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# Market design for European electricity trading

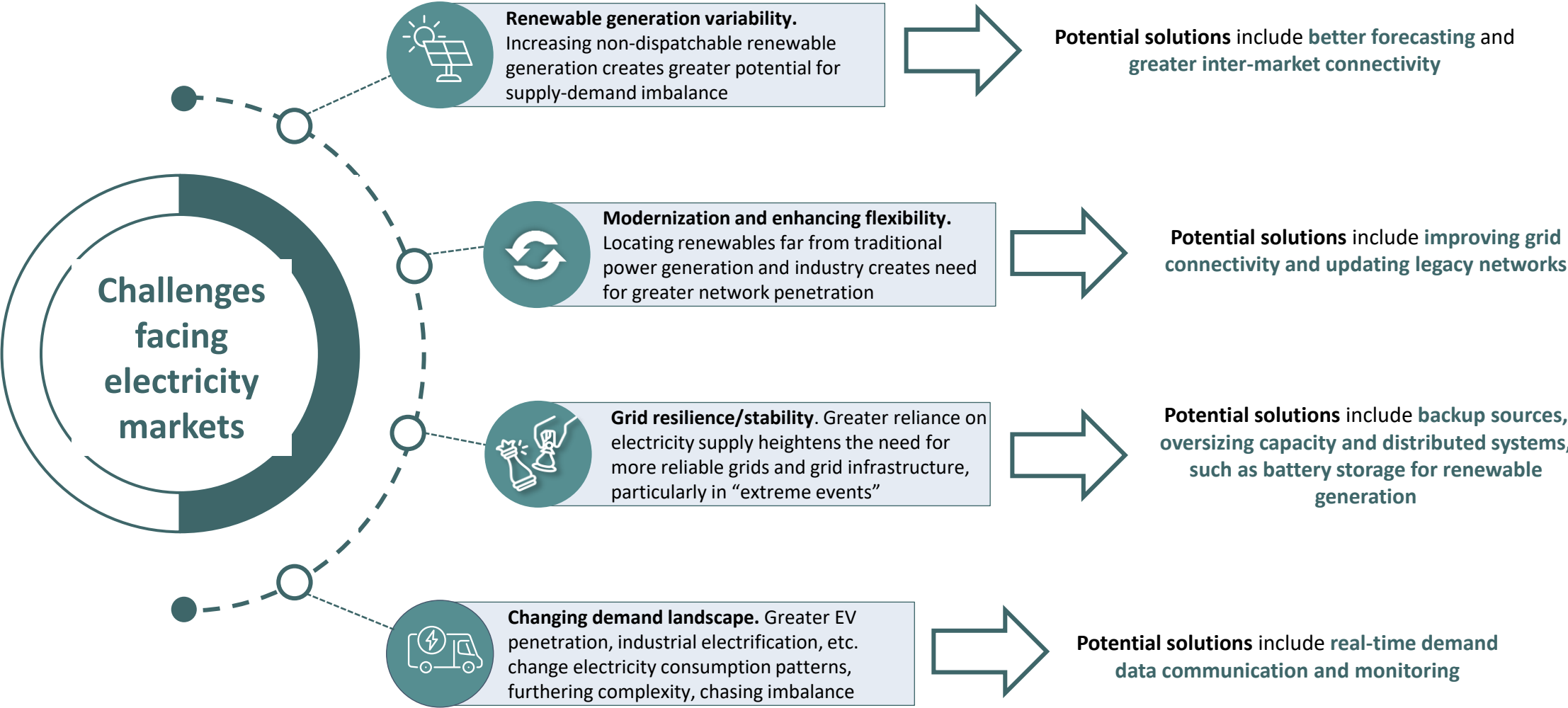
Technical, financial, and regulatory challenges

Dane Inglis, Management Consultant

**13th Athens Energy Summit**

July 2024

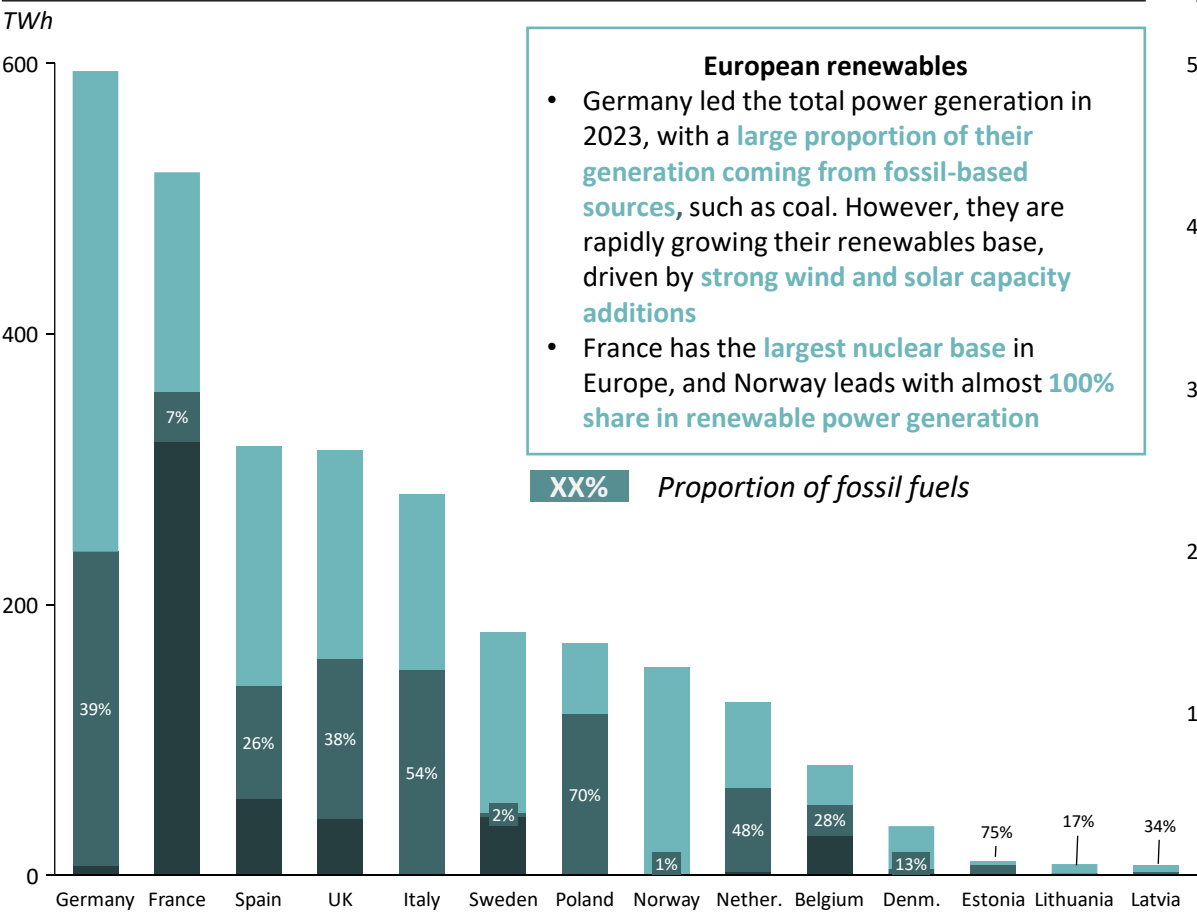
# Electricity markets in the Energy Transition | Growth in VREs driving the need for new market design



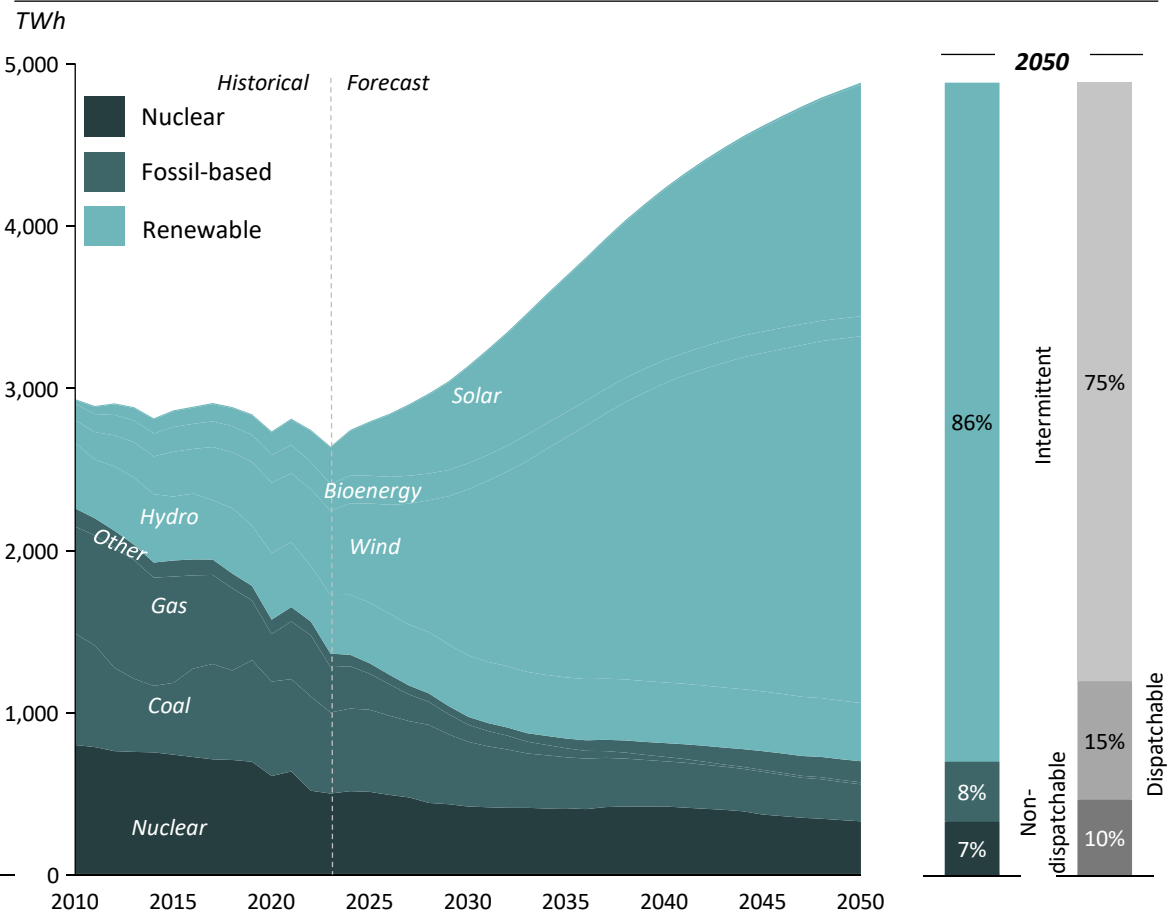
Source: Rystad Energy research and analysis

