AURORA ENERGY RESEARCH

Net Zero = Zero Value Power?

Manuel Köhler, Managing Director Germany

Markets across Europe will move towards Net Zero…

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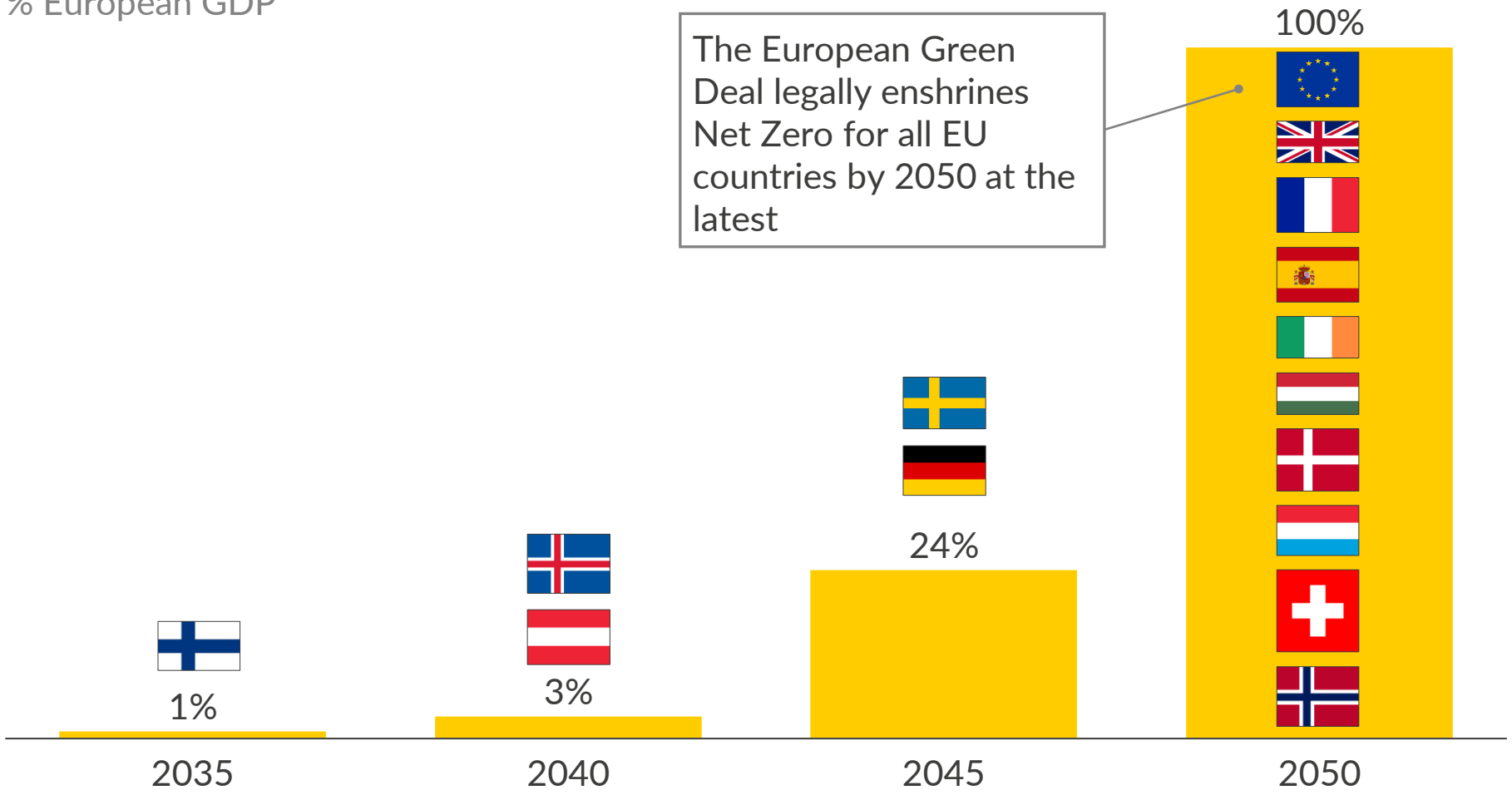
Policy commitments to reach Net Zero[1]

% European GDP



Private sector commitments

> € 124 bn

New low-carbon investments by European companies in 2019

> €40 tn

Assets of banks committed to aligning their portfolios with Net Zero by 2050

1) Includes all EU countries as well as Switzerland, Norway, UK, and Iceland

Sources: Aurora Energy Research, OECD, ECB, ECIU, CDP, UN

Reaching Net Zero requires 1.7 trillion EUR of investments in wind and solar

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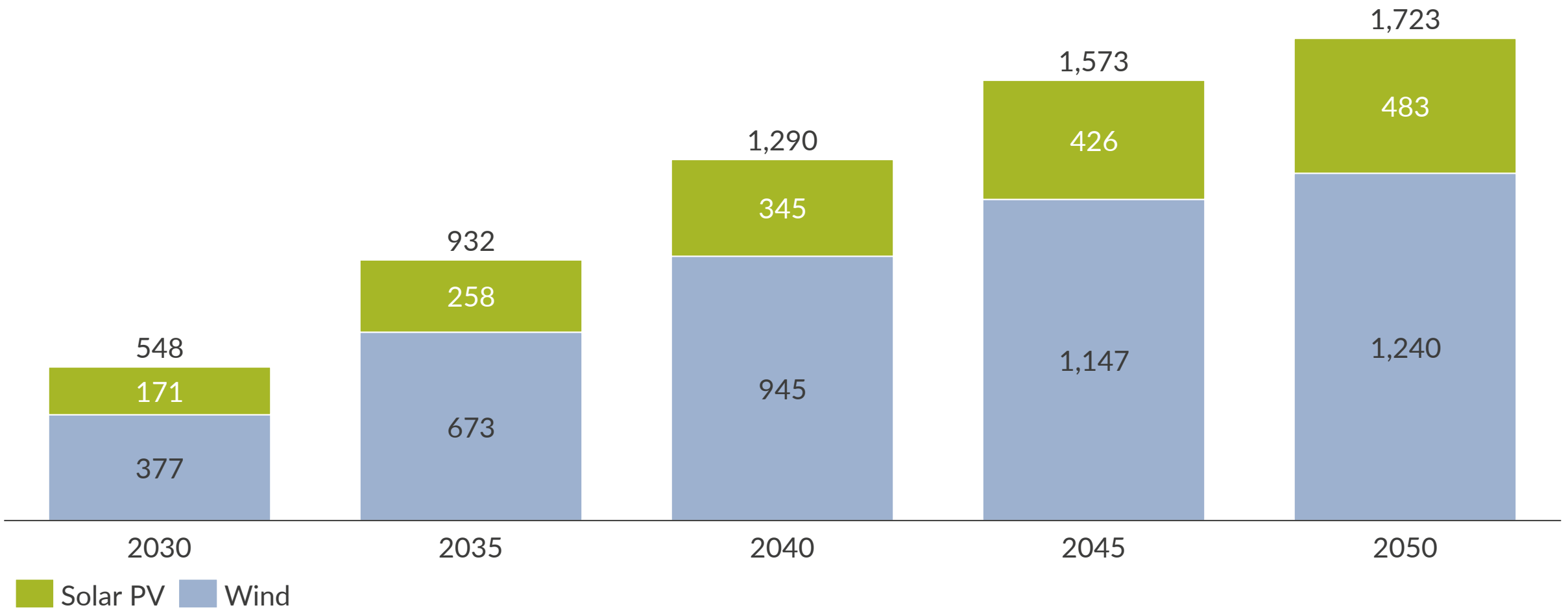
Investments in renewables, Europe, cumulative[1]

