

## Aurora Keynote:

# The European energy crisis: what are the learnings & outlook?



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## Spring Forum

Oxford 2023

In partnership with:



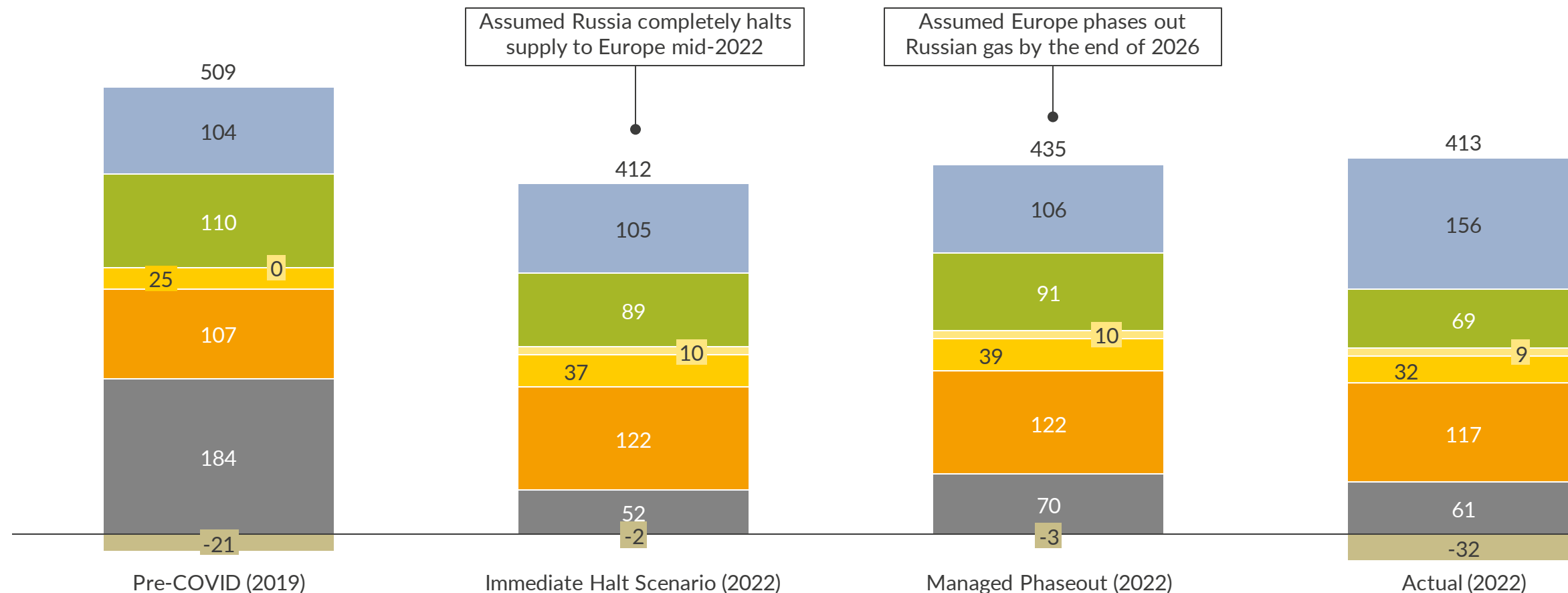
Engineer - Install - Maintain



- I. The European energy crisis: reflections on the past year
- II. Policy responses and learnings
- III. Gas and power markets outlook

# Ramp down in Russian gas supplies was offset by rapid increase in LNG (partly to fill storage) whilst domestic supplies dwindled

European gas supply mix  
bcm



■ Russia ■ Norway ■ North Africa ■ Azerbaijan ■ Domestic production ■ LNG ■ Storage