# Renewable generation | Despite the share of renewables growing considerably post-2010, many developed economies are still heavily reliant on fossil fuels

Power generation in the relevant countries\* by energy group, 2023



Power generation in the relevant countries\* by energy source

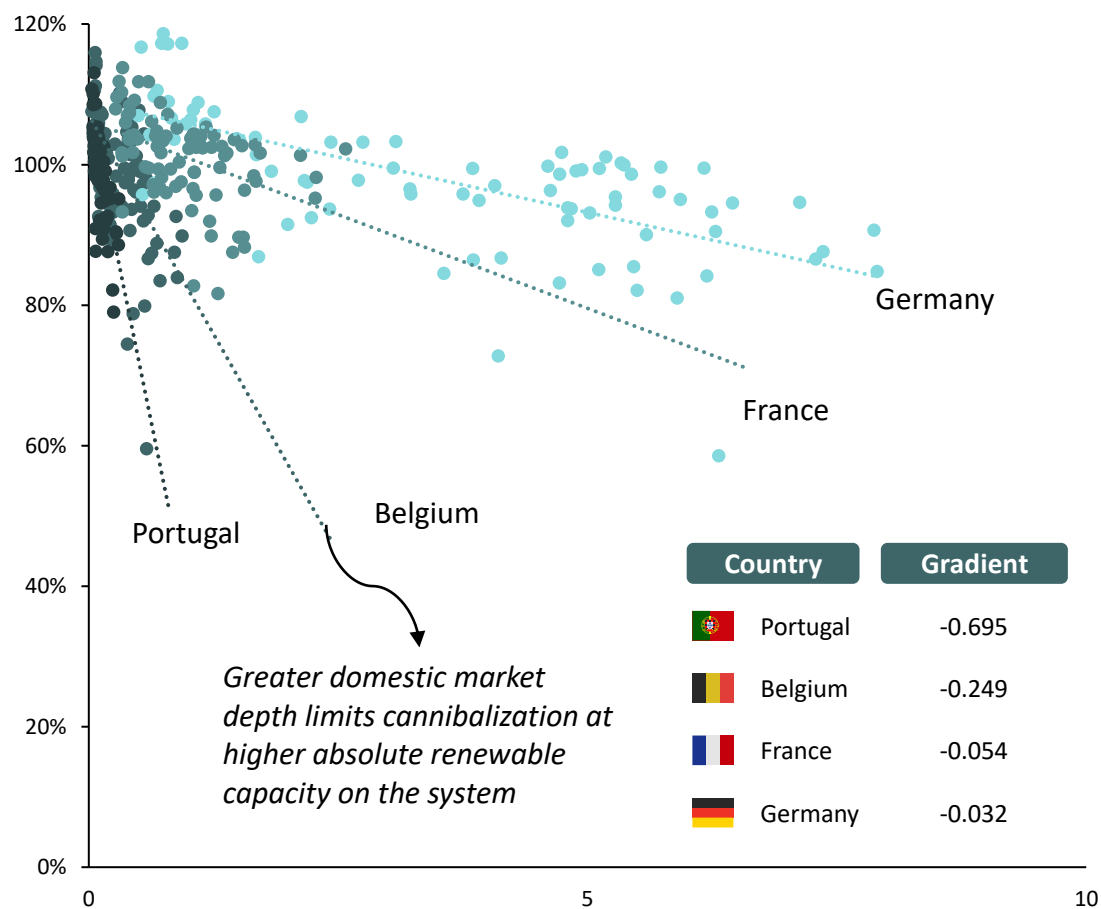


\*Refers only to the listed countries of interest (Belgium, Denmark, Estonia, France, Germany, Great Britain, Italy, Lithuania, Netherlands, Norway, Poland, Portugal, Spain, and Sweden)  
Source: Rystad Energy research and analysis; Rystad Energy PowerCube

# Capture risk | Deeper power markets less at-risk of lower prices from incremental deployment of VREs

Capture factors vs. generation for solar PV, selected relevant countries

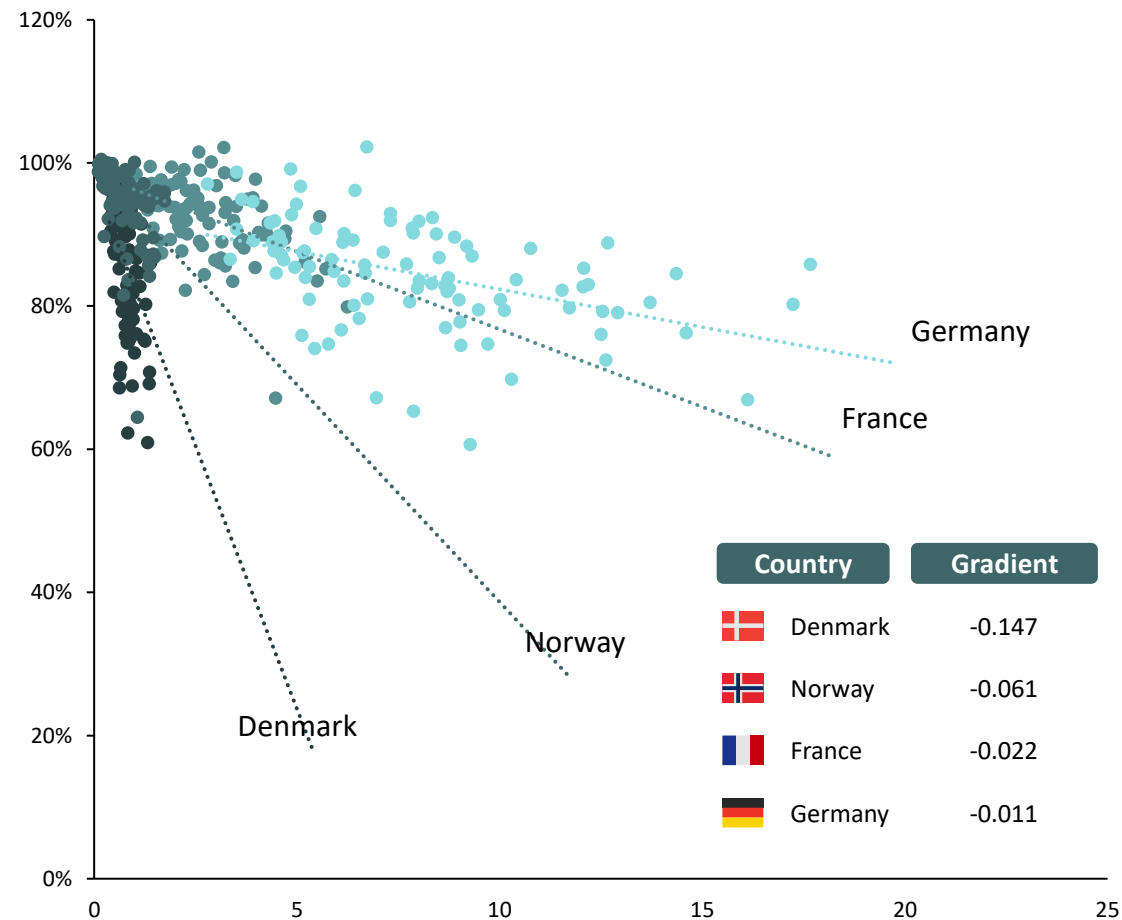
Percentage of reference price realized (y-axis); generation (TWh)