EUR bn (real 2020)



1) Includes EU, UK, Norway, Switzerland, Iceland, Balkans, Ukraine, Turkey

Source: Aurora Energy Research

More than 45% of the investments by 2030 will have merchant exposure

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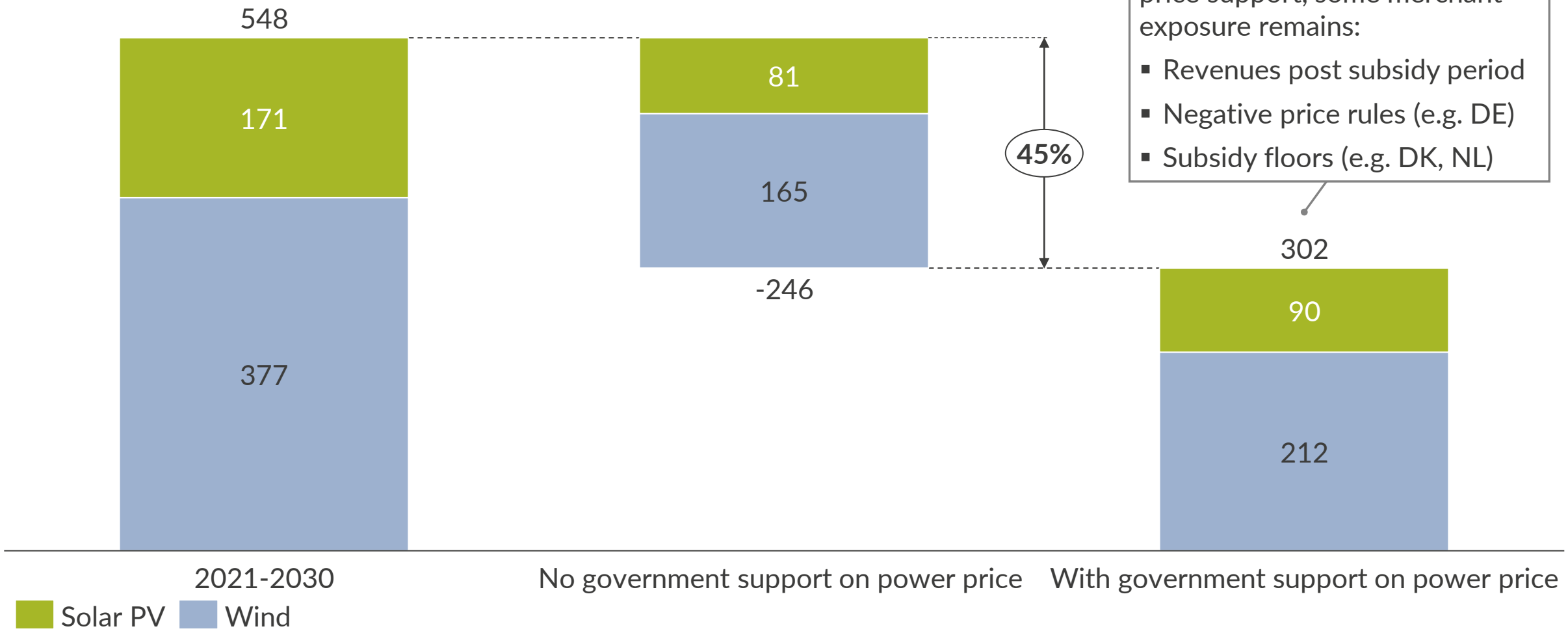
Investments in renewables, cumulative[1]
EUR bn (real 2020)



Even with government backed price support, some merchant exposure remains:

- Revenues post subsidy period
- Negative price rules (e.g. DE)
- Subsidy floors (e.g. DK, NL)

1) Includes EU, UK, Norway, Switzerland, Iceland, Balkans, Ukraine, Turkey

Source: Aurora Energy Research

Does push for Net Zero mean power prices will collapse?

