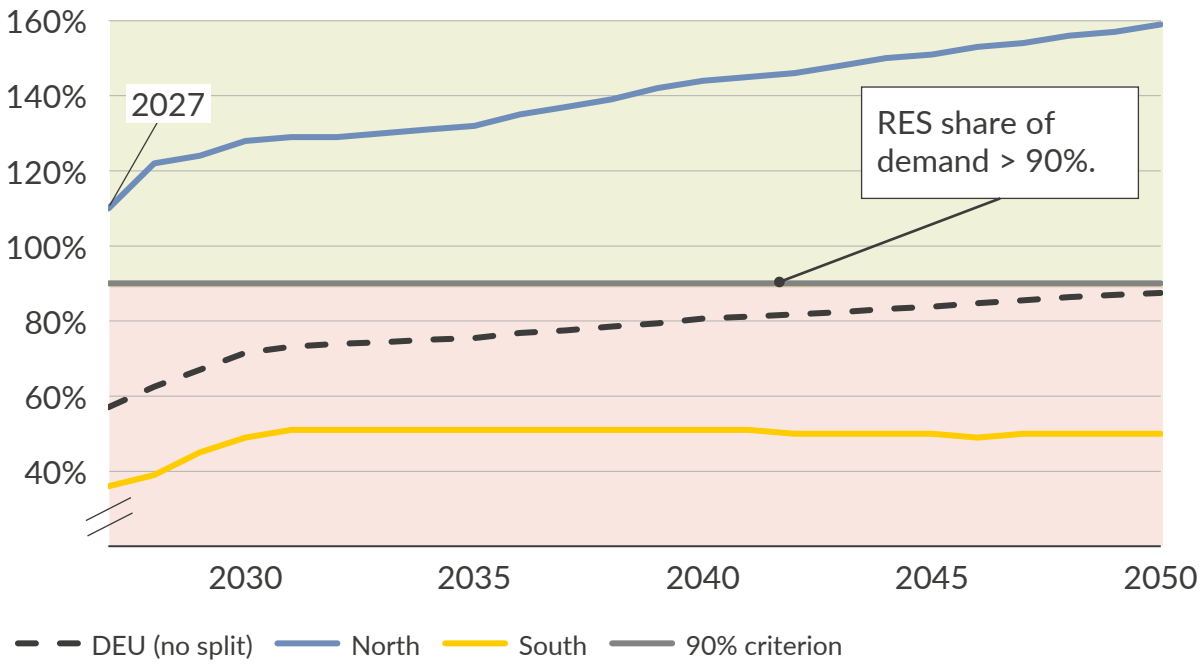
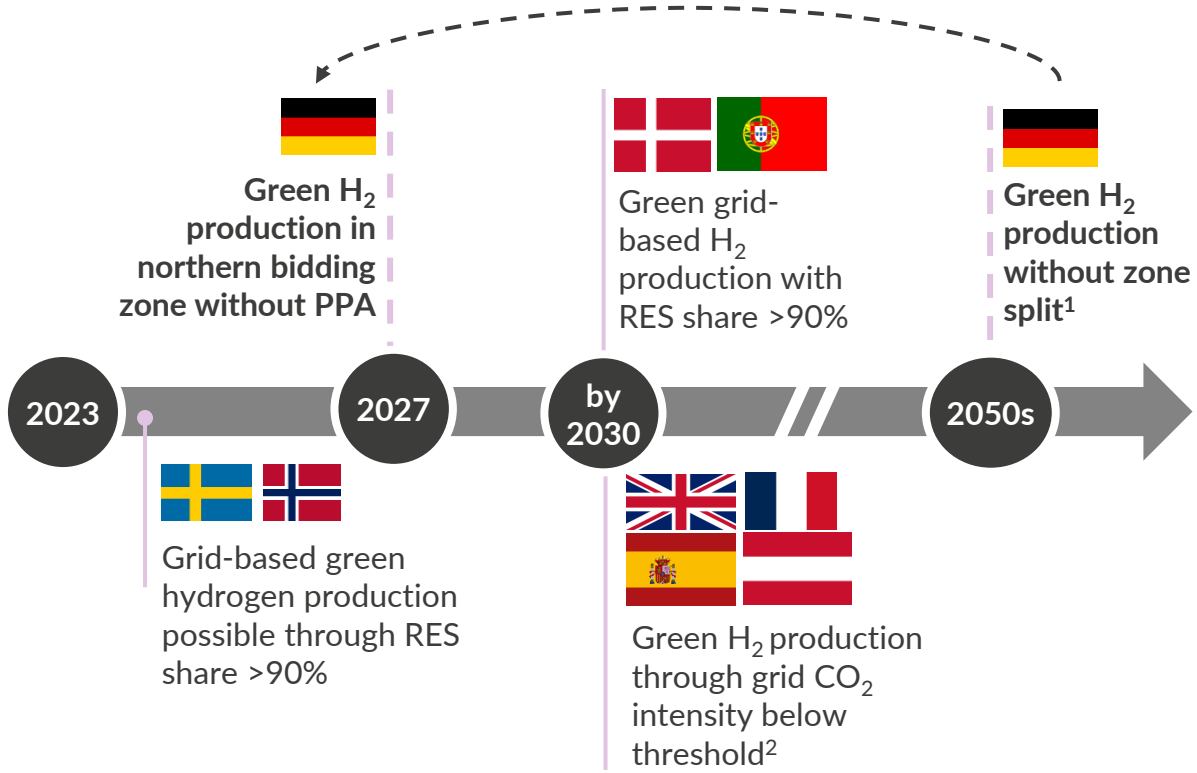
Renewable generation relative to power demand ("RES share")



