# LONG-TERM OUTLOOK AND THE IMPACT OF RENEWABLES GROWTH ON POWER PRICES

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# PÖYRY IN BRIEF

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Thermal Power & Renewable Energy, Hydro, Transmission & Distribution, Nuclear Energy

**Ranked within**
**TOP 10**
in power generation in the world*

70%
of Europe‘s major energy players rely on our market projections

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Chemicals & Biorefining, Mining & Metals

**Ranked**
**#1**
in pulp & paper in the world*

Delivered projects for
90%
of the World‘s major pulp & paper companies

**INFRASTRUCTURE**
Transportation
Water
Environment

**More than**
**1,000km**
of transportation tunnels in the last decade

Conducted
2,000+
environmental due diligences in the last decade

**10,000+** projects delivered p/a across ~ 100 countries

**5,500** experts across 70 nationalities

**130** offices in 40 countries

1958

**~60** years

*ENR 2016

# EUROPEAN ENERGY MARKETS ARE IN TRANSITION

## Renewables are penetrating the markets

- Wind and solar have changed the markets – storage will follow
- Solar and battery will reach grid parity in southern Europe soon

## The European generation mix is changing

- Solar and wind are the biggest winners in new build
- Selected market policies have large impact on the mix

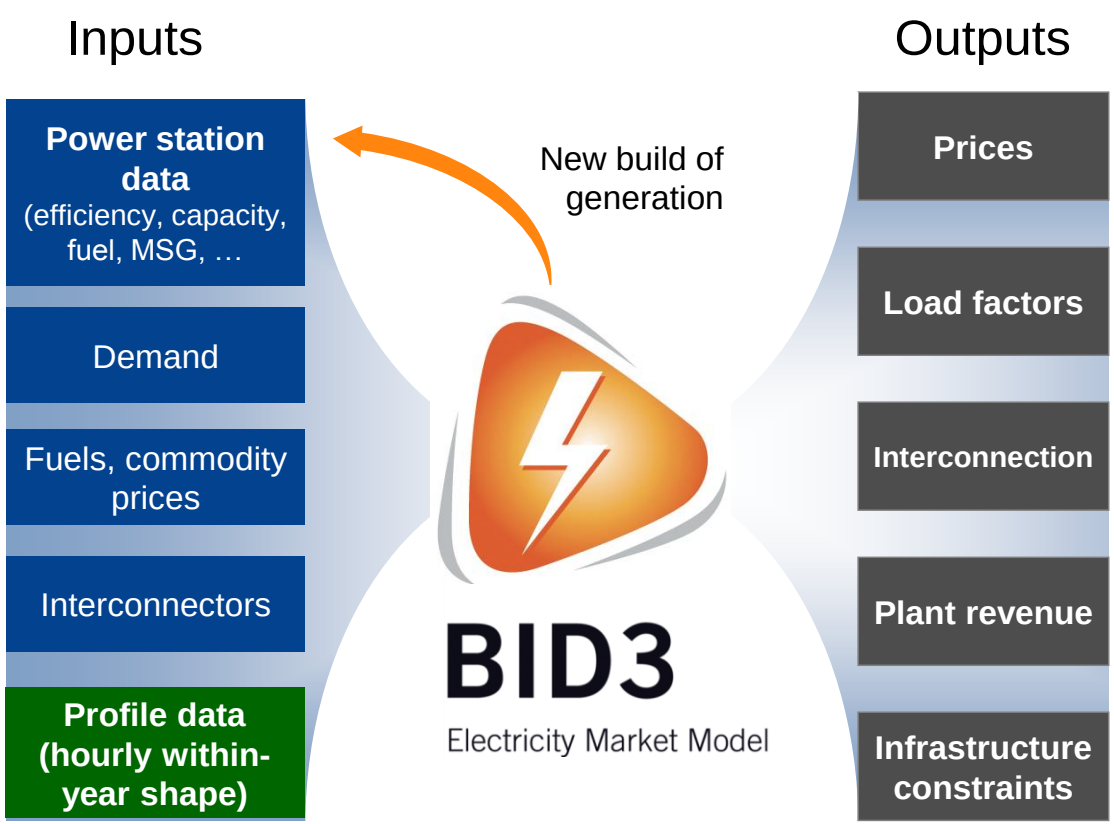
## Value along the value chain will be re-distributed and roles will evolve

- Value will move downstream and closer to customer (e.g. distributed generation, electrification of heat and transport, flexibility, energy efficiency, etc.)
- Profits from generation are impacted by market policies
- Decentralisation will change retail business