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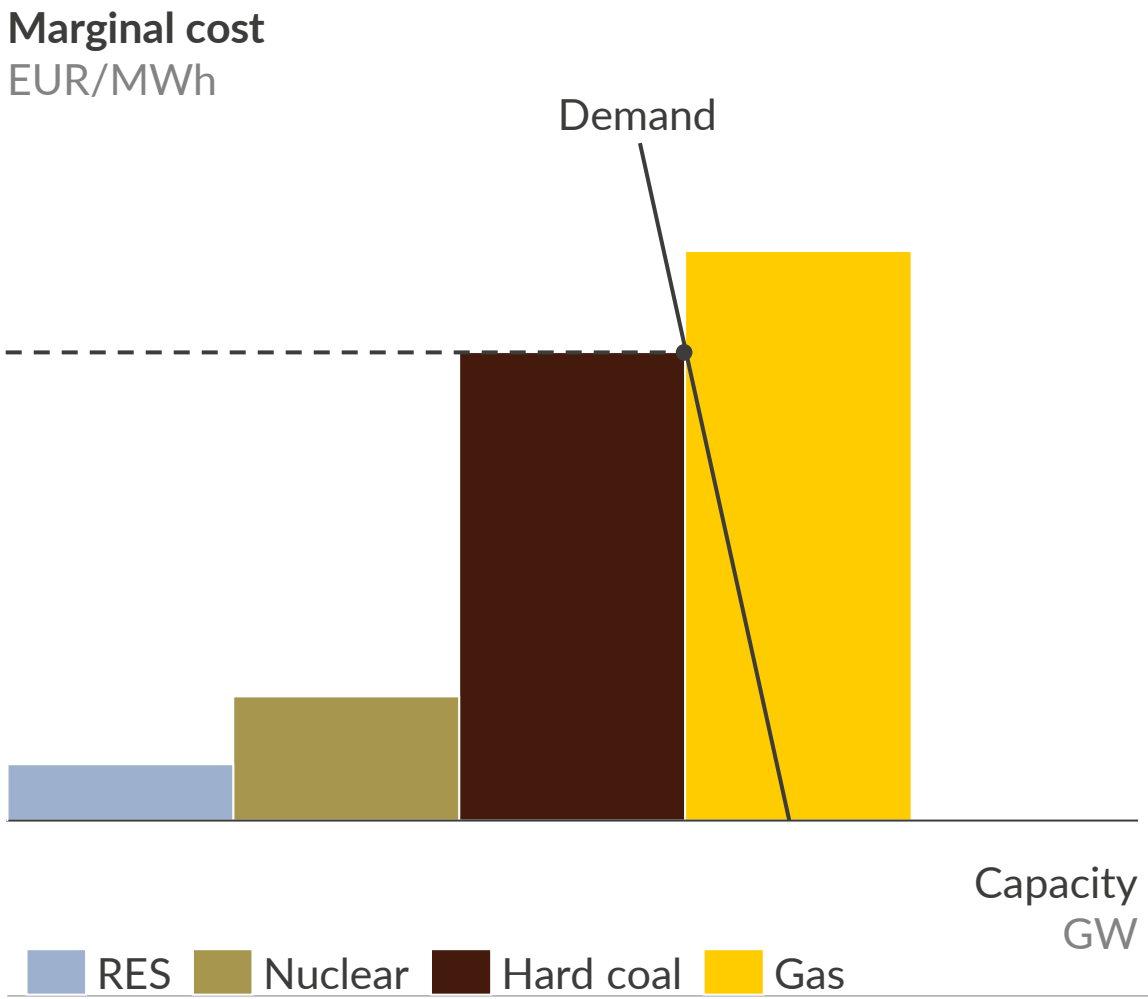
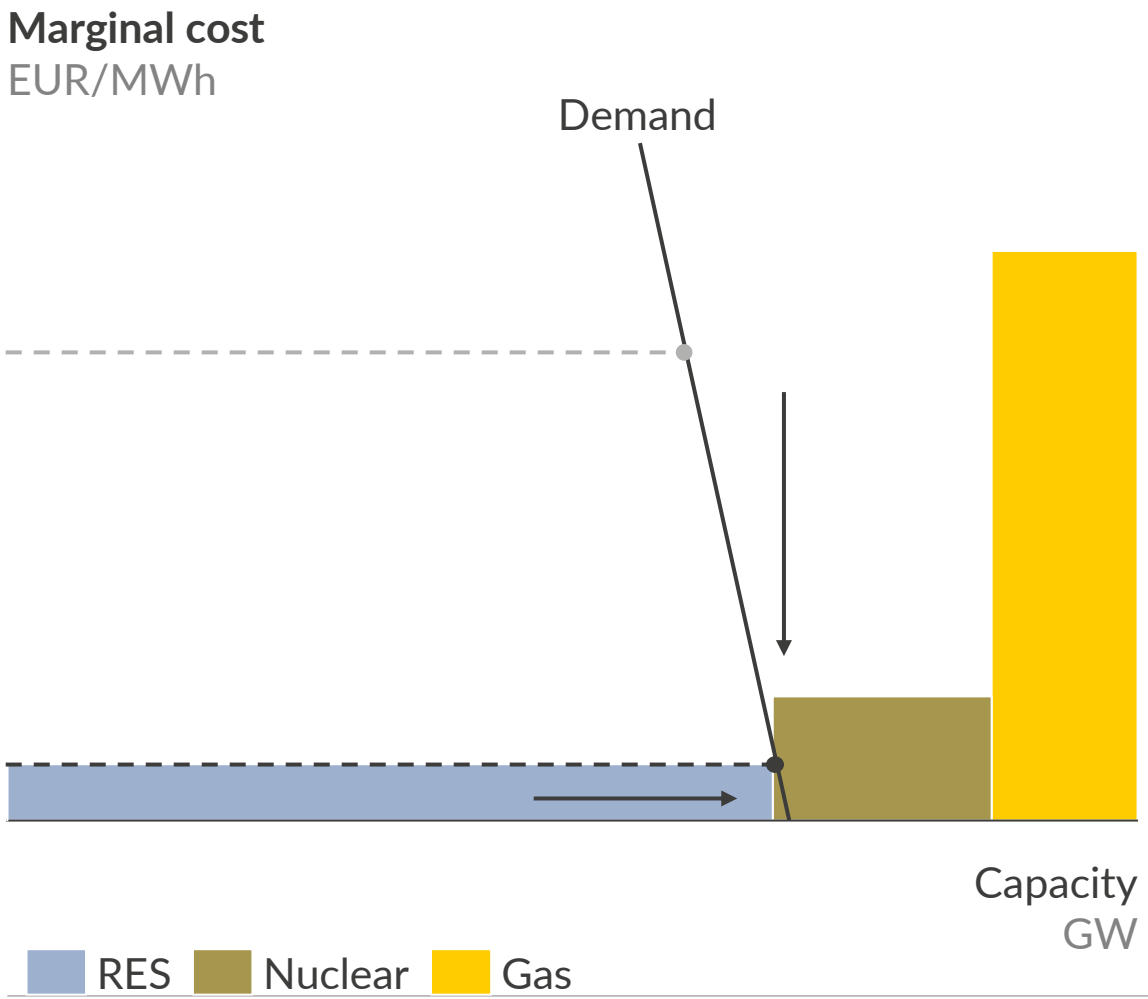
Merit order effect



Source: Aurora Energy Research

Does push for Net Zero mean power prices will collapse?

Merit order effect



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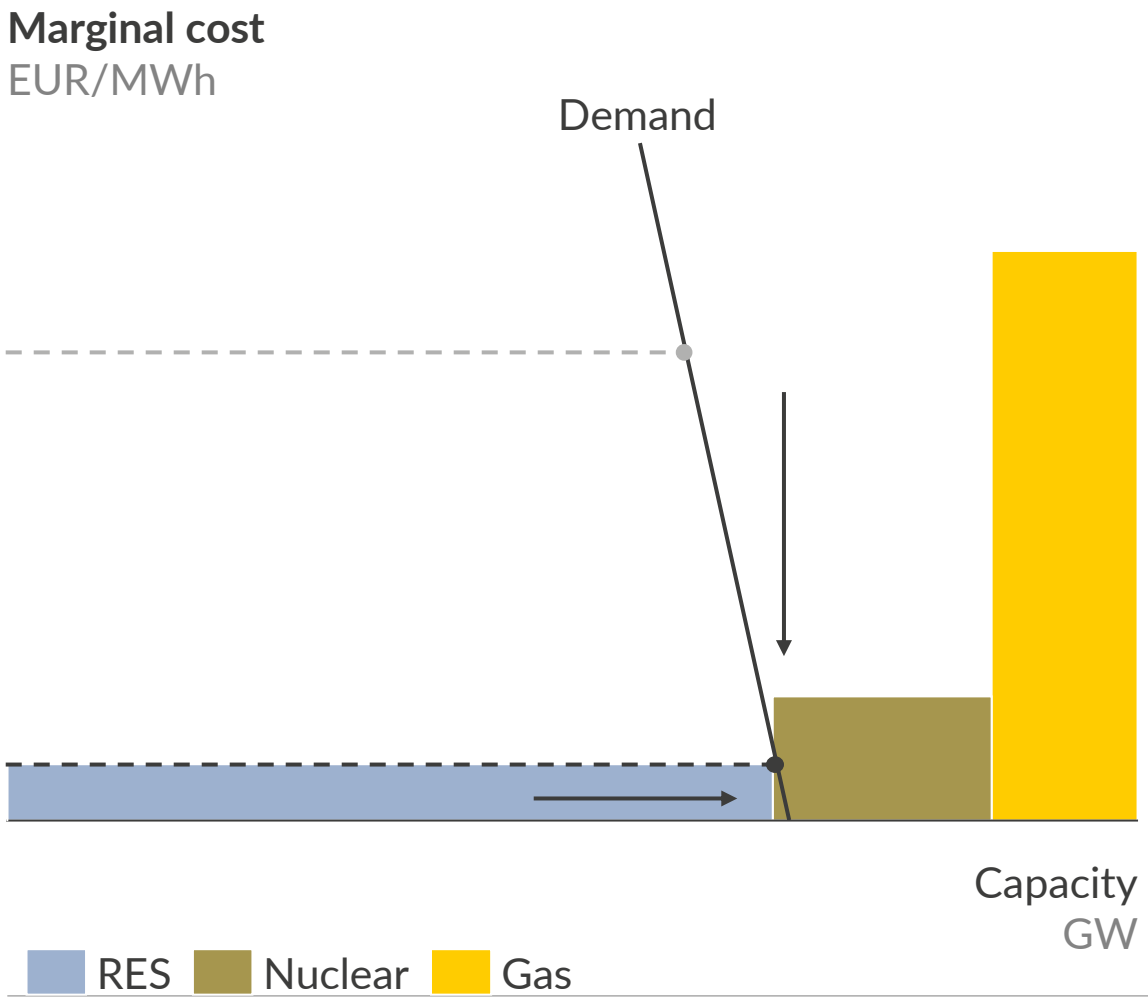
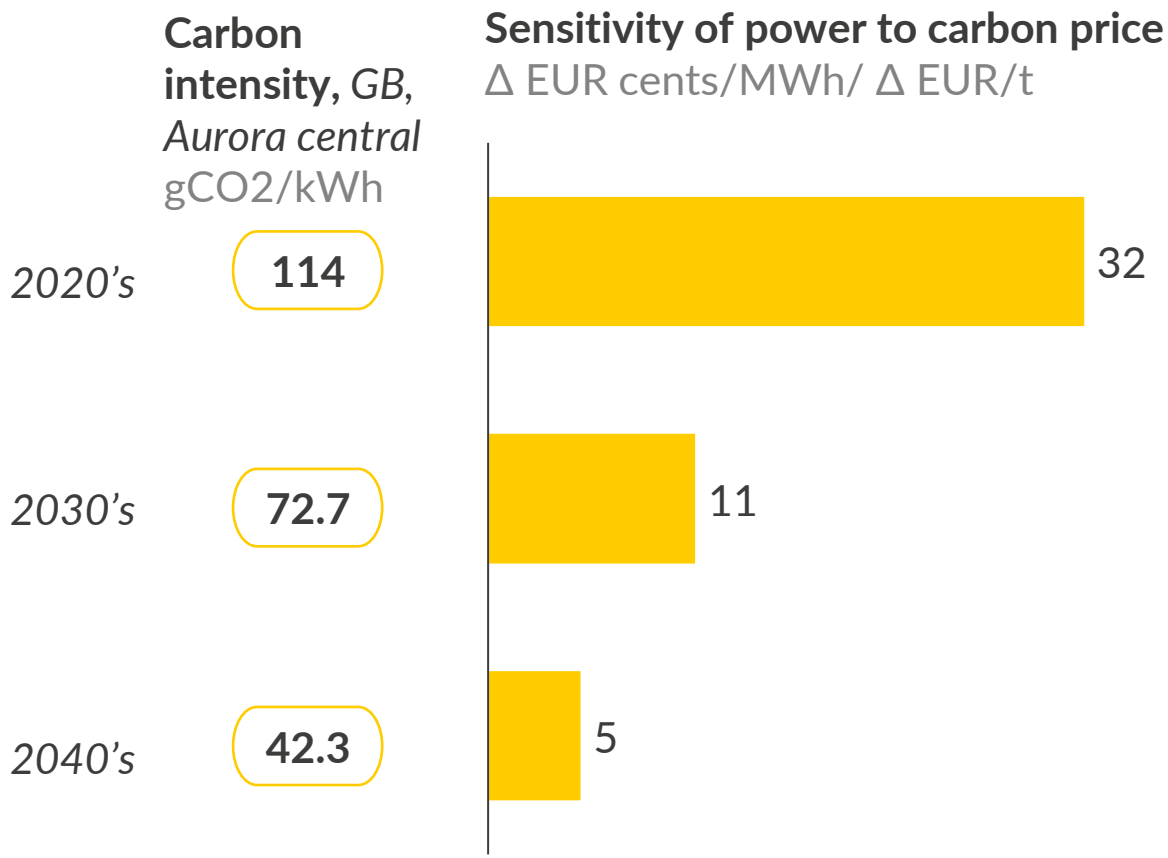
Does push for Net Zero mean power prices will collapse?