Source: Rystad Energy research and analysis

Capture factors vs. generation for onshore wind, selected relevant countries

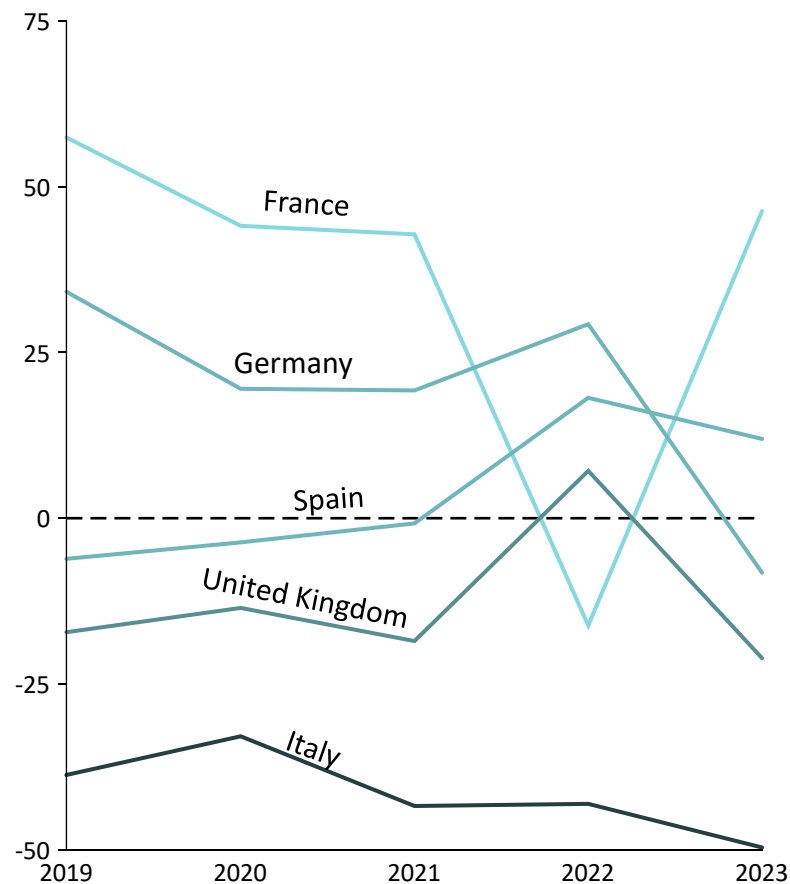
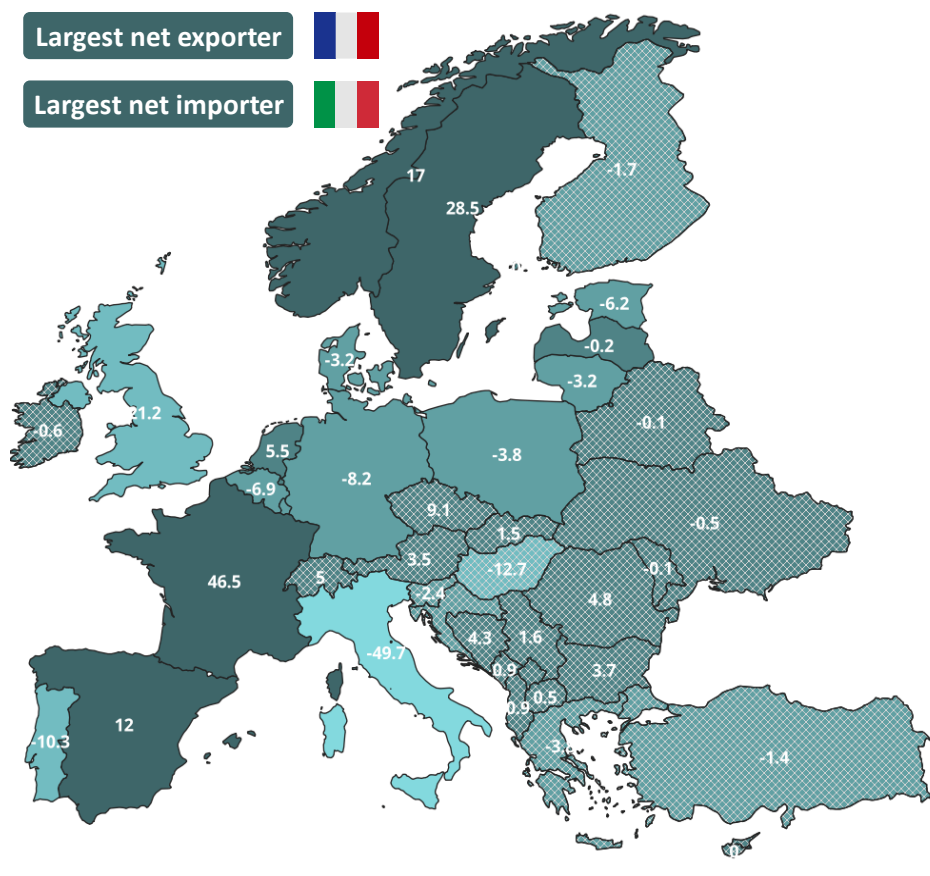
Percentage of reference price realized (y-axis); generation (TWh)





## Power system integration | Germany and Spain highlight changing fortunes in the energy transition

### European electricity trading in 2023 and net export in selected markets (2019-2023)

 $TWh$ 

## Key takeaway

## Power system integration

- In 2023, the **largest net exporter of electricity was France**, leveraging their large nuclear fleet to make up for gas shortages driven by the war in Ukraine, whilst the **largest net importer was Italy**, historically a key consumer for Russian gas.
- The significant decline in French exports in 2022 was attributed to **extensive outages in their nuclear power plants**, which operated at only 40% of maximum capacity for approximately a month when outages were worst.
- The decline in French power production impacted Italy most, as the country is the largest net importer in Europe, with France being its biggest supplier.

Source: Rystad Energy Power Solution; ENTSO-E

# Risks | Cross border flows

## Understanding basis risk conceptually

*This is the risk, primarily in VPPAs, that the relationship between the market price at the renewable generator's location and the price the consumer pays for its electricity changes from locational price differences.*

- 1 When virtual PPAs are signed, the price is typically determined as function of a **hub price** (a form of a regional average), instead of **node price** because they are typically more stable and predictable than node prices. This implies that the revenue a seller receives for each MWh is based on the regional prices

↳ This implies that the seller **must settle and absorb any differences between nodal and hub prices for each MWh**

↳ In some extreme cases, producers may **reduce production to avoid selling electricity at a loss** (low node price) or alternative store it in battery facilities

### Node price > Hub price

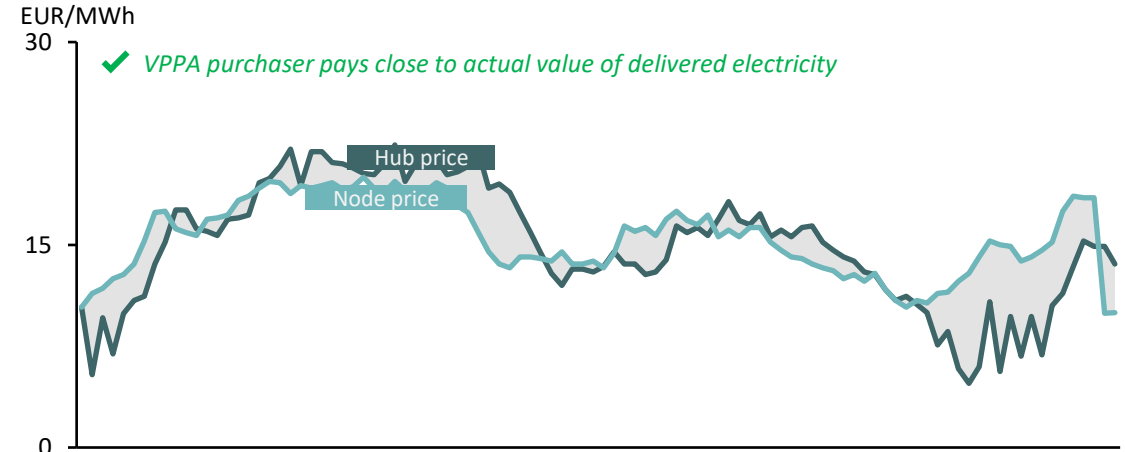
- In this scenario, the node price is greater than the hub price (showcased by the red shaded area on the graph)
- The seller must absorb the losses as the VPPA was sold at a lower price than delivered electricity

or

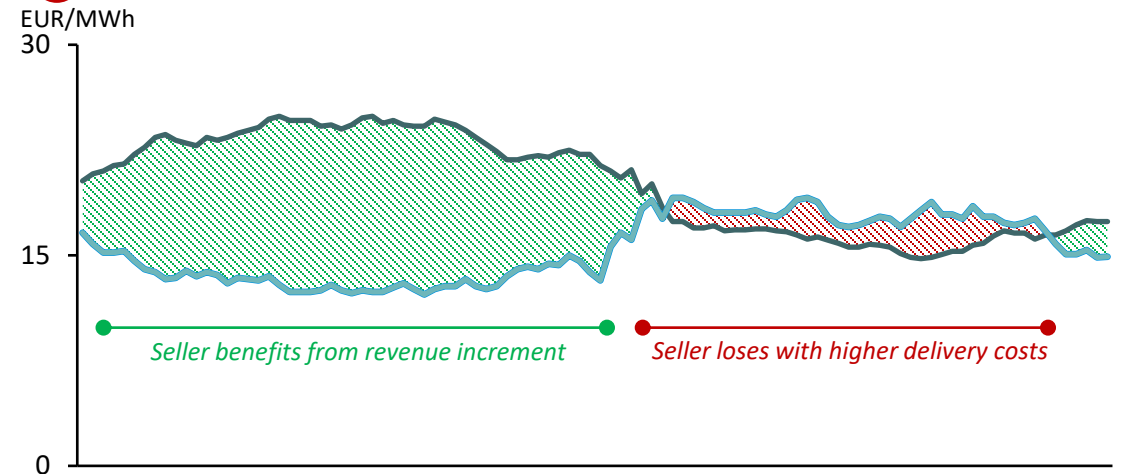
### Node price < Hub price

- In this scenario, the hub price is greater than the node price (showcased by the green shaded area on the graph)
- The seller benefits from the additional price increment above the pre-agreed VPPA price