# BID3 – PÖYRY'S ELECTRICITY MARKET MODEL

## BID3 projects physical operation (generator output, electricity flows, emissions) and economic behaviour (electricity prices, revenues)

### Inputs and outputs of *BID3*




### Basics of BID3

- BID3 is an optimisation which minimises the system cost in a year subject to constraints
- It models all 8760 hours of the year and accounts for varying renewables, demand-side management, hydro and storage
- It has the following key plant dynamics
  - Start-up, Part-loading (no-load), Minimum Stable Generation
  - Minimum on- and off-times
  - Temperature dependent start cost
  - Ramping
  - CHP and co-firing
- It also models
  - reserve constraints
  - capacity expansion (new build and retiral)
  - Flow Based Market Coupling

# PROJECTING WHOLESALE ELECTRICITY PRICES

## We assume a high level set of modelling principles

### Our modelling methodology

- Based on market fundamentals
- Project values for outturn electricity prices, which should not be confused with forward prices
- Assumption of competitive ‘free market’ behaviour
- A ‘merit order’ of plant is compiled based on variable cost of generation
- Plant runs on basis of position in merit order, not whenever the market price is above its marginal cost of generation

### The scenario approach

- Our approach is to develop detailed and internally consistent scenarios for the future behaviour of energy markets
- Each scenario tells a story about what could happen in the market
- Scenarios are not forecasts … but can act as shock therapy!
- We analyse typical market conditions in the long term
- We do not attempt to predict random events, or the weather
- Our scenarios have been used by lenders on a wide range of asset transactions in European energy markets

# FACTORS DRIVING ELECTRICITY PRICES

# RES-E SENSITIVITIES IN TARGET CEE/SEE REGION

**BID3 produces electricity prices, output, cross-country flows for over 30 European countries, here we apply our Central Scenario and focus on selected countries**

## Modelled Region and Focus Countries

## Pöyry BID3 Central Scenario

- Is consistent with current policy targets
- The Central market scenario is an 'expected' pathway for market wholesale electricity prices at the time of projection
- In comparison to the High scenario, we assume less aggressive economic growth, medium growth of fuel and carbon prices, renewables capacity and costs of new entry