Merit order effect



Carbon price loses significance



Source: Aurora Energy Research

Also, a Net Zero power market requires firm capacity…

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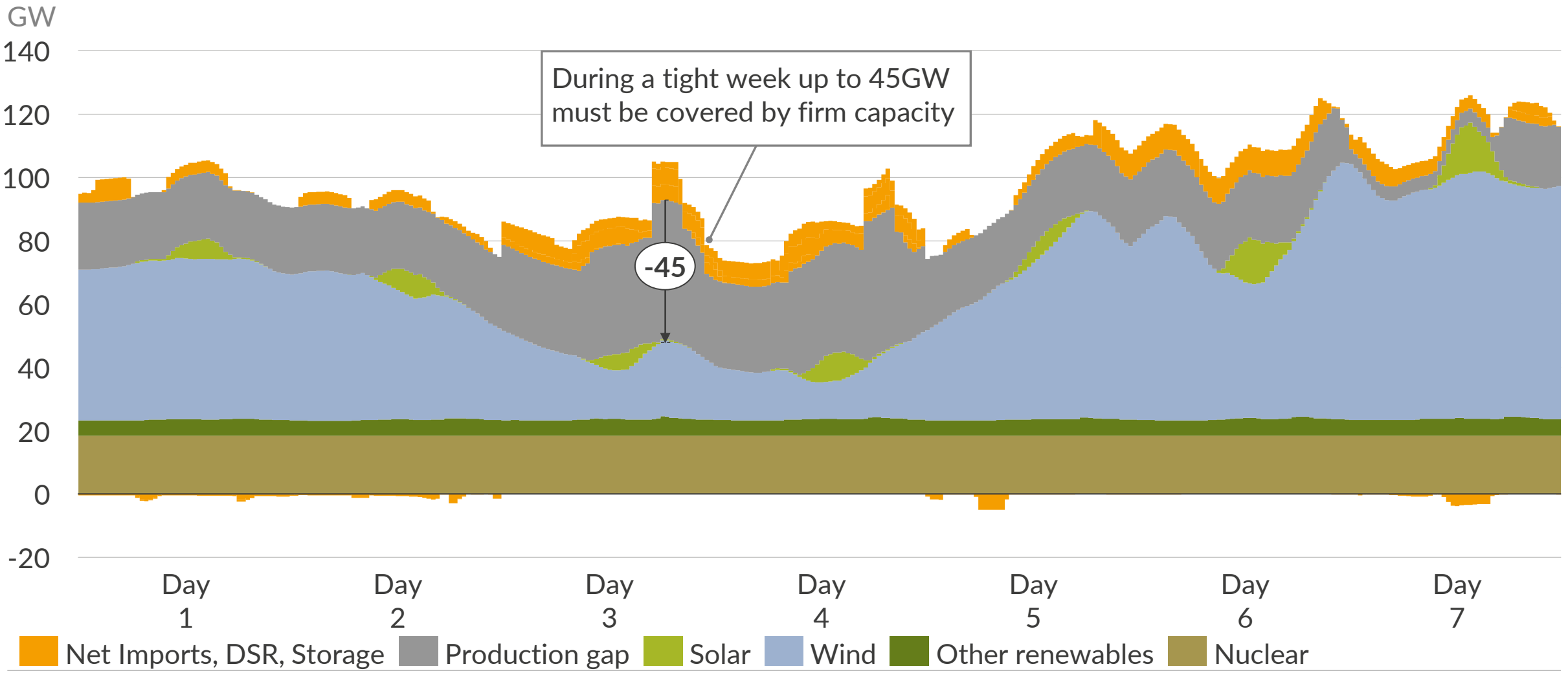
Half-hourly generation over a tight week in winter in 2050, GB Net Zero example