## A Low basis-risk: Hypothetical hub and node price forecasts



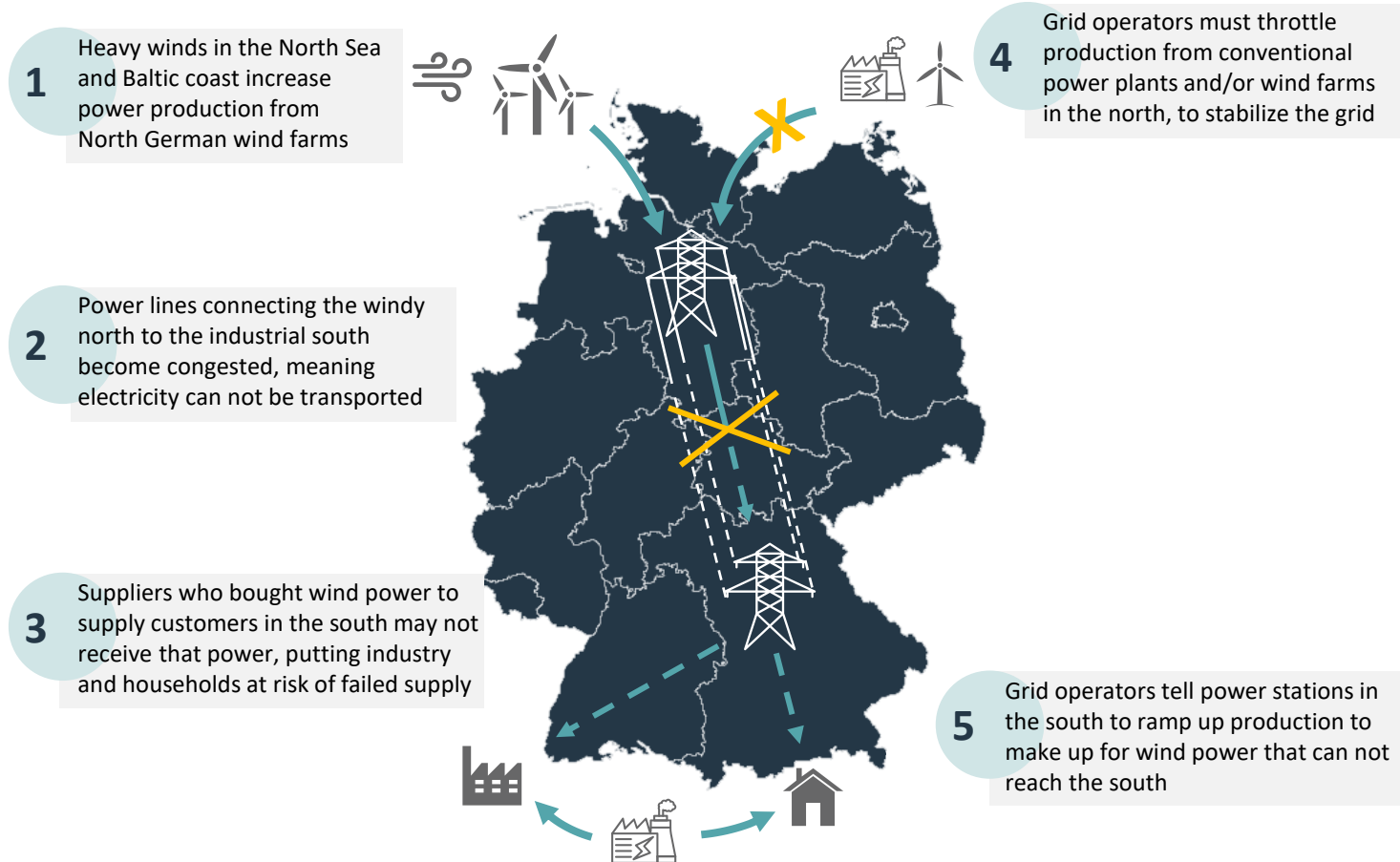
## B High basis-risk: Hypothetical hub and node price forecasts



Source: Rystad Energy research and analysis

# Modernization | Large-scale RES buildout requires ambitious grid development plans from system operators

## Transmission/distribution related drivers for Long-Duration Energy Storage



### Key takeaways

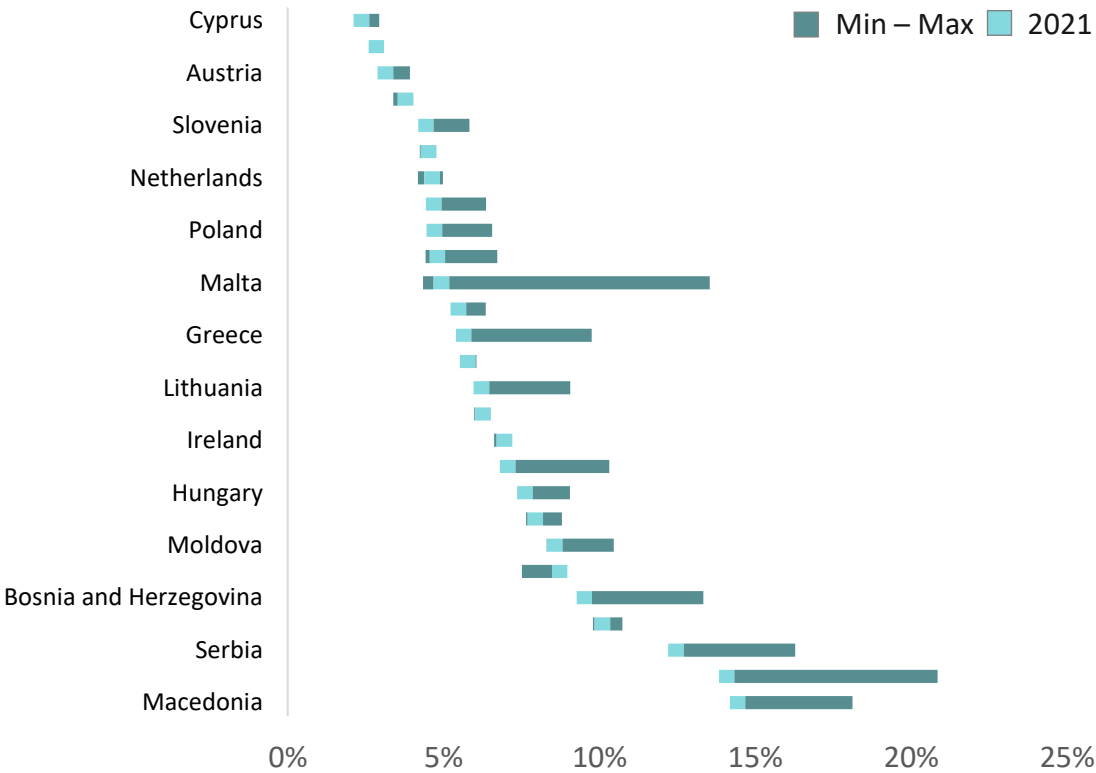
- Significant grid development is required to enable the large-scale rollout of RES. Offshore wind particularly will present a challenge for Germany and the UK's north-south transmission capability.
- **Virtual transmission** refers to utilizing specifically configured BESS in place of transmission capacity to provide a combination of capacity, services, and capabilities.
- Virtual transmission projects can be in the form of single assets, pairs of assets (as "virtual transmission lines") to mimic flows at both ends or as a portfolio of assets across the system. Germany has approved the construction of a trio of such assets.
- **Virtual transmission lines may also be used to enhance cross-border capacities** to further 'connect' the European electricity grids.

Sources: Rystad Energy research and analysis; Clean Energy Wire

# Modernization| Networks face distribution losses and capacity inadequacy

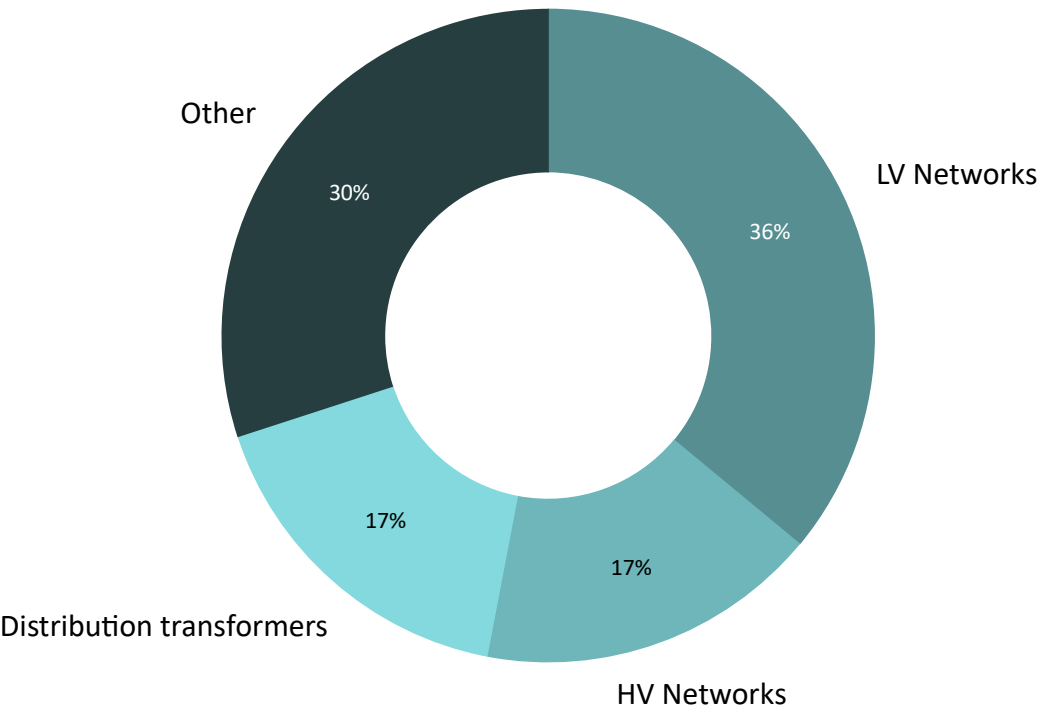
Distribution losses in the distribution grid, 2010-2021