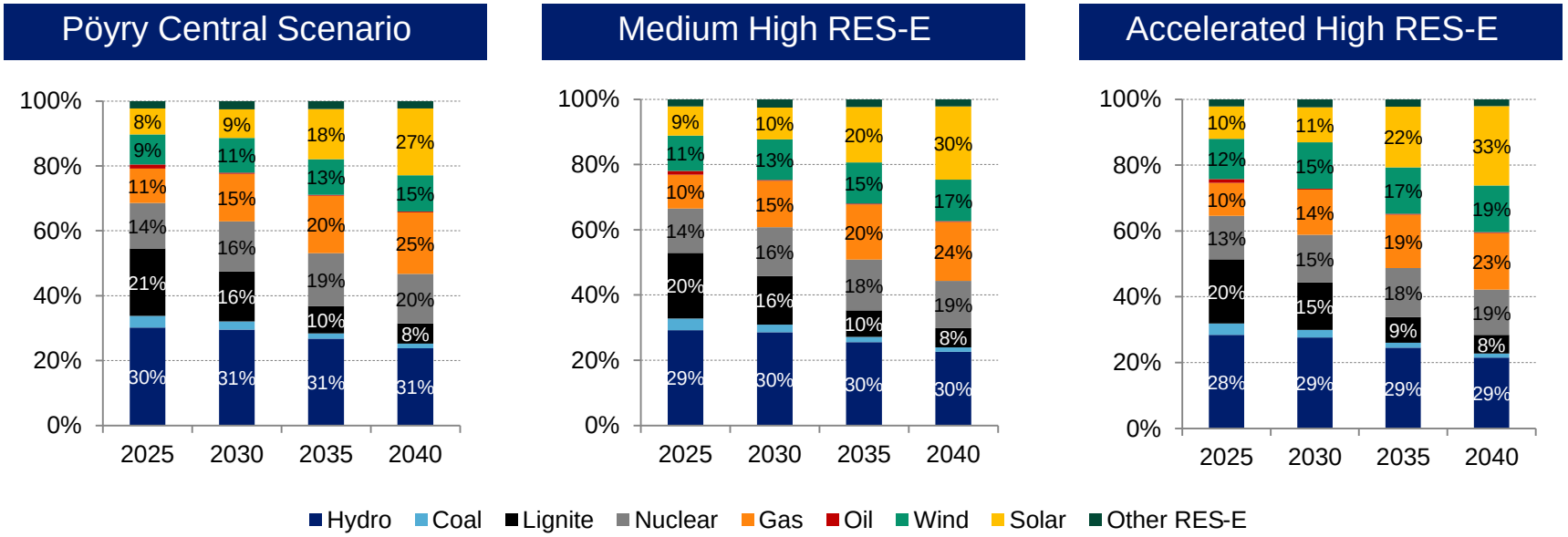
***Key question for CEE/SEE region***

How would higher deployment of intermittent RES-E capacities affect
- Wholesale prices
- Generation patterns
- Cross-border flows

compared to Pöyry's Central Scenario?

# NET INSTALLED CAPACITY IN CEE/SEE

## In the RES-E sensitivities, the renewables share in the capacity mix was increased compared to the Central scenario over the modelled timeline



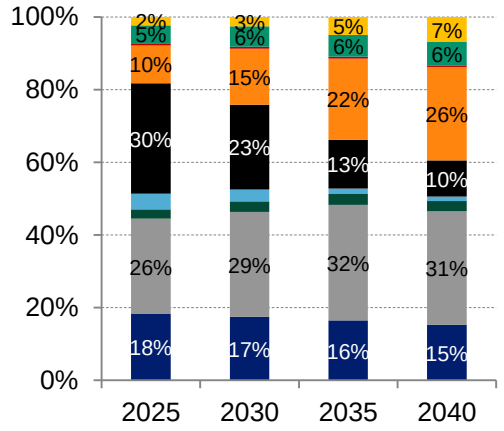

| | Central | Medium High RES-E | Accelerated High RES-E |
|---|---|---|---|
| Wind | 100% | 120% | 140% |
| Solar | 100% | 115% | 130% |

Target CSEE Region: Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Montenegro, Albania, FYROM, Romania, Bulgaria, Serbia, Kosovo, Bosnia and Herzegovina

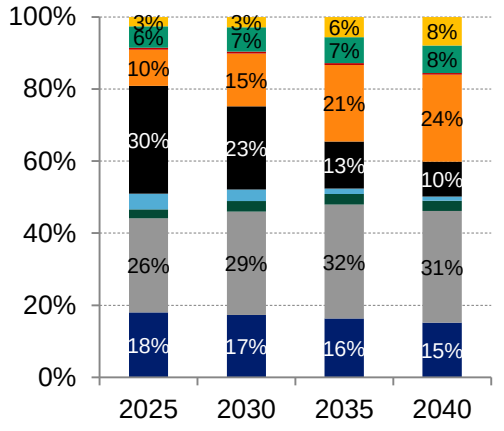
# GENERATION MIX IN CEE/SEE

## In both sensitivities, the increase of intermittent renewables generation is apparent. Correspondingly, gas-fired generation is decreasing in the modelled years