Source: Aurora Energy Research

…and low carbon dispatchable thermal is by far the most economic solution

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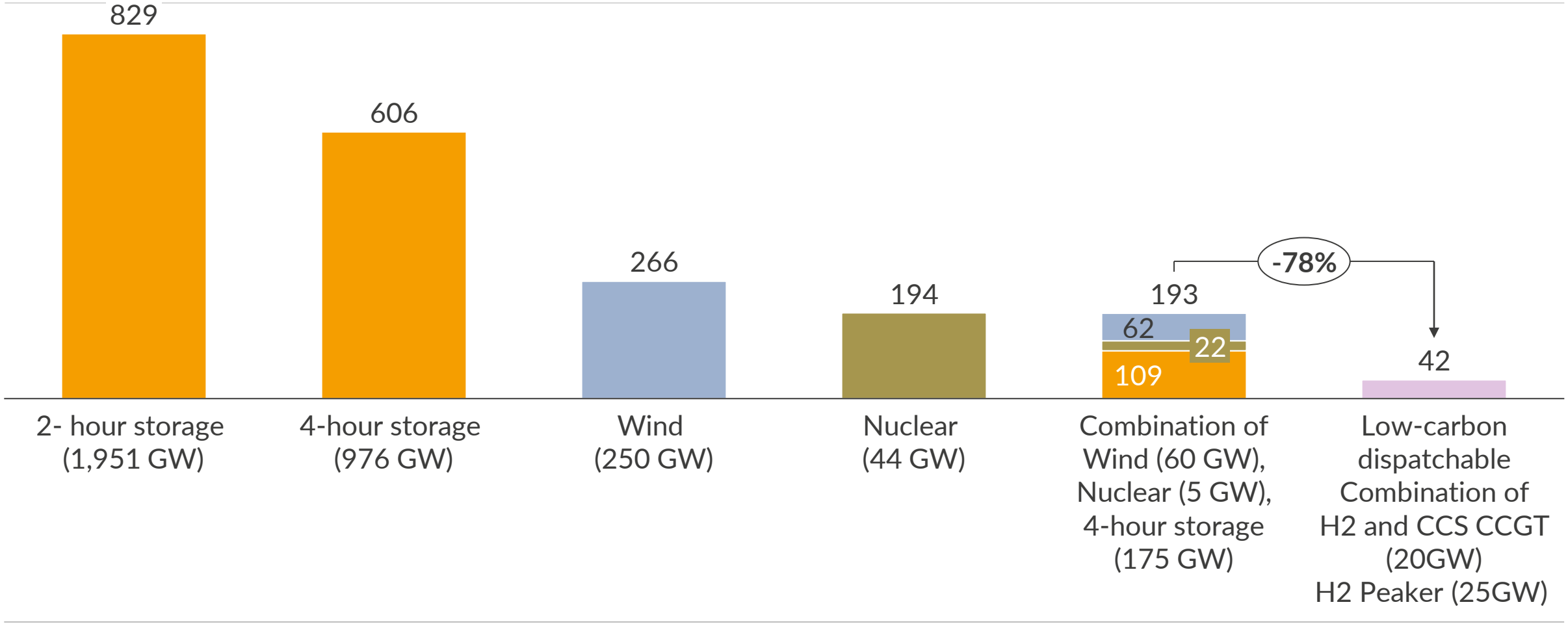
Plant CAPEX required to fill production gap in 2050, GB Net Zero example

EUR bn (real 2020)



Source: Aurora Energy Research

The last tonnes of carbon are costly to abate, raising questions on fully decarbonising power

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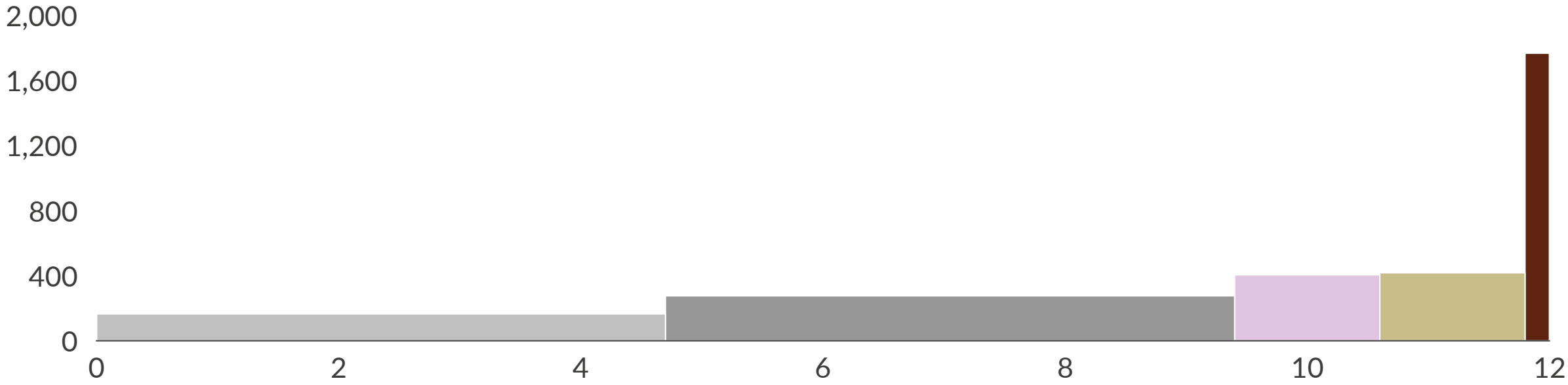
Cost of abating remaining emissions in power, GB example 2035[1,2]

EUR/tCO2



	a	b	c	d	e
Technology	▪ New build CCS	▪ Retrofit CCS	▪ H_2 CCGT	▪ H_2 peaker	▪ H_2 peaker
Capacity required	▪ 5GW	▪ 8 GW	▪ 5 GW	▪ 8 GW	▪ 10 GW
Load factor	▪ 28-40%	▪ 11-28%	▪ 6-11%	▪ 1-5%	▪ <1%

1) New build CCS assumed to have 30-year lifetime, retrofit CCS 20-year lifetime, H2 CCGT 30-year lifetime and H2 peaker 25-year lifetime. 2) Cost of abated emissions calculated by dividing the total abated emissions over the lifetime (from 2035 onwards) with difference in LCOE to the alternative technology (excluding carbon costs), for example moving from new build CCGT to new build CCS