# Demand reduction has been hugely important to balance the market; but much of this has been temporary not permanent

	Driving factor	Actual change in gas demand 2021 – 2022 (bcm)	Permanence?	Comparison to initial Aurora expectation	
Power sector	Increased RES deployment	-11	Permanent	↑	Better than expected
	Gas to coal switching	-6	Temporary	✓	As expected
	Lower electricity demand	-15	Mixed	?	Unforeseeable
	Reduced nuclear generation	22	Temporary	↓	Worse than expected
	Reduced hydro generation	12	Temporary	?	Unforeseeable
Residential	Behaviour change and fuel switching	-7	Mixed	✓	As expected
	Efficiency gains including heat pumps	-3	Permanent	↑	Better than expected
	Milder winter weather	-18	Temporary	?	Unforeseeable
Industry	Industry consumption reduction	-13	Mixed	✓	As expected
	Gas to oil switching	-7	Temporary	↑	Better than expected
	Efficiency gains and avoided demand	-5	Permanent	↑	Better than expected

# Agenda

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## Over the past year, many market interventions and policy reforms were introduced at EU and national levels to manage the crisis



### Market design changes

Deep dive



Temporary price cap on gas generators



Greece: proposed two-tier wholesale market split



UK's Review of Energy Market Arrangements (REMA) – zonal pricing, market split, etc.



### Managing cost to consumers



Netherlands: temporary inframarginal revenue cap of 130 €/MWh



UK's 'Cost-Plus-Revenue Limit'