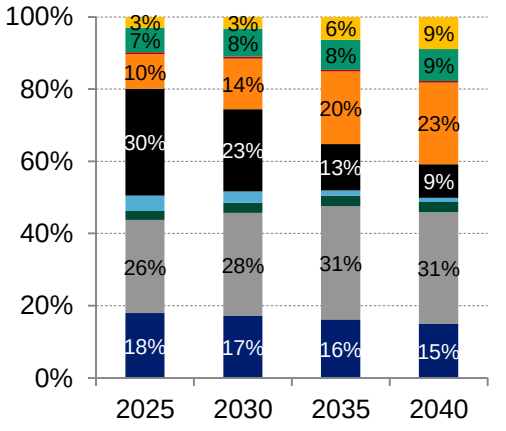
**Pöyry Central Scenario**




**Medium High RES-E**




**Accelerated High RES-E**



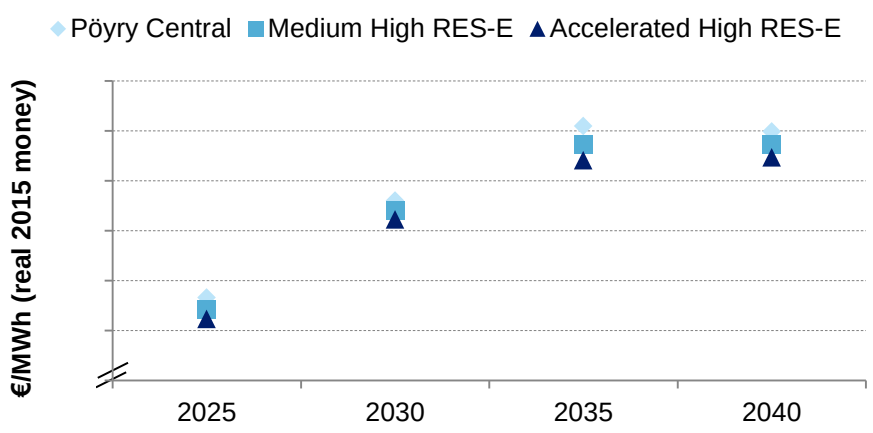

Hydro Nuclear Other RES-E Lignite Coal Gas Oil Wind Solar

- Higher installed RES-E capacity changes the merit order curve and, therefore, reduces the share of gas-fired generation
- Share of renewables rises from 7% (2025) / 13% (2040) in Central to 10% (2025) / 18% (2040) in the accelerated High RES-E sensitivity
- Generation from hydro, nuclear and coal/lignite is broadly unaffected from the sensitivities
- In general, gas is modelled to contribute more to the generation mix in the long run as its share increases from 10% to around 25%
- Generation from lignite and coal is generally decreasing towards 2040

# WHOLESALE ELECTRICITY PRICES

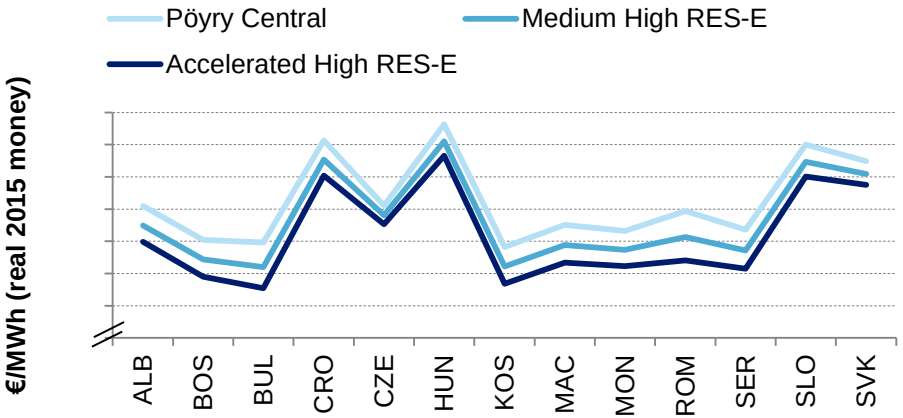
## The higher the intermittent generation from RES-E, the larger its potential impact on the power price, compared to Pöyry's Central scenario

Target Region Power Prices




- A higher deployment of RES-E results in lower power prices
- Generally, renewables exert downwards pressure on power prices through low or even negative bidding
- Renewable energy sources affect power prices by:
  - From -2.2% (2030) to -1.3% in (2035) in Medium High RES-E
  - From -4% (2030) to -2.4% (2035) in Accelerated High RES-E

TWA Power Prices in 2025




- The percentage increase of RES-E has a stronger impact on countries with higher existing renewables shares

NB: On a country-by-country comparison, prices decrease (from the four anchor years modelled in the sensitivities):

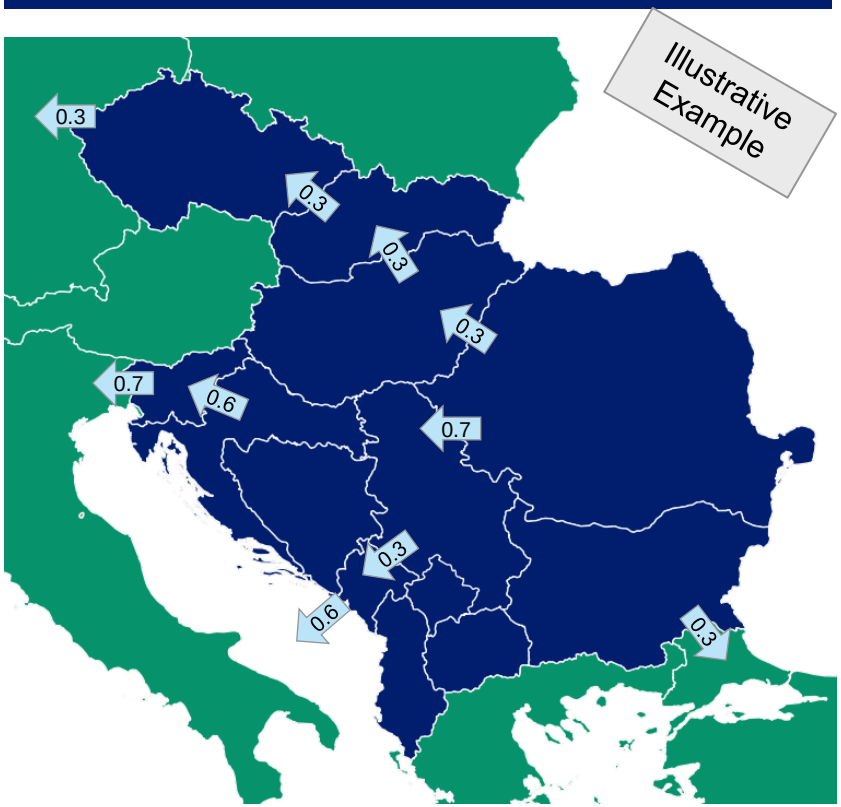
- Minimum and maximum price changes in the Medium and High Sensitivities
- -3.3 and -6.3% in Romania in 2035
- -0.6% and -1.2% in the Czech Republic in 2030