Source: Aurora Energy Research

What the most economic dispatchable solution is depends on load factor…

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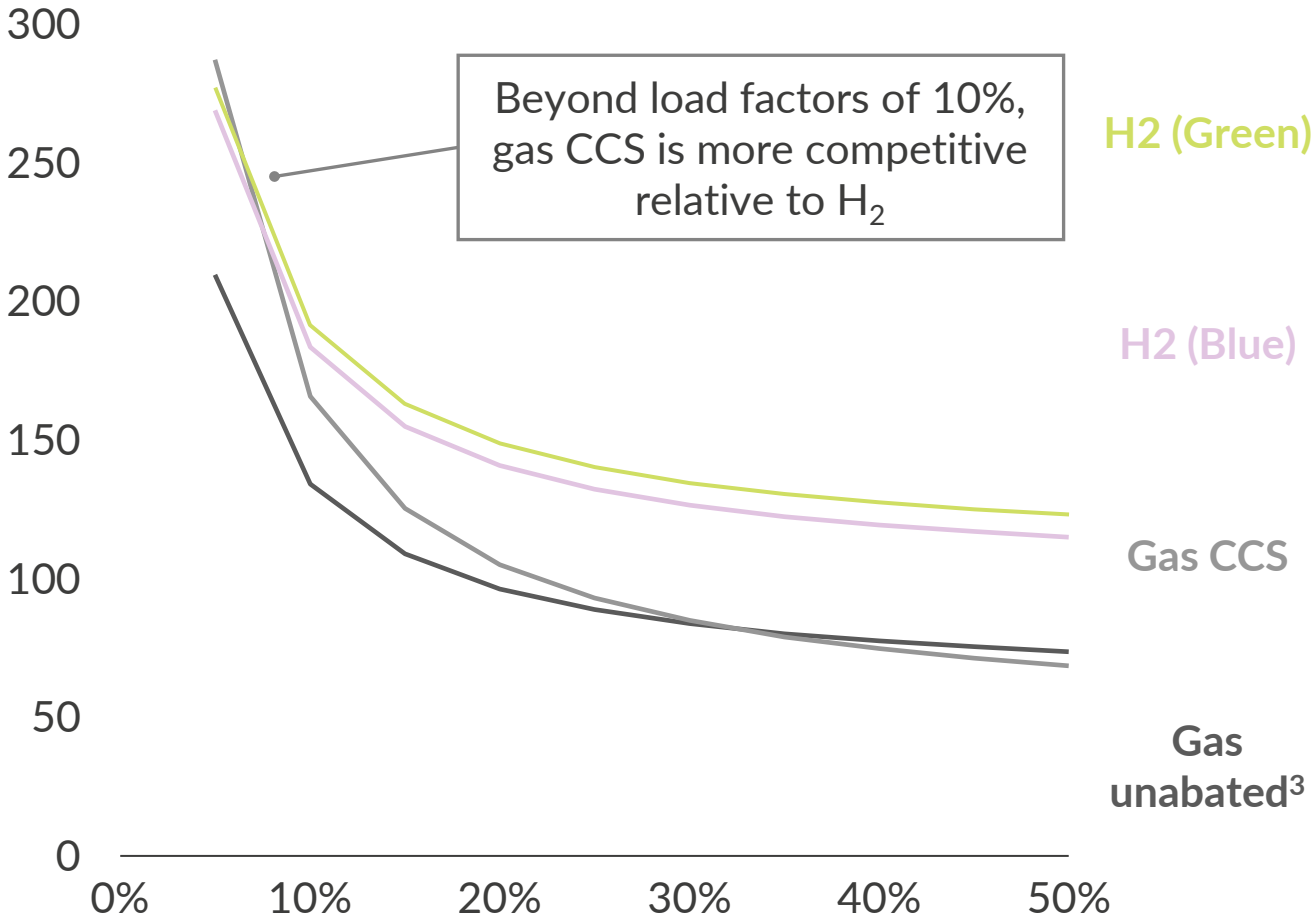
LCOE (Entry in 2050)[1,2]

EUR/MWh, (real 2020)



1) Assuming lifetime of 30 years for new build CCGTs and CCS, 20 years for CCS retrofit and 25 years for peakers. 2) Analysis done without assuming any policy support and including carbon prices. 3) Assumes carbon price of 83.2 in 2050

Source: Aurora Energy Research

… but all come with significant marginal cost

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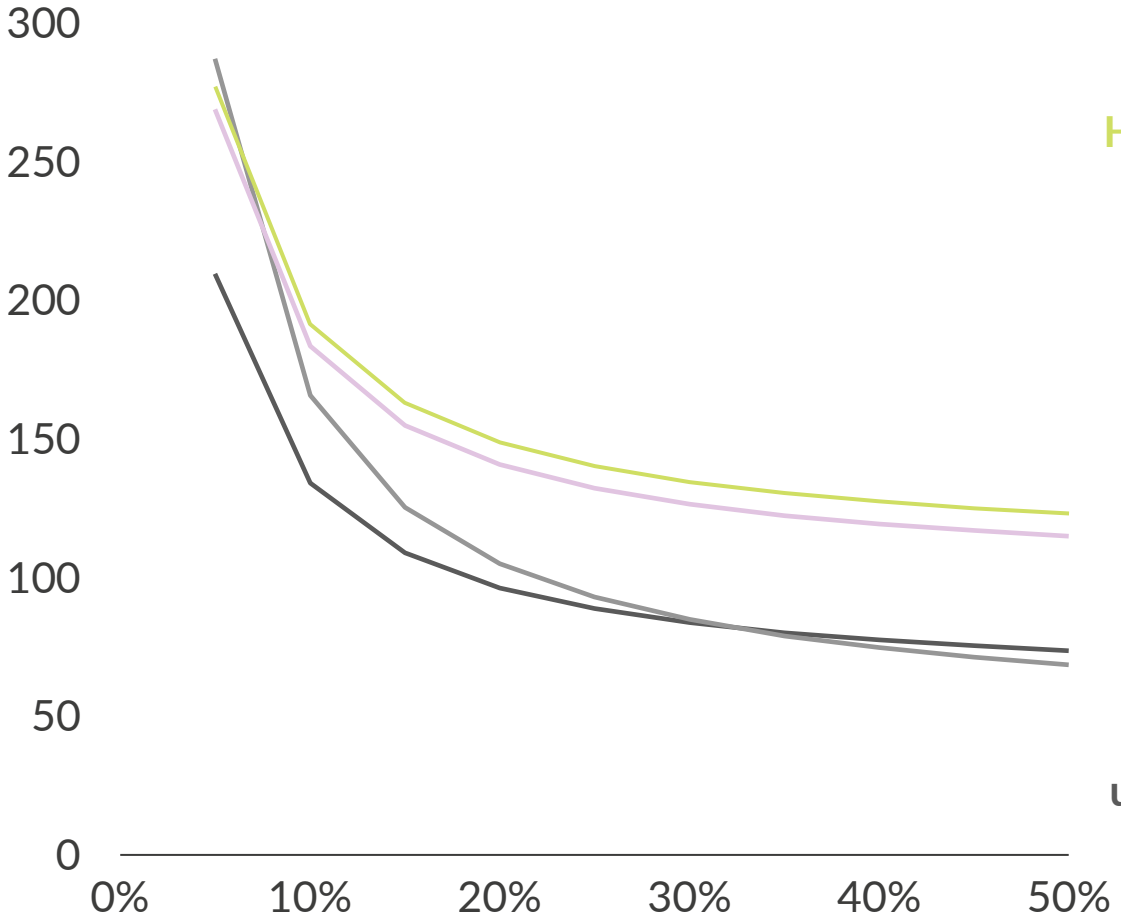
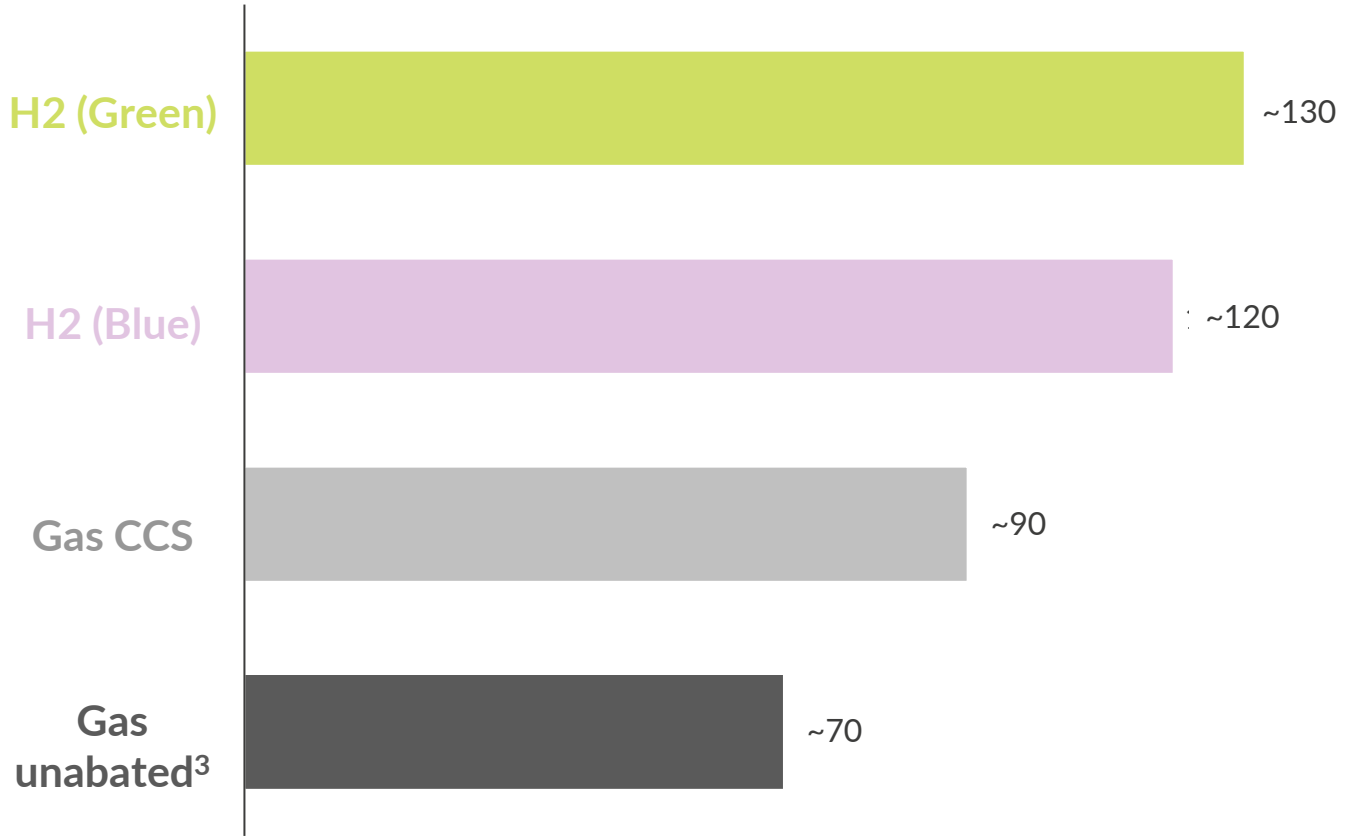
LCOE (Entry in 2050)[1,2]