Percent



Source of distribution losses on the UK grid, 2010-2021

Percent



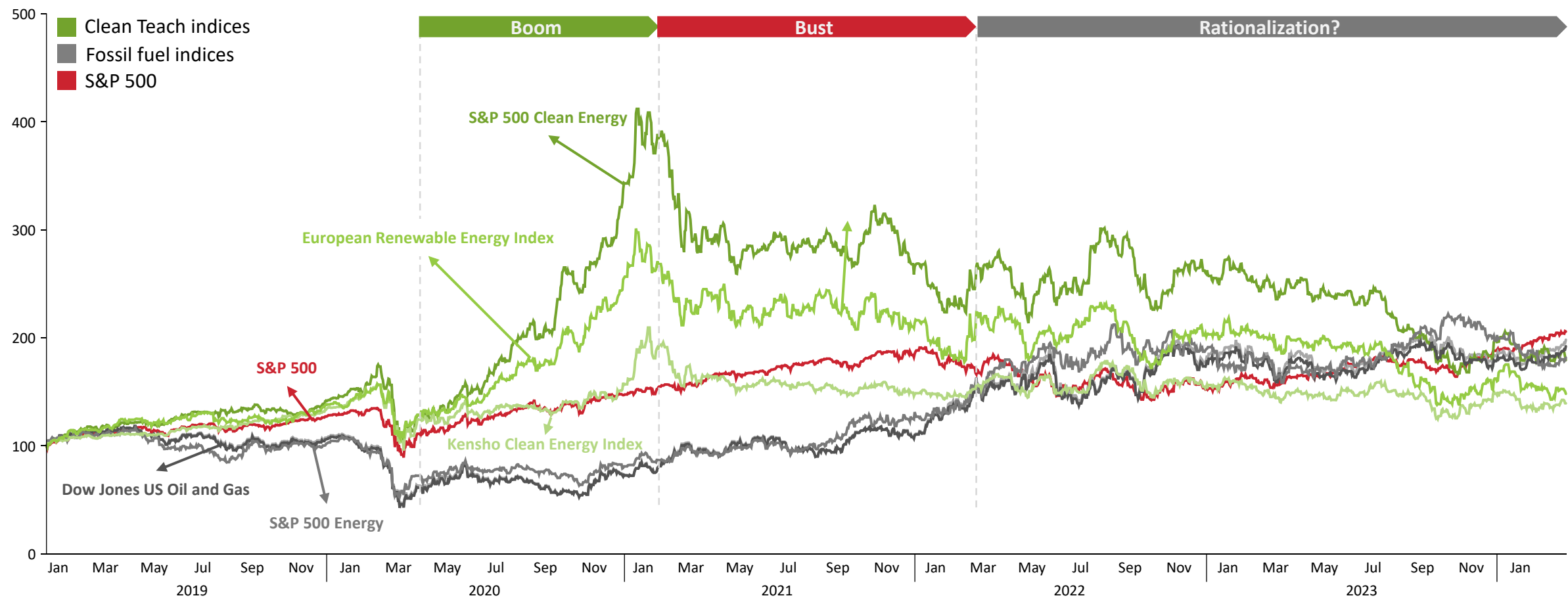
\*Max and minimum benchmark values based on distribution losses from 2010 to 2018  
Source: Rystad Energy research and analysis; EDS; CEER



# Capital Markets | But investors are stepping back from supporting green projects just investments are needed most

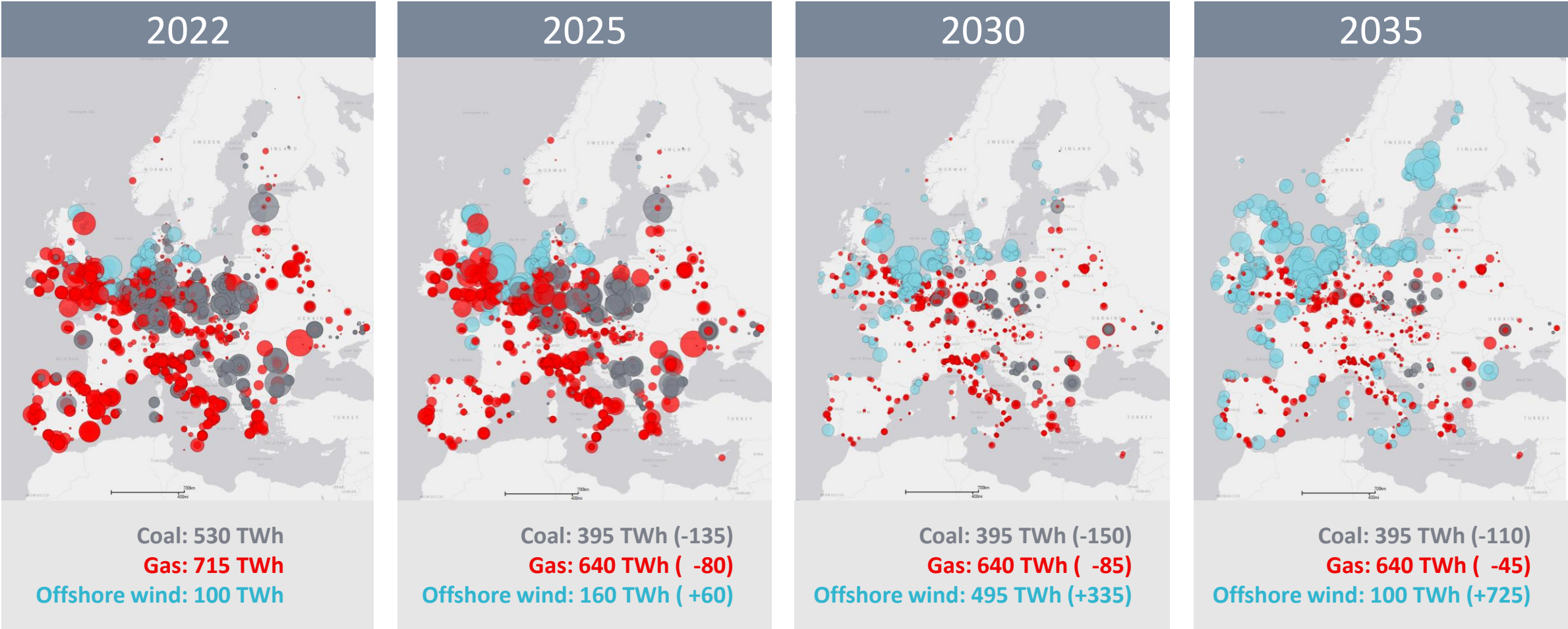
Global clean energy market indices vs. traditional energy indices and the S&P500

Indexed against January 1st 2019



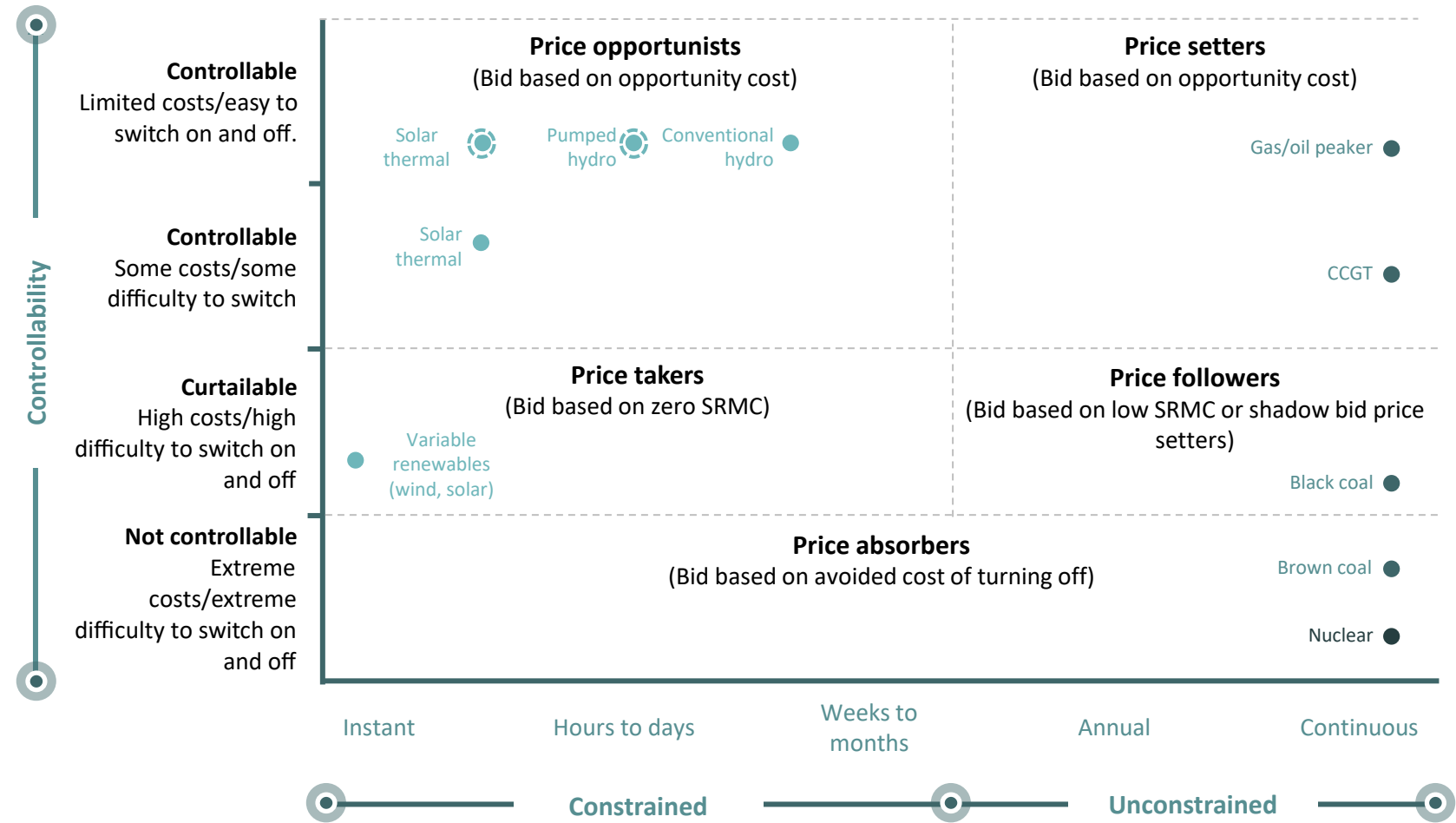
Source: Rystad Energy research and analysis