1. For the region, generation weighted average prices are considered

# MAIN CHANGES IN NET FLOWS (TWH, DIFFERENCE TO CENTRAL)

**Net power exports largely increase from Romania towards Northern and Western regions, as the country had the most significant increases in RES-E capacity**

## Medium High RES-E




## Accelerated High RES-E

# DRIVERS FOR POWER PRICES

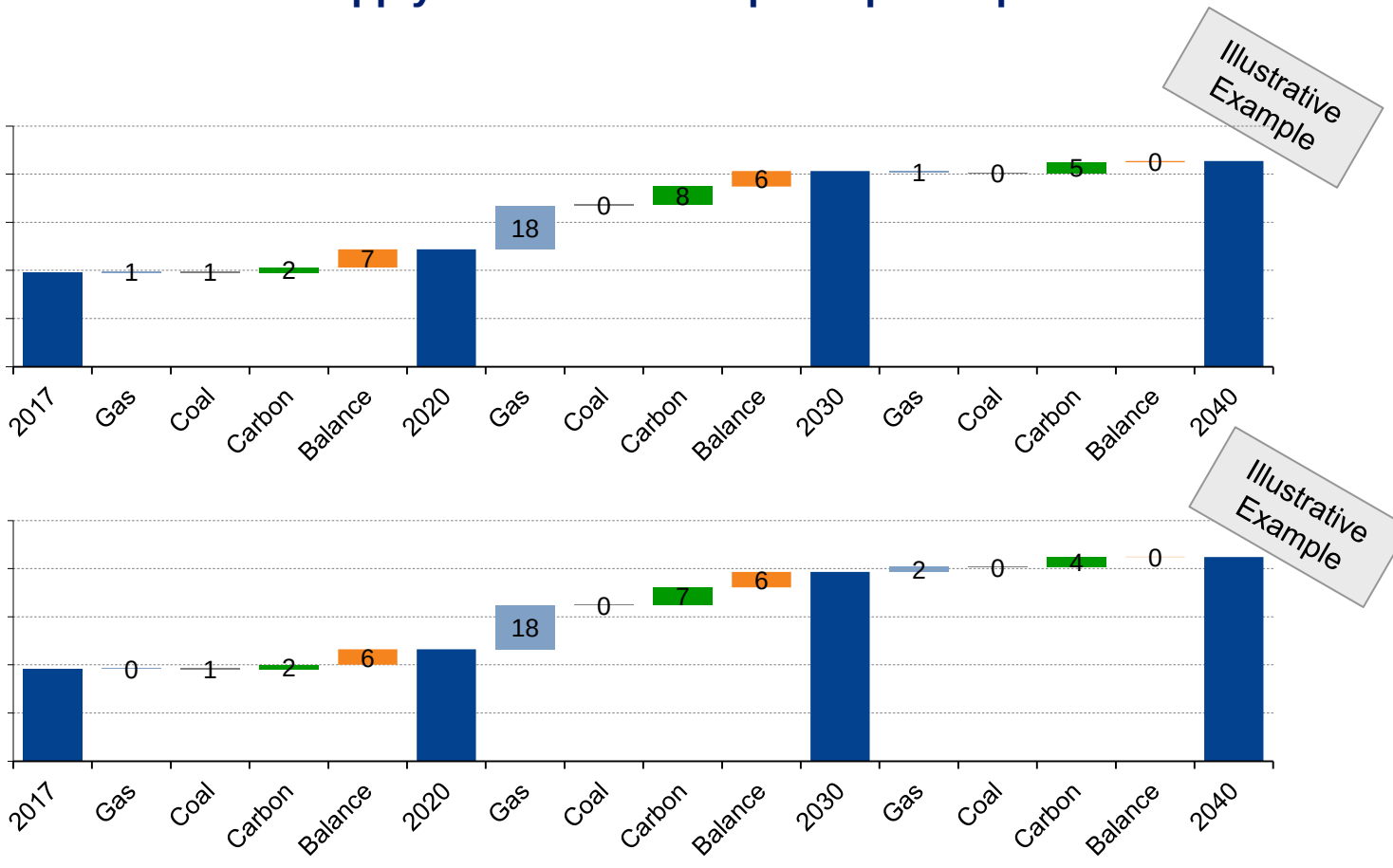
**In Hungary and Romania, the gas price is the main driver of electricity prices in the mid-term, while the demand-supply balance also impacts power prices in the short- to mid- run**