Grid-based green hydrogen production in Europe



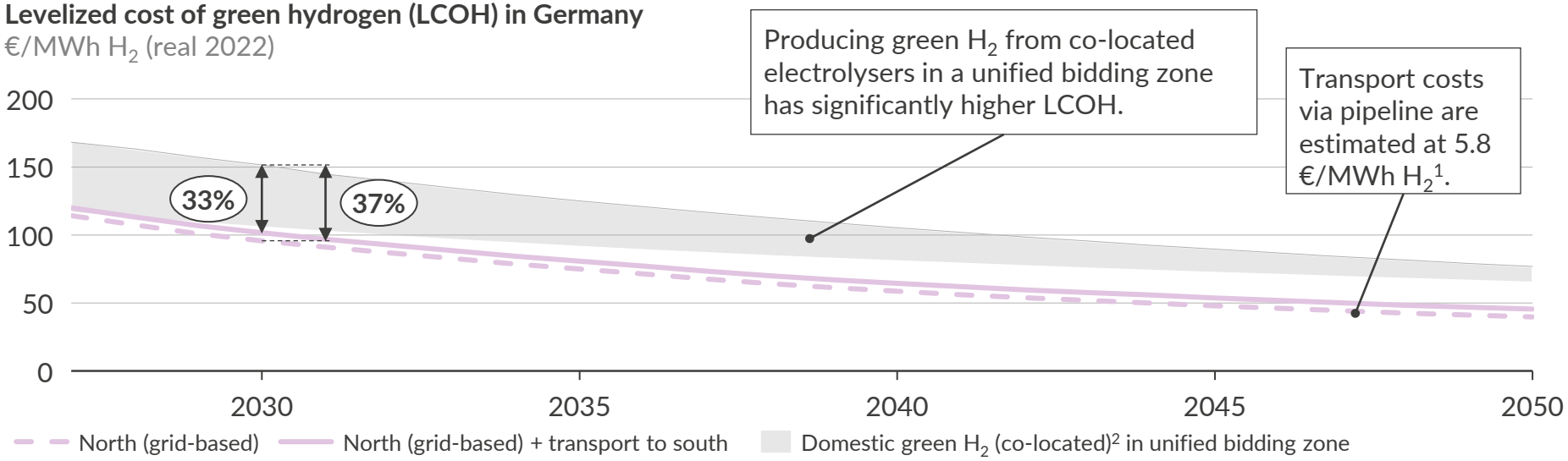
1. With a bidding zone split, the northern zone has RES share of demand > 90%.
2. Compliance with DA allows the production of green H_2 from grid-based electrolysers.
3. Germany could become the third producer of grid-based green hydrogen in Europe.