Distributed grids | The job of replacing coal and gas with offshore wind is a massive grid challenge



Source: Rystad Energy research and analysis

Price signals | Without gas setting the price for electricity, market signals for all segments break down



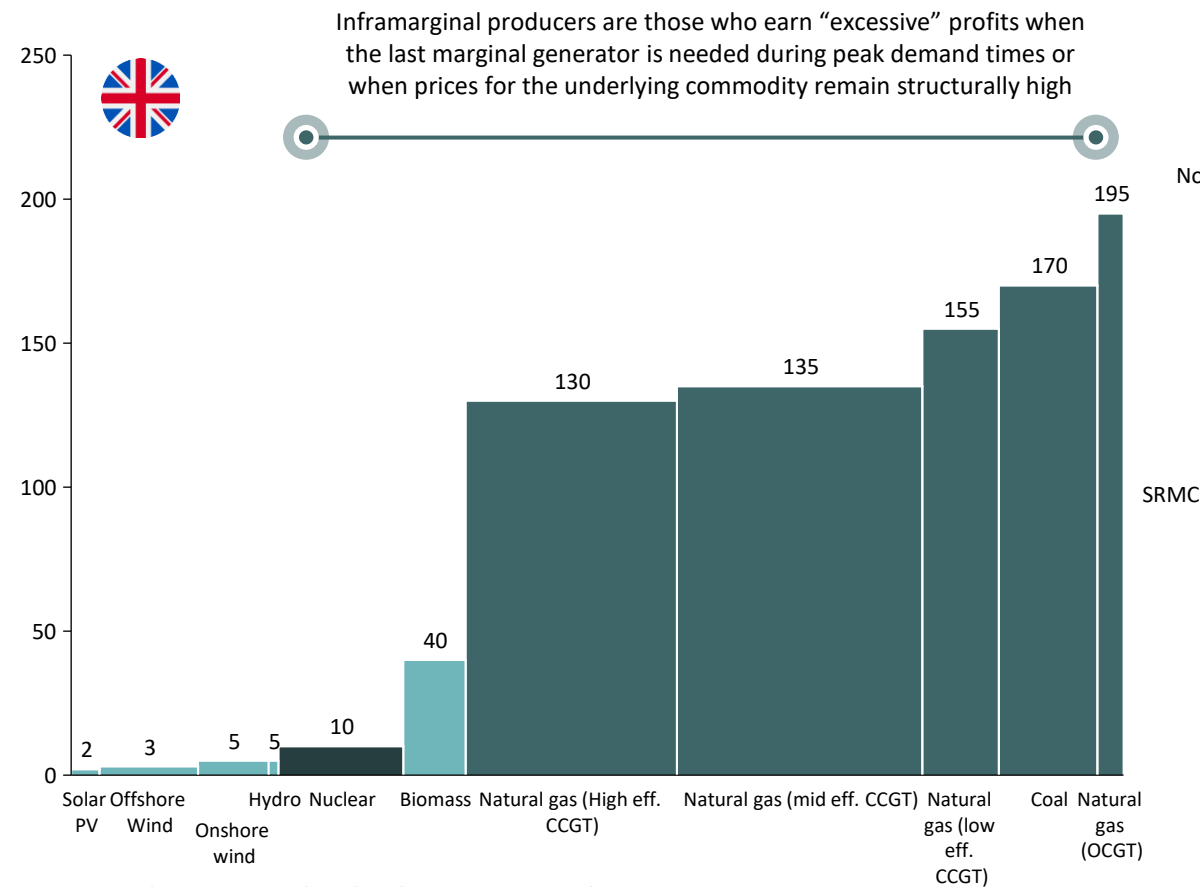
- Key takeaways**
- Electricity markets typically operate on a marginal cost pricing system, where the price is set by the most expensive source dispatched, normally gas, due to its controllability and durability.
  - Historically, the price setters provide price discovery and other generators rely on gas as a key price signaller. This has led to the practice of “shadow pricing”, where other generators price themselves just below that of the most expensive gas expected to enter the market to boost their own profit.
  - Opportunists use gas prices as a cue for when to deploy, Followers depend on it for long-run price discovery, Takers cause volatility without moderation, and Absorbers require it for balance bidding and ramping volume.

Source: Rystad Energy research and analysis; BCG

# Marginal price setter | Current market design functions to limit short-term imbalance

Short-run marginal cost of operation for UK generators, 2022

Price, £ per MWh

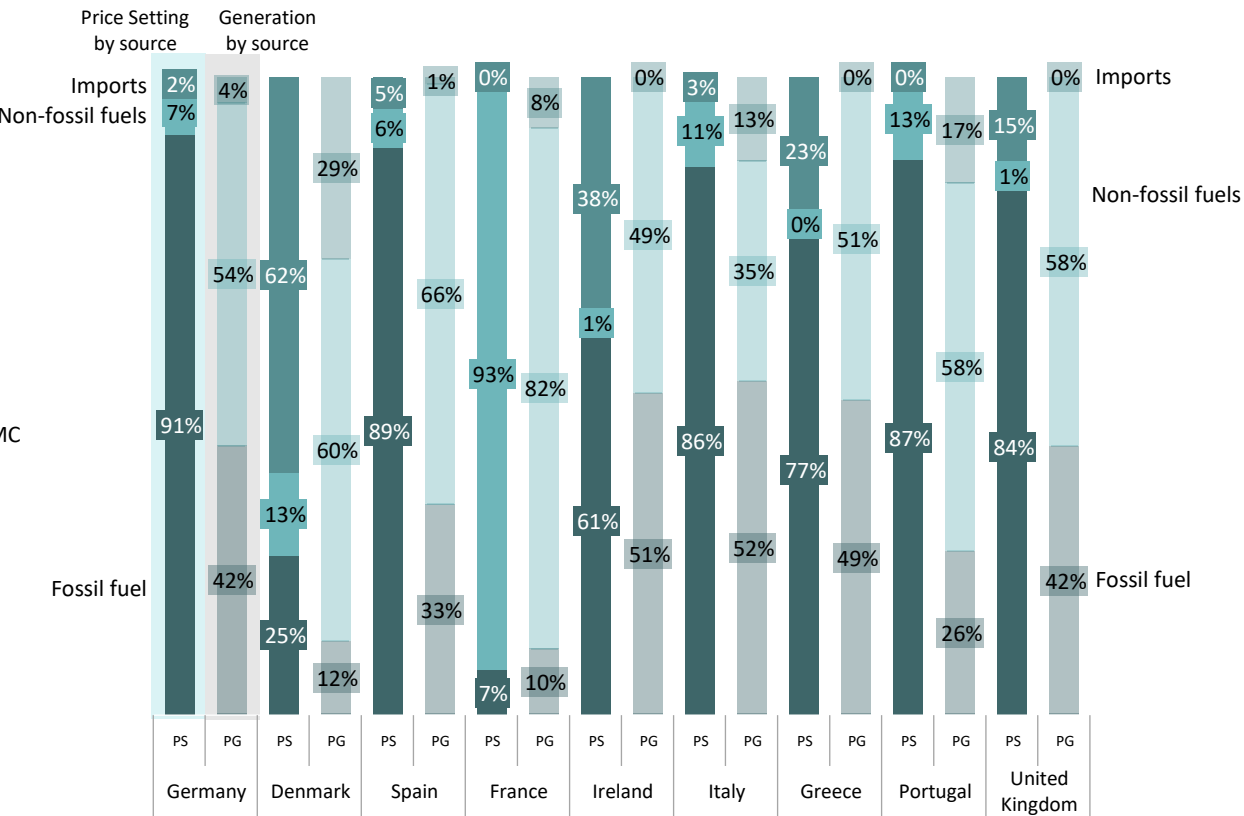


Source: Rystad Energy research and analysis, UCL; PowerCube

Price setting power sources share (PS) and power generation share (PG)