Hungary

Romania

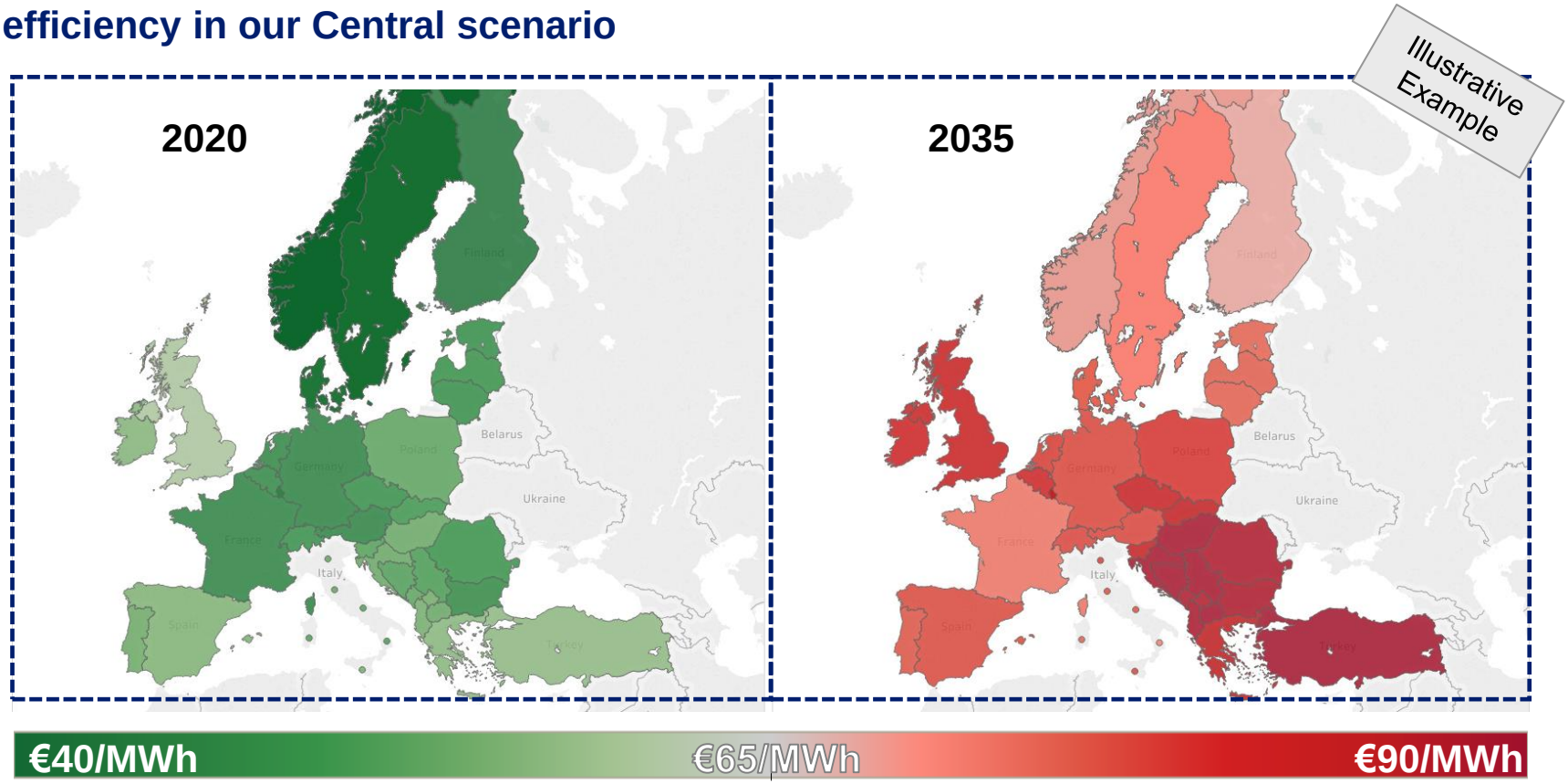
Driver

Indicative contribution to change in wholesale electricity price (€/MWh, real 2015 money)