1) Grid-based H_2 production would generally be possible earlier at substantially higher costs and the need for a renewables PPA. 2) CO_2 intensity criteria for France and Spain likely already fulfilled in the mid 2020s.

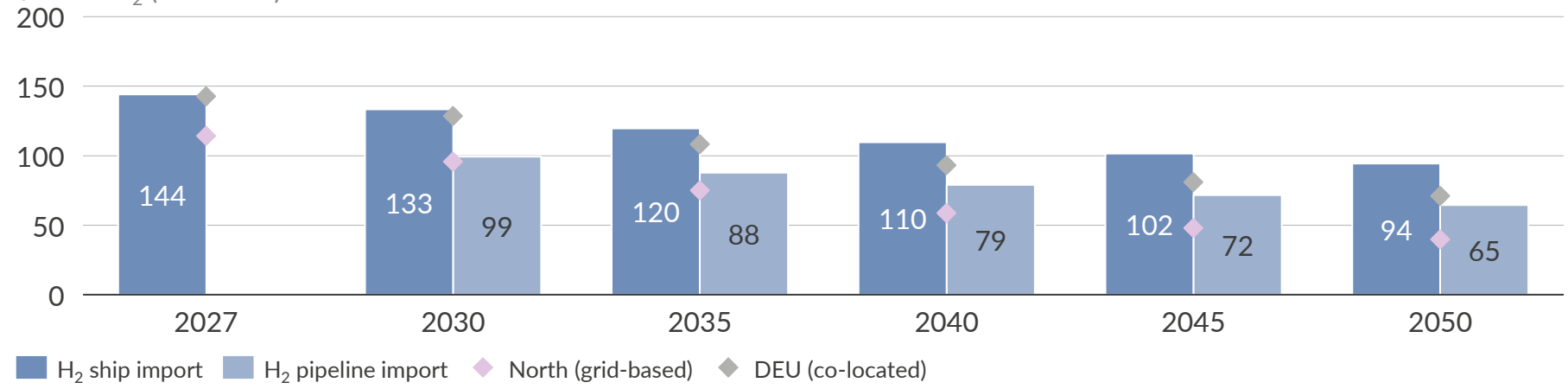
Source: Aurora Energy Research

Fulfilment of green H_2 criteria by grid-connected electrolysers due to a bidding zone split allows a reduction of LCOH by up to 37%

Levelized cost of green hydrogen (LCOH) in Germany
€/MWh H_2 (real 2022)



Hydrogen import costs via different modes of transport[3]
€/MWh H_2 (real 2022)



1) Transport costs were calculated based on 1000km pipeline transport where the share of refurbished pipelines is assumed to be 60% in line with FNB Gas. 2) Range of domestic LCOH based on renewables load patterns from roughly 50 reference locations in Germany. 3) Represents the average import price from different origins (Ship: CHL, UAE, AUS, MAR, ESP; pipeline: MAR, ESP).

Source: Aurora Energy Research

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Green H_2 production in Germany

- With a bidding zone split, cheap grid-based green hydrogen can be produced in the North. This offers the opportunity of reducing the cost of decarbonisation for southern industry and accelerate the transition process.
- Domestic hydrogen production will play a pivotal role in the mid-term, as large import volumes can only be expected post 2030.
- However, investments in transport infrastructure via pipelines will be essential to make cheaper hydrogen available to southern industry.
- By 2030, domestically produced green H_2 could become cheaper than H_2 imported via pipelines from Spain or Morocco.