EUR/MWh, (real 2020)



Short run marginal cost (2050)[4]

EUR/MWh, (real 2020)



1) Assuming lifetime of 30 years for new build CCGTs and CCS, 20 years for CCS retrofit and 25 years for peakers. 2) Analysis done without assuming any policy support and including carbon prices. 3) Assumes carbon price of 141 EUR in 2050 4) Uses LCOH of blue and green hydrogen in GB as proxy for fuel costs. Green hydrogen LCOH assumed to be collocated with onshore wind.

Source: Aurora Energy Research

...and even with a 10% generation share, will set the price more than half of the time

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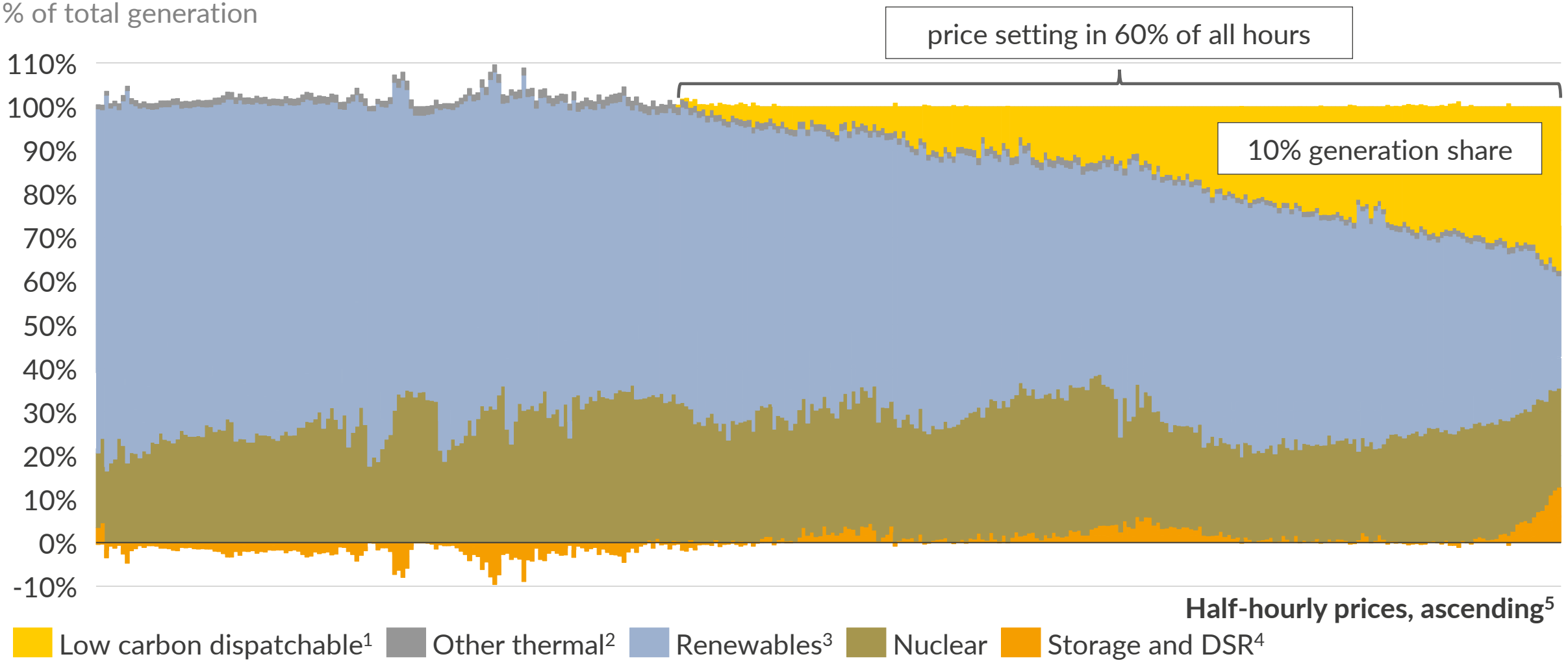
Generation 2050 in GB

% of total generation



1) Includes CCGT and peakers 2) Mainly CHP 3) Includes wind, solar and other renewables 4) Includes batteries and pump storage 5) Grouped into periods of 25 hours