# PRICES RISE ACROSS ALL MARKETS, BUT NOT EQUALLY

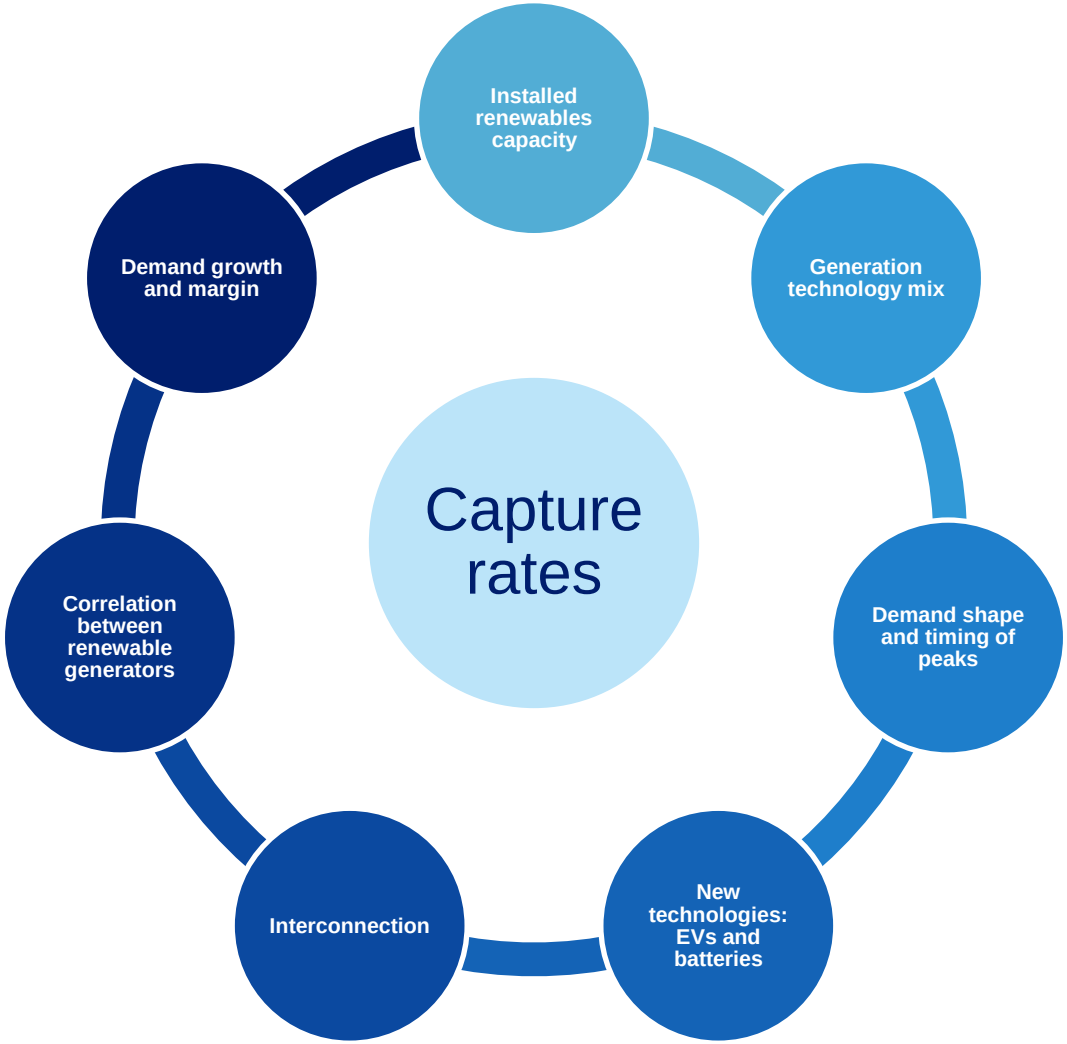
**Increasing commodity and carbon prices, and growing demand in the long term, are driving up prices despite growth in renewables and increased energy efficiency in our Central scenario**