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Industrial power prices in the South are expected to increase by 3% in 2030 due to a split which could be alleviated through compensation payments

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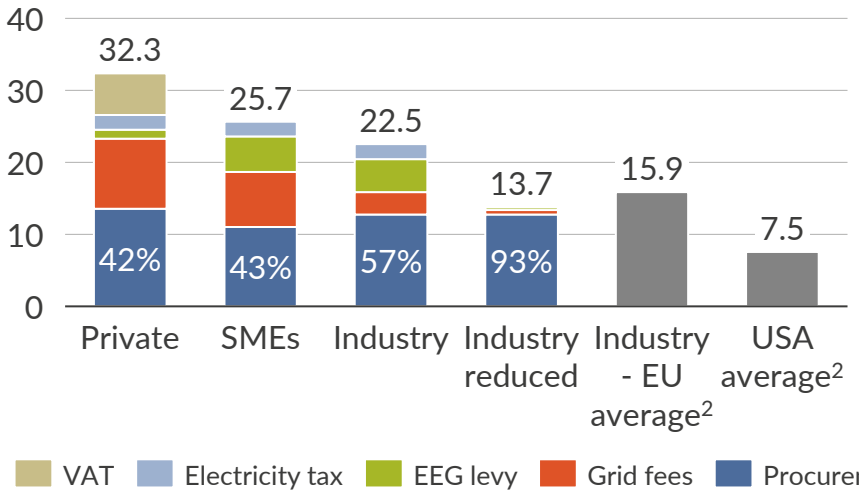
1 Exposure to wholesale power prices and international competitiveness

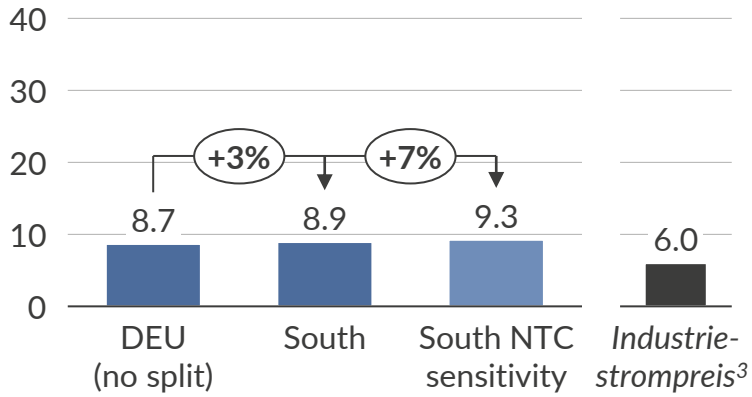
Power price components by consumer group in H1 2022[1]
€ ct/kWh (real 2022)



- Energy-intensive industrial consumers are more vulnerable to increases of wholesale prices (procurement costs), as they make up more than 90% of their power costs.

2 Industrial power prices with a bidding zone split

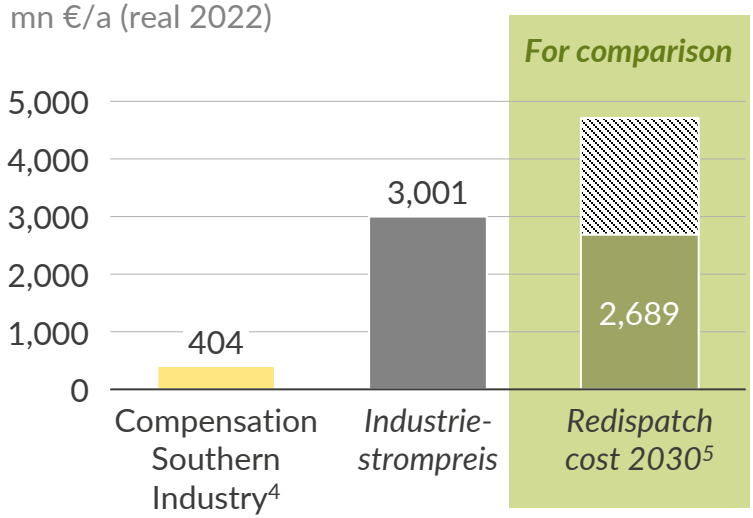
Power prices for energy-intensive industry in 2030[3]
€ ct/kWh (real 2022)



- European competitiveness of energy-intensive industry is affected by a bidding zone split to a limited extend. However, global competitiveness of southern consumers would come under further pressure.