Source: Aurora Energy Research

As a result, we don't expect prices to collapse, not even in a net zero market

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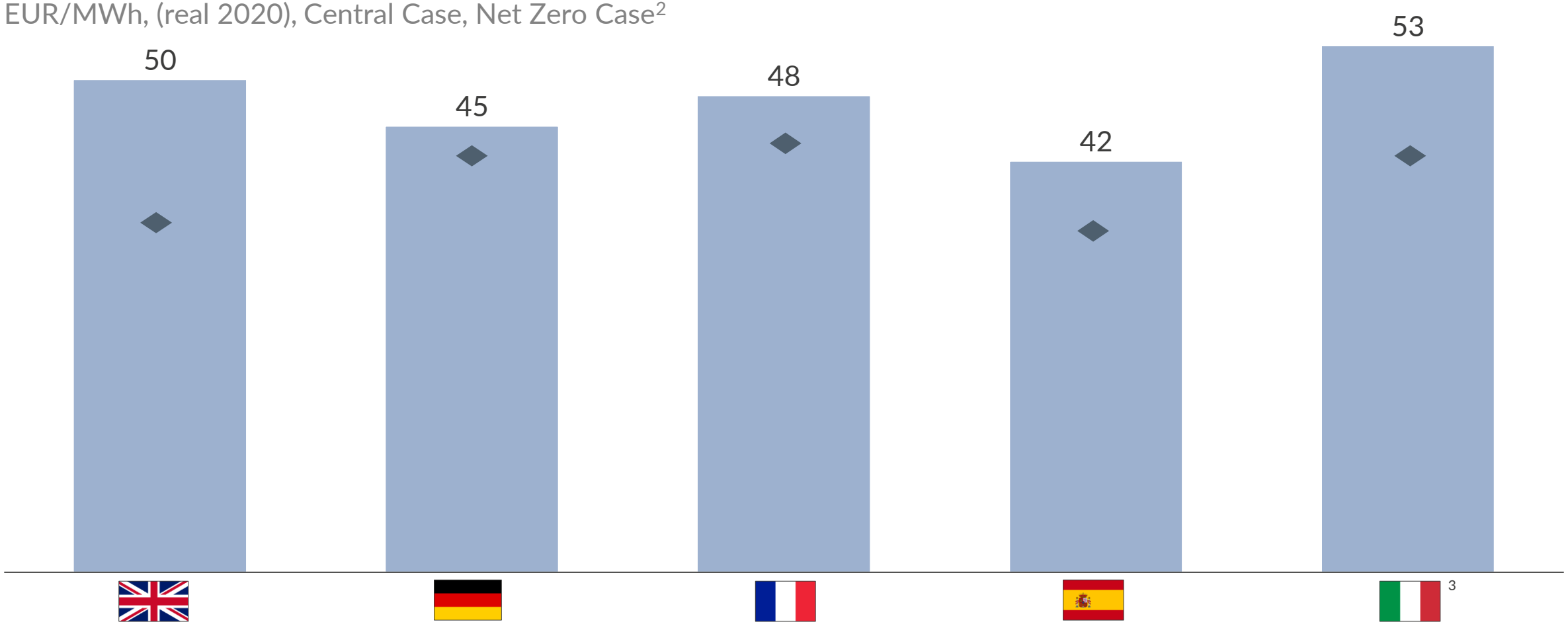
Onshore wind capture prices 2050[1]

EUR/MWh, (real 2020), Central Case, Net Zero Case[2]



1) Generation-weighted average price, uncurtailed as of April 2021 2) Central Case – in bright blue bars - reflects ambitious decarbonisation, Net Zero Case - in dark blue diamonds - a complete decarbonisation of power sector. 3) Refers to South price zone

Source: Aurora Energy Research

What could go wrong where? Applying a simple framework suggests…

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Risk		Indicator to watch	Exemplary market to watch
Renew-ables	▪ Over-procurement	▪ Planned tendered capacity[1]	 (Offshore)
	▪ Pork cycles	▪ Project pipeline[1]	 (Solar)
	▪ Rapid cost decline	▪ CAPEX of new projects	▪ Solar
Other low-carbon	▪ Limited interconnection	▪ Existing and planned capacity[1]	
	▪ Over-supply of nuclear	▪ Support for new capacity/lifetime extensions[1]	
	▪ High hydro availability	▪ Existing capacities[1], potential for new capacity[1]	 (NO 3, NO4)
	▪ New low marginal cost dispatchable tech's	▪ Economics of technologies exiting R&D phase ▪ Availability of support to achieve economics of scale	
Policy	▪ Regulated dispatch	▪ Policy proposals in discussion	 (DPA[2])
	▪ Grid/locational pricing	▪ Grid cost components not (yet) borne by renewables ▪ Policy proposals in discussion	

1. *In relation to Net Zero Power Demand in respective market 2 Dispatchable power agreement*

Source: Aurora Energy Research

Italy, Iberia and Finland are medium risk markets while Germany, UK, Netherlands and Denmark are more resilient

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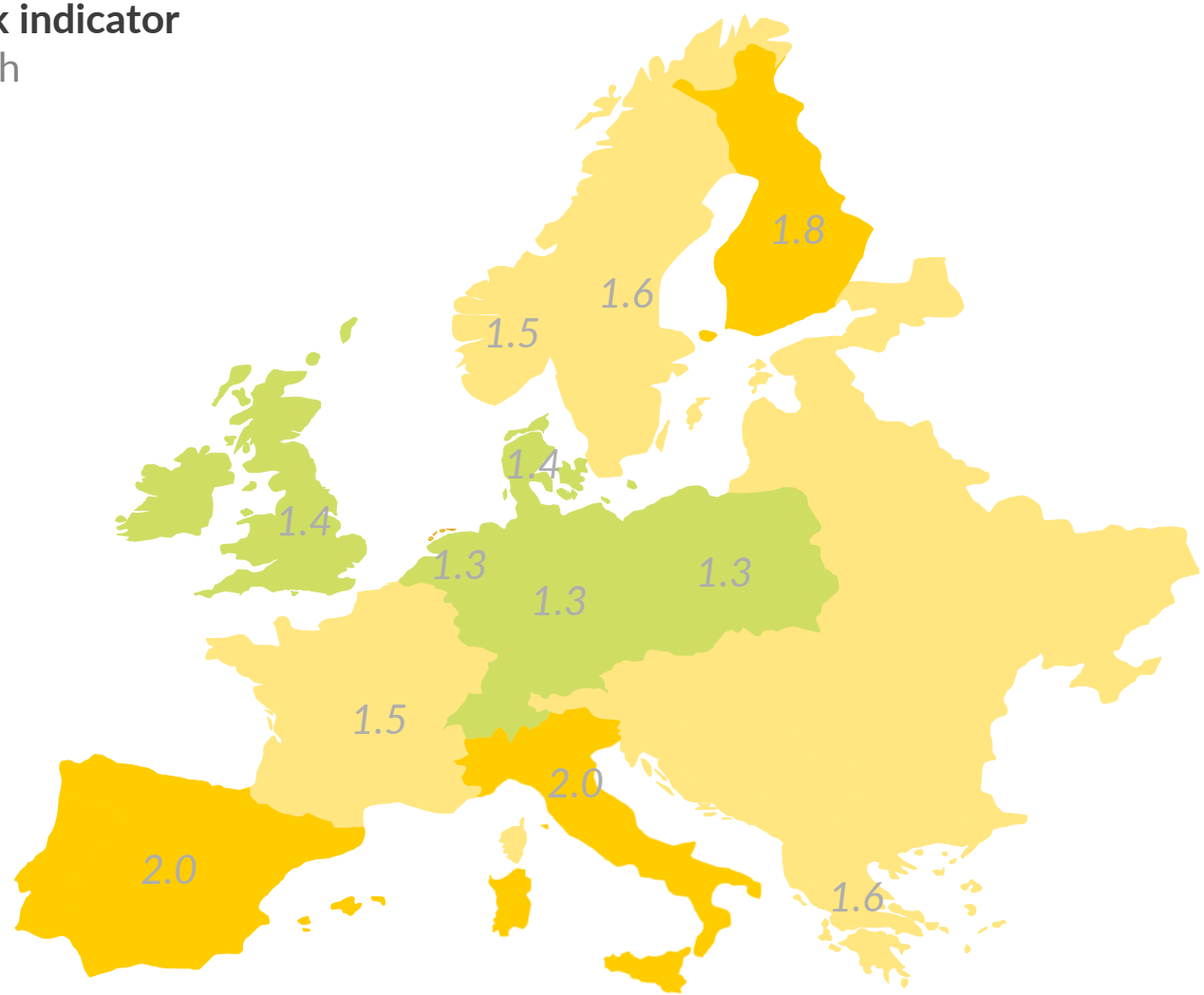
Weighted risk indicator
1=low, 3= high



Comment

- Risk of solar overinvest
- Limited interconnection to France

- Risk of solar overinvest
- Limited connection between price zones

- Risk of wind overinvest
- Relatively high availability of hydro

- Heavily interconnected
- Limited alternatives for low carbon dispatchable

Source: Aurora Energy Research

Any further questions?

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