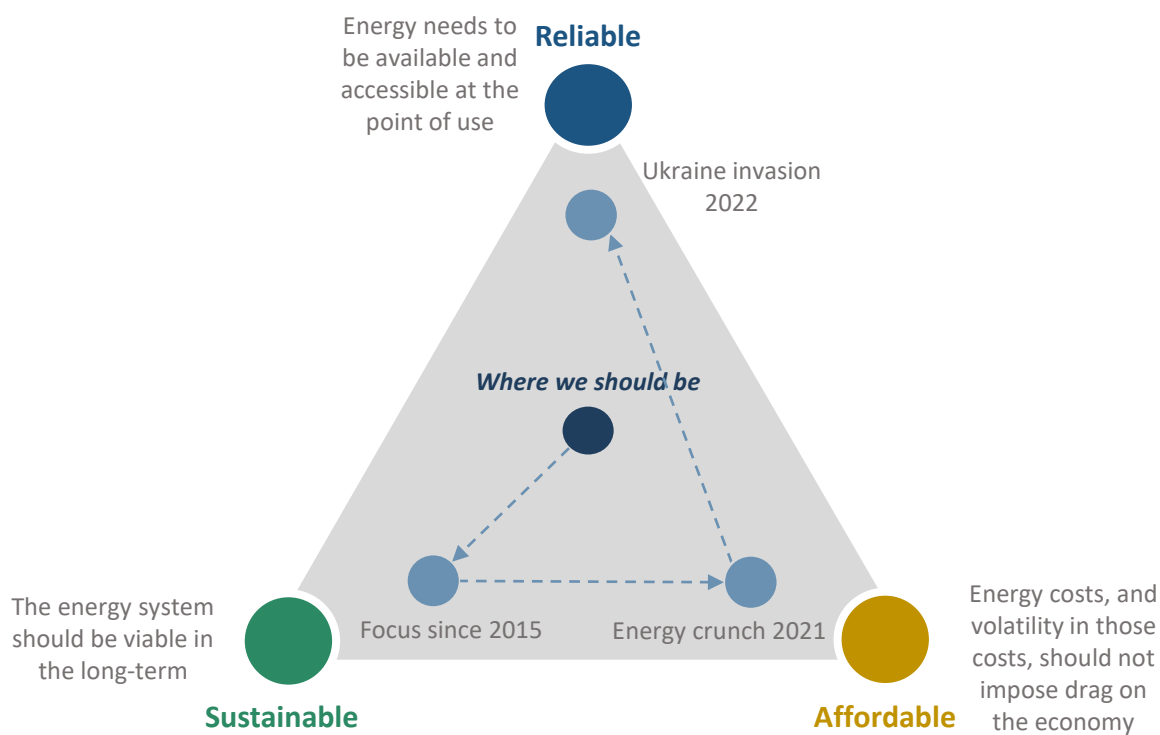
%

Even though all the selected countries, except Italy, generate **more than 50%** of their energy from **renewable sources**, **fossil fuels** still **dictate market prices** on average **three out of four times** across these nations.

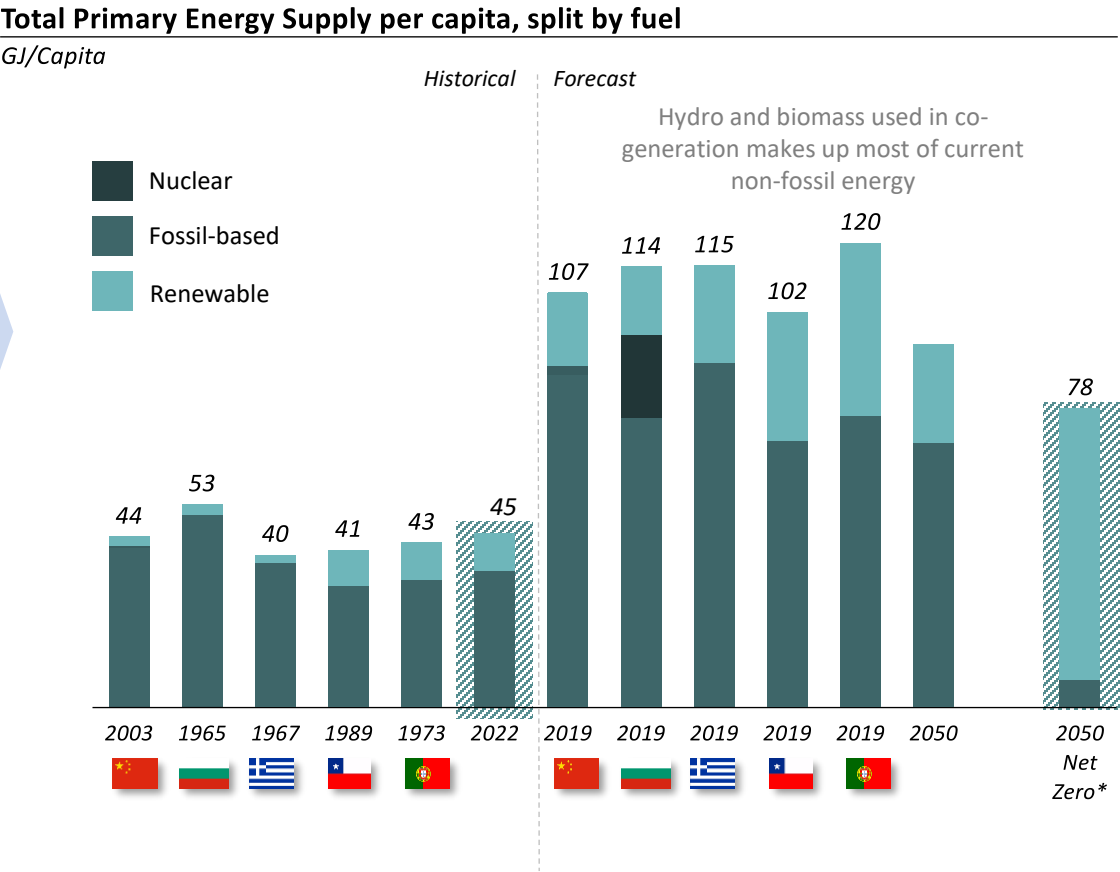


# What should electricity market design solve for? | Focus across the energy trilemma has shifted to reliability

The energy system should be **affordable**, **sustainable** and **reliable**...



...and the focus on the trilemma elements has shifted in recent years



Source: Rystad Energy research and analysis



# Marginal price setter | Key challenges prevent short-term power market decoupling from gas market prices

## Overview of key decoupling challenges



### 1. Difficult implementation

Several short- and long-term strategies have been proposed, from revenue caps and taxes to derivatives and specialized markets for different power types, to resolve the current market difficulties.

While there are many proposed solutions, problems remain with implementing these strategies.



### 2. Short-term imbalances

Gas remains critical to settle short-term imbalances in the power market being the marginal producer.

Meanwhile, inframarginal producers have lower costs but benefit from the price set by the marginal producers. This means that inframarginal producers have little incentive to change, but strong reasons not to change the market dynamics.



### 3. Fragmented market

Although European electricity markets engage in cross-border exchange of information and bids, national policies and regulations vary significantly.

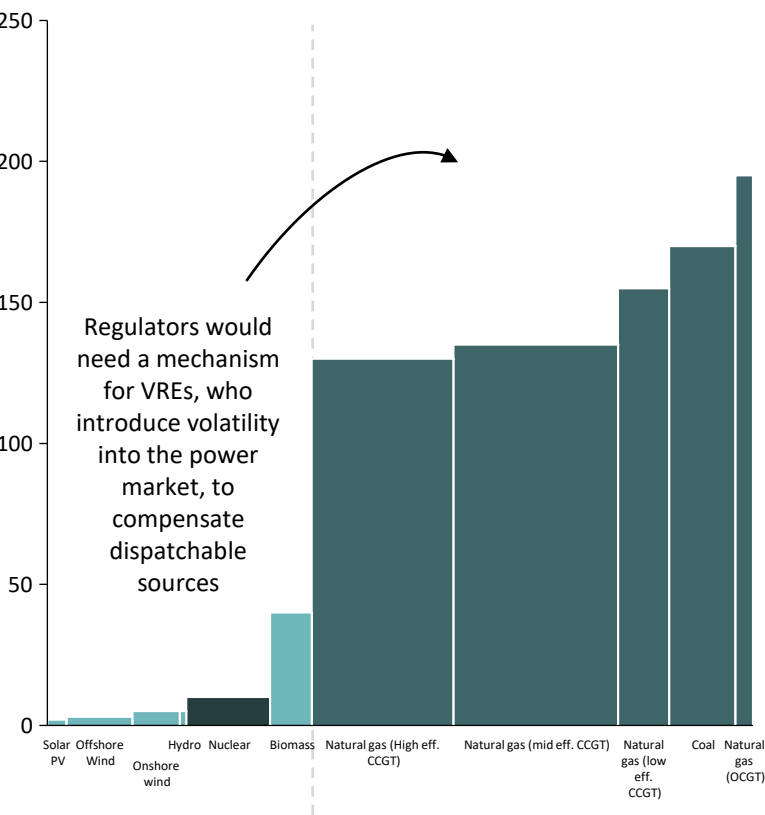
Implementing new market proposals will necessitate a robust, interventionist regulator with authority spanning all interconnected power markets to prevent cannibalization and the creation of market winners and losers.

By the mid-2030s, long-term decoupling strategies are expected to shift power market dynamics away from gas reliance

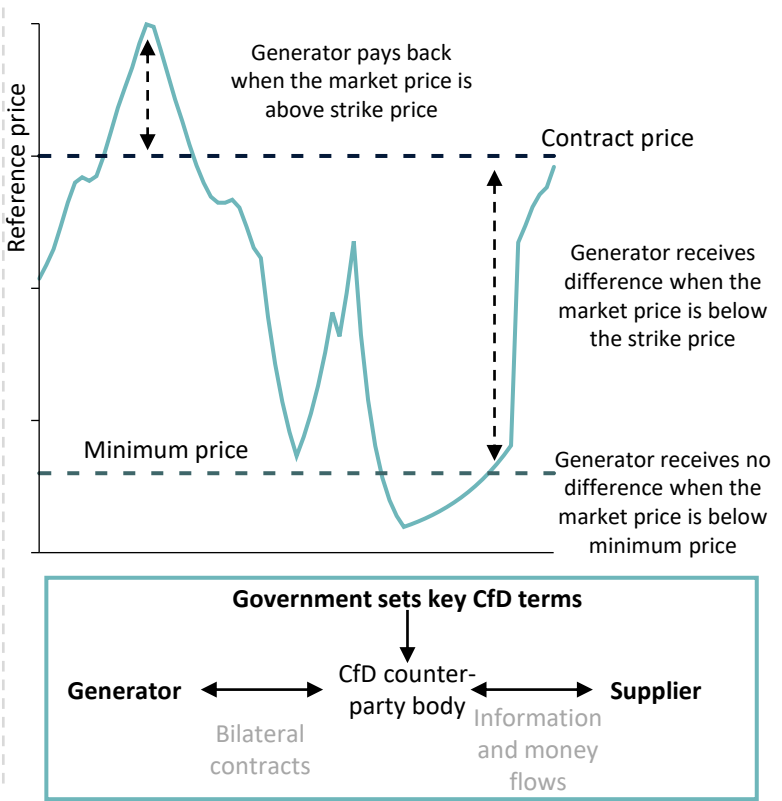
Source: Rystad Energy research and analysis