3 Costs for potential price compensation for energy-intensive industry

Compensation payments in 2030
mn €/a (real 2022)



- Direct cost impacts on Southern industry could be compensated at relatively low cost but other negative effects (e.g., ability to contract PPAs with offshore wind) may persist.
- Additionally, the impact on locational incentives and EU state aid rules needs to be considered.

1) Prices refer to reference consumer cases of 3,500 kWh (private), 50 MWh (commercial), and 24 GWh (industry). 2) 2022 EU27 country average for non-households consuming more than 20 GWh per year; excluding taxes and levies. US average based on IEA data. 3) Proposed by the Federal Ministry of Economic Affairs and Climate Action. 4) Estimated by multiplying demand from southern energy-intensive industry by North-South price delta. 5) A bidding zone split will likely only partially lower redispatch costs.

Sources: Aurora Energy Research, BNetzA, Agora Industry

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A price zone split is only one way of introducing local incentives; it addresses some, but not all areas where grid and market are currently not aligned

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	Instrument	Reliable capacity	Hydrogen	Energy-intensive industry	Renewables	Advantages	Disadvantages
System-wide instruments	1 Bidding zone split					▪ Hourly regional price signals ▪ Market-based solution ▪ Proven in other markets	▪ Reduced market liquidity ▪ Higher prices for consumers and industry in the South
	2 Grid fees for generators					▪ Regional investment incentives ▪ Grid costs are shared between consumers and generators	▪ No regional hourly price signals ▪ Difficult to estimate adequate fee, especially in the long run
	3 Time-variable grid fees					▪ Granular (regional) price signals ▪ Can tap large flexibility potential	▪ Rather difficult to implement, depending on digitalisation ▪ Risk exposure for consumers
	4 Auctioning excess generation					▪ Could reduce redispatch management cost and curtailed renewables generation	▪ Rather small expected impact ▪ Risk of strategic gaming, unless very well designed
Targeting specific actors	5 Regional EEG subsidies					▪ Effective steering of regional renewables buildout, lowering redispatch and congestion cost	▪ Requires more complex subsidy/auction system ▪ No regional hourly price signals
	6 Regional subsidies for H2-ready plants					▪ Can steer regional deployment of new H_2-ready gas plants effectively	▪ Targets only sites for new plants ▪ Requires complex subsidy/auction system

Steering effect: High – Low

Sources: Aurora Energy Research, European Commission

Beyond the discussion on the German bidding zone, power market design is reviewed both on the EU and German level

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Industrial power price

How can Germany's industry access power reliably at competitive prices?

2024 → 2030

Short-term: Brückenstrompreis

- Capping cost at 60 €/MWh for energy intense industry

Long-term: Transformationsstrompreis

- Passing on cost of low-cost renewable power through state-backed CfDs

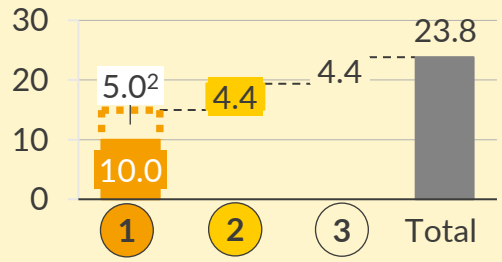
Securing dispatchable capacities

How can enough reliable capacity be built, while fossil sources are phased out?

In total, the *Kraftwerksstrategie* is set to deploy 24 GW of dispatchable capacity

1. H_2-ready natural gas power plants
2. Green H_2 "sprinter" power plants tendered between 2024-2028
3. H_2 power plants with co-located hydrogen storage, timeframe tbd

Tendered Plants by 2035



Development of national hydrogen strategy

How can the full H2 value chain be ramped up in Germany?

Ensuring supply of green H2	Establishing infrastructure for transport and storage
Forming applications and use for H2	Securing reliable regulatory conditions

› **Latest update: Electrolysers shall be built in "system-friendly" locations**

EU Electricity Market Reform

How can the EU's integrated electricity market be made ready for net zero?