**But will my assets be able to capture these prices?**

**Where and when are the investment opportunities arising?**

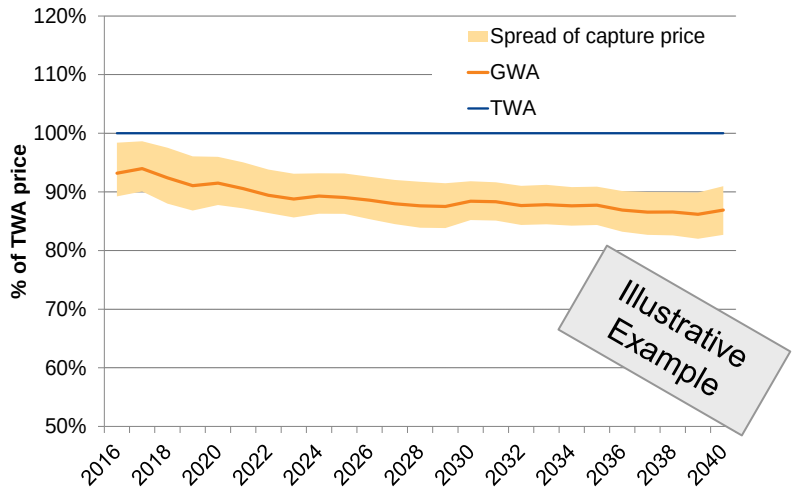
# CAPTURE PRICES DETERMINED THROUGH THE COMPLEX INTERACTION OF A NUMBER OF FACTORS



# GENERATION-WEIGHTED AVERAGE (GWA) POWER PRICE

## The increase of intermittent generation share has an impact on the revenues of renewable generators, as shown herewith in the chart

### GWA-price (wind) compared to the power price




- Initially, the wind price captures the annual baseload wholesale electricity price
- Once more wind farms come onto the system, then this reduces the power price in hours the renewables are generating
- This leads to a lower power price wind farms are able to capture (as can be seen above)

### Cannibalisation effect of intermittent generation

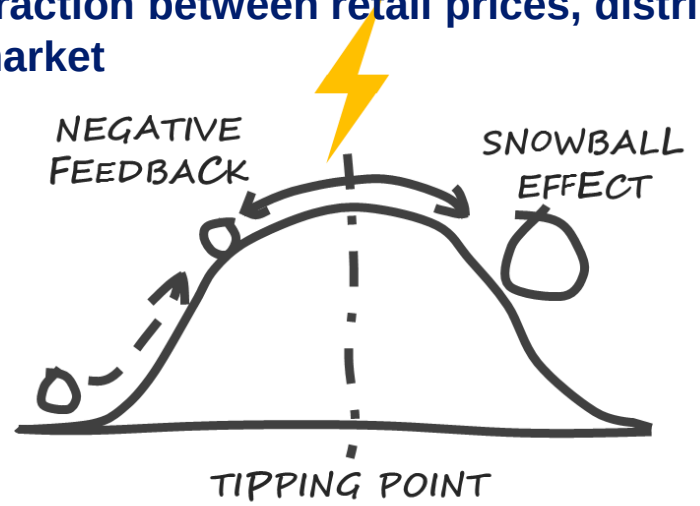
- Little control when wind plants generate
- They tend to produce electricity when the wind share in the total generation mix is higher
- In case of substantial amounts of wind production this can result to lower prices, i.e. there is an inverse relationship between wind output and prices – known as cannibalisation effect

### Plant specific analysis

- The location and hourly generation profile significantly affects the captured revenues
- In case the asset is situated in a region with a significant proportion of wind capacity, it may generate electricity, when the cannibalisation effect is at its highest
- This leads to a generation weighted average price, which is below the baseload power price

# A NEW PÖYRY MULTI-CLIENT STUDY: TIPPING POINTS

## Investigating the interaction between retail prices, distributed generation and the future of the power market




## Key questions

| | |
|---|---|
| • How far can future technology costs fall?<br>• Which technologies dominate where? | • How will distribution and transmission recover costs? |
| • Will decentralised solar deployment accelerate uncontrollably? | • Will EV deployment accelerate? Will cheap batteries cascade into power markets? |
| • Will solar and batteries become dominant?<br>• Will cheap wind allow $CO_2$ targets to be met? | • Will retail tariffs have to change? And how quickly? |
| • What does a utility look like in this transformed market? | • What areas might deliver profitable growth?<br>• What are the consequences for players? |

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