# Decoupling gas prices | Three proposed strategies have come to the fore as the most promising to decouple power prices from gas prices

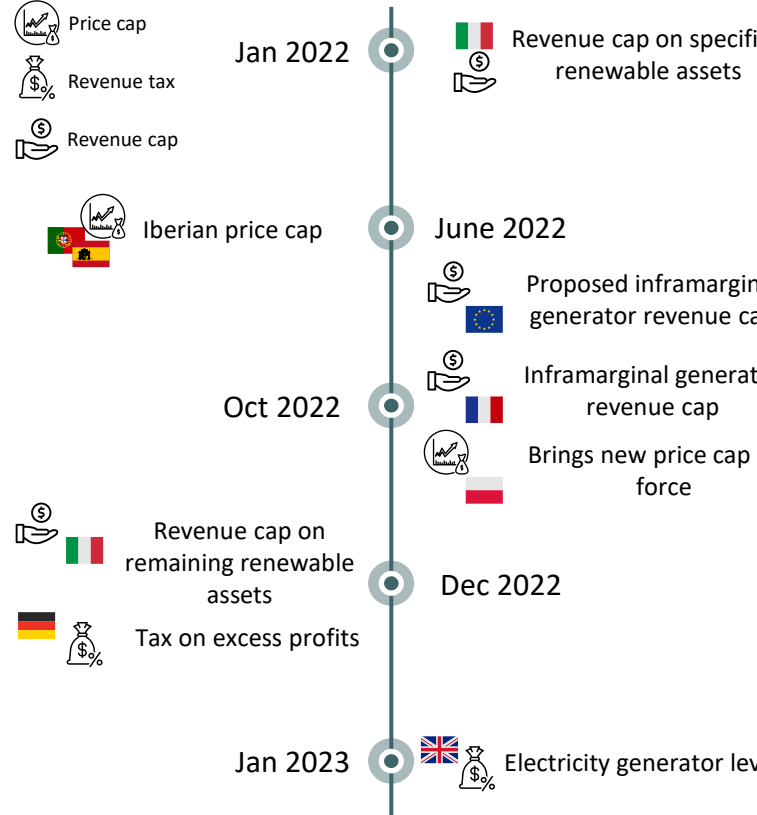
## 1 Splitting dispatch and non-dispatchable sources



## 2 CfDs for all generating assets



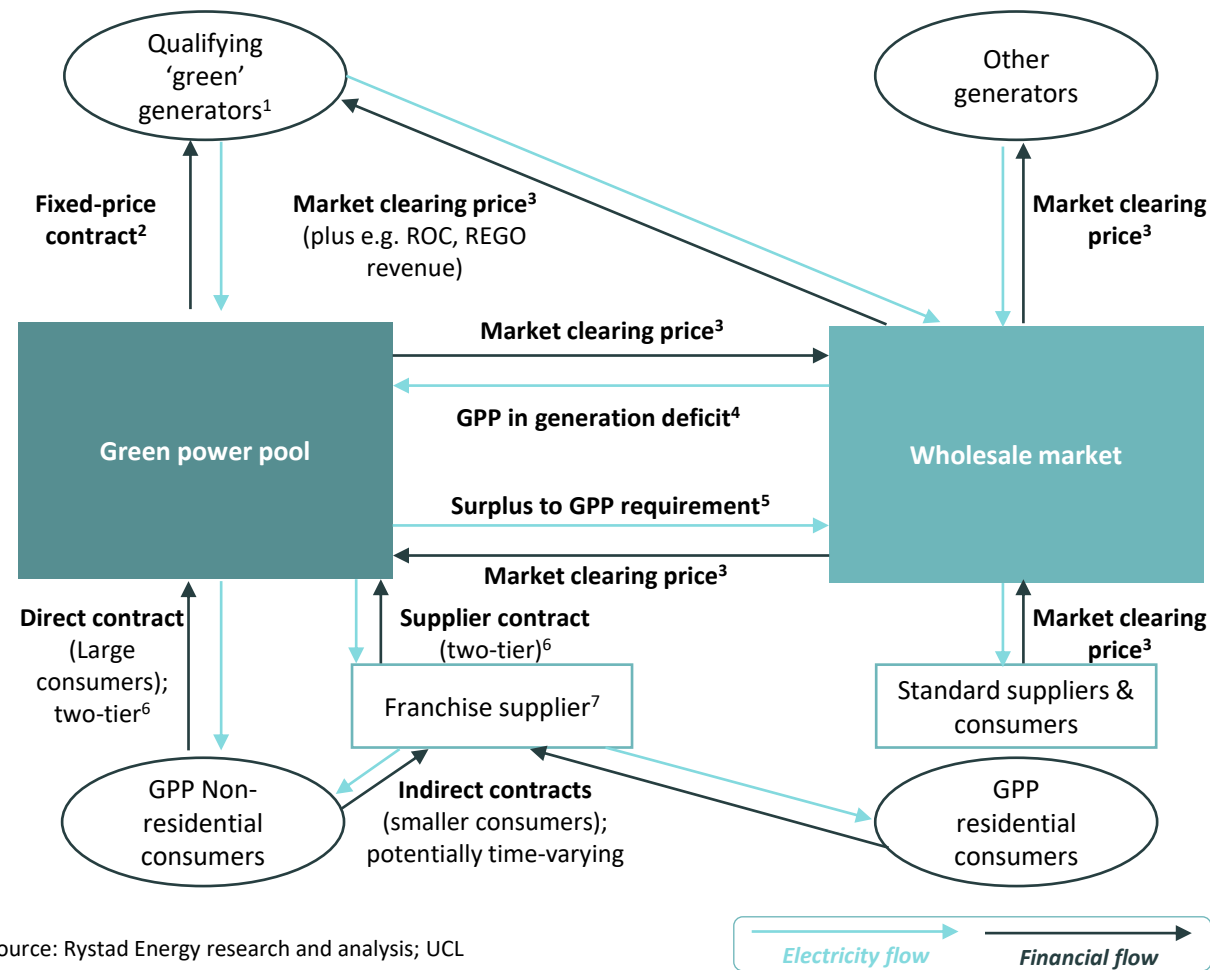
## 3 Capping infra-marginal generation asset profitability



Source: Rystad Energy research and analysis; Rystad Energy PowerCube; UCL

# Splitting the market and CfDs | VPPAs would be critical to market function and PPAs could offer buyers and sellers a hedge against the wholesale market

Diagram of how a market split between renewables and wholesale dispatchable power could work



Source: Rystad Energy research and analysis; UCL

## Key takeaways

- Splitting the fossil fuel wholesale and green power markets would require significant intervention by market regulators, with management and allocation of imbalance directly handled by authorities.
  - The complexity of this market configuration would make CPPAs an important hedge against the CfDs set by the regulator and would provide the market investment signals for additionality in new renewable capacity.
1. Specific generator qualification criteria may vary
  2. Fixed price per unit of generation, as per CFDs
  3. A combination of spot and forward market sales, as appropriate
  4. At times when the generation in the GPP cannot satisfy its consumers' needs, the pool itself could buy from the wholesale market
  5. At times when the GPP has surplus electricity (exceeding its consumers' needs) the pool itself could sell to the wholesale market, or limit its own purchase from GPP generators who then sell surplus to wholesale market
  6. Two-tier contracts combine involve fixed unit price (reflecting the cost of the CfD contracts), with a variable component reflecting trades with the wholesale market
  7. Franchised supplier, passing GPP costs through with cost+margin, regulated to prevent on-selling

# Electricity market reform | UK is increasingly aware of this market dislocation and is actively seeking to change the electricity market design



**GOV.UK**

## Review of Electricity Market Arrangements (REMA) 2024

On March 12<sup>th</sup> 2024, Claire Coutinho, the Secretary of State for Energy Security and Net Zero, announced the latest iteration of the REMA consultation, with the establishment of zonal location marginal pricing being a key change. This change to zonal marginal pricing replicates similar schemes that exist in Norway, Italy, Australia, and Sweden

### Before: Common Charging Basis

- 1 Wholesale market**
  - Electricity is delivered, bought, and sold on the wholesale market with supply and demand driving any fluctuations in the price of electricity
- 2 Energy Price Cap**
  - Ofgem, the UK energy regulator, sets a price cap for standard variable tariffs paid by household consumers, with a limit that producers can charge (reviewed twice per year)
- 3 Single national price**
  - Ofgem, the UK energy regulator, sets a price cap for standard variable tariffs paid by household consumers, with a limit that producers can charge (reviewed twice per year)

### After: Locational Marginal Pricing

- 1 Zonal pricing**
  - Divided into seven zones where the price of electricity varies depending on the zone based on generation capacity, demand and infrastructure costs
- 2 Market-based dynamics**
  - The price in each zone is determined by local supply and demand balances in each zone, as opposed to the one national market price
- 3 Regional balancing mechanisms**
  - These factors such as localised pricing and infrastructure considerations allows for project development in regions of high demand instead of cost optimized placements

By better matching local energy supply with demand, the REMA reforms could **shave £45 off households' average annual electricity bills**. The reforms are also expected to **incentivize more renewables development in the southeast**, where demand is highest, and encourage more energy consumers - such as factories and data centers - to locate in Scotland or the southwest, **where surplus renewables power is available and energy costs would therefore be lower**.



Department for  
Energy Security  
& Net Zero

Source: Rystad Energy research and analysis



# RystadEnergy

Navigating the future of **energy**

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