- **Promoting long-term markets** for producers (i.e., through CfDs) and for both producers / consumers through PPAs[2] and hedging options
- **Promoting flexibility** through improved wholesale markets and flexibility support schemes, as well as peak shaving products
- **Consumer protection** through peer-to-per trading and greater tariff choice

DEU Level EU Level

1) Contracts for Differences. 2) Power Purchase Agreements.

Sources: Aurora Energy Research, EU Commission

Splitting the bidding zone into 2 zones is expected to increase prices in the South; this is strongly dependent on development of the system

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1 Splitting the German bidding zone into **two zones** results in higher electricity prices in the south, with **prices deltas of up to 9 EUR/MWh in 2045.**

2 Major **delays in the grid expansion** can lead to an **increased price delta** of 13 EUR/MWh in 2030 and 24 EUR/MWh in 2045.

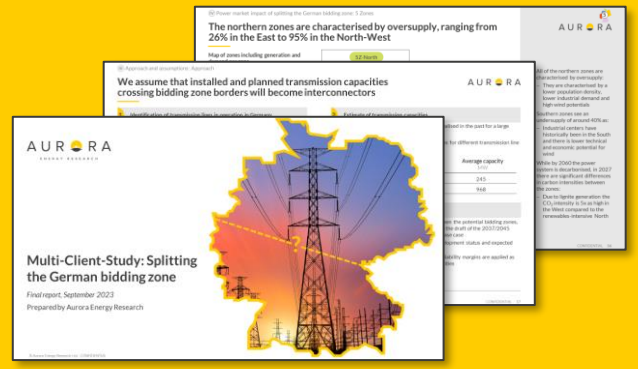
3 A stronger **concentration of electrolysers in the North** could result in a **lower price delta**, more noticeable in the longer term.

4 A price zone split would allow **green H_2 production by grid-based electrolysers** and **improves the international cost competitiveness** of green H_2 produced in (Northern) Germany by up to one third.

5 Electricity prices for energy-intensive industry in the southern zone would be **3% higher in 2030** compared to a single bidding zone. A compensation to offset price increases from a bidding zone split would **cost about €400 million per year**[1].

Interested in more?

For access to the full reports of our recent multi-client study & group meeting, reach out to **Emily May Yee Leung**



Deliverables from Aurora's Multi-Client-Study

Report & Databook with detailed modelling results, assumptions, asset impact and sensitivities

Strategic Insight Report as part of German Power & Renewables Service

Report on implications for green hydrogen and industry as well as alternative instruments for local signals

1) Compensation payment is calculated by multiplying price South-North price delta with projected power demand from energy-intensive industry in 2030.

Source: Aurora Energy Research

German Power & Renewables Market Service:

Dive into key market analysis and forecasts for the German power and renewables market

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Full Power & Renewables Market Service

Forecast Reports & Data

Biannual forecast reports with quarterly data updates

- **Forecast data of** wholesale and capture prices to **2060** with annual, monthly and quarterly granularity **under Central, Low, High, and Net Zero** Scenarios
- **Capacity development**, generation mix, interconnector capacity, capacity buildout, and exports
- **Regional capture prices (**5 wind & 2 solar PV regions in Germany)
- Capacity additions under EEG subsidy-free/region
- Negative prices and impact of 6-hour/ 4-hour / 3-hour / 2-hour / 1-hour-rule periods, technology costs, and imbalance costs
- **Guarantees of Origin (GOO)** market statistics and price forecast

Market Summary Reports

Take an in-depth look back at the past month's technology and market updates*

Strategic Insights

3 Strategic Insight Reports

Three in-depth thematic reports on topical issues

Policy Updates

Timely research notes on recent changes to policy and regulation, demonstrating the impacts and opportunities for market participants

3 Group Meetings

Three Group Meeting roundtable events **in Berlin** with key market participants such as developers, investors, financiers, utilities, grid operators, and government officials

Analyst Support

Biannual workshops and support from our bank of analysts, including native speakers and on-the-ground experts

Explore how your business can benefit from our regular forecasts and market updates from **Emily May Yee Leung, Commercial Associate**

✉ **emily.leung@auroraer.com**

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