Germany: €200 billion fund to subsidise consumer bills



### Accelerating decarbonisation



EU: REPowerEU targets >1000 GW of wind and solar by 2030



Hungary: mandatory 25% reduction on gas consumption

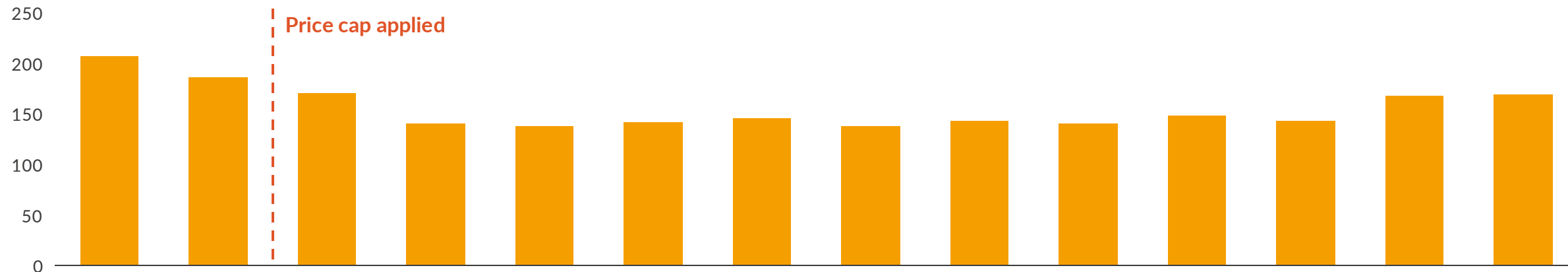


Bulgaria: Recovery and resilience plan (RRP) targets 3.5 GW of RES by 2026

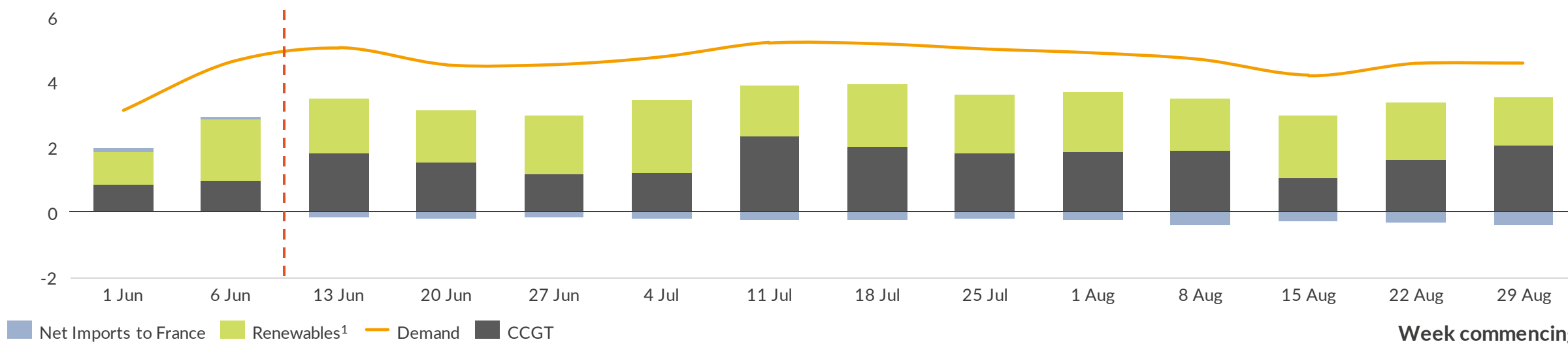
# Iberian gas price caps lowered wholesale prices in the short term, but resulted in higher gas generation and power exports



Spanish wholesale electricity price in 2022, €/MWh, 2022 



Spanish weekly demand and generation in 2022, TWh



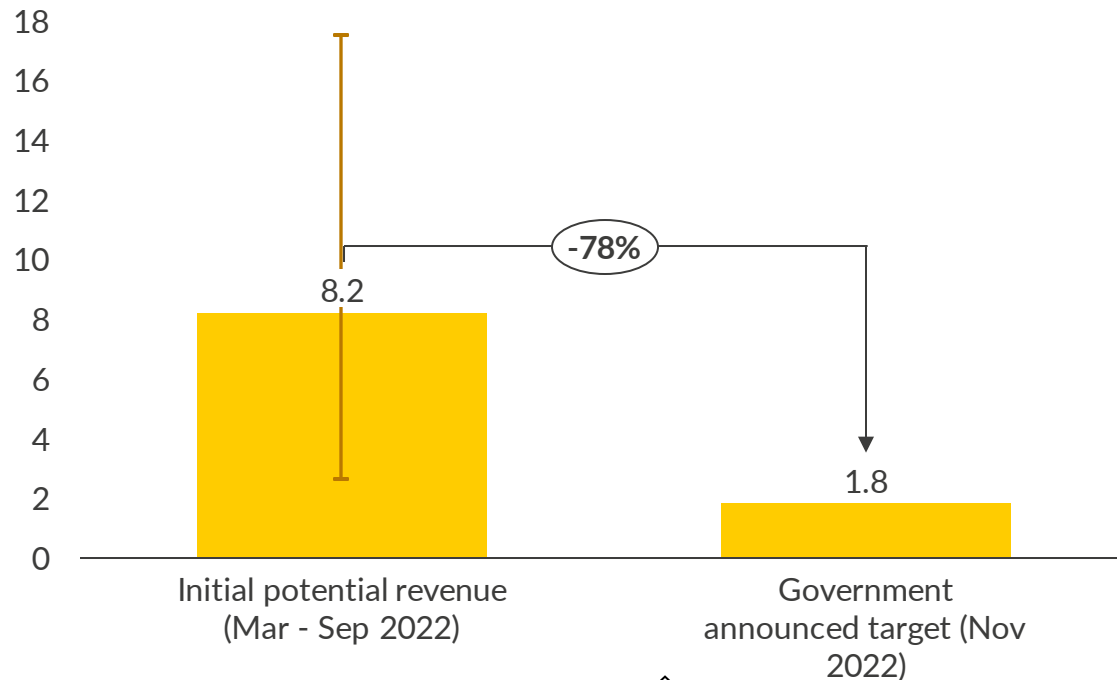
1) Renewables: Solar PV, solar thermal and onshore wind

# Implementation of low carbon revenue caps resulted in relatively little gain for a lot of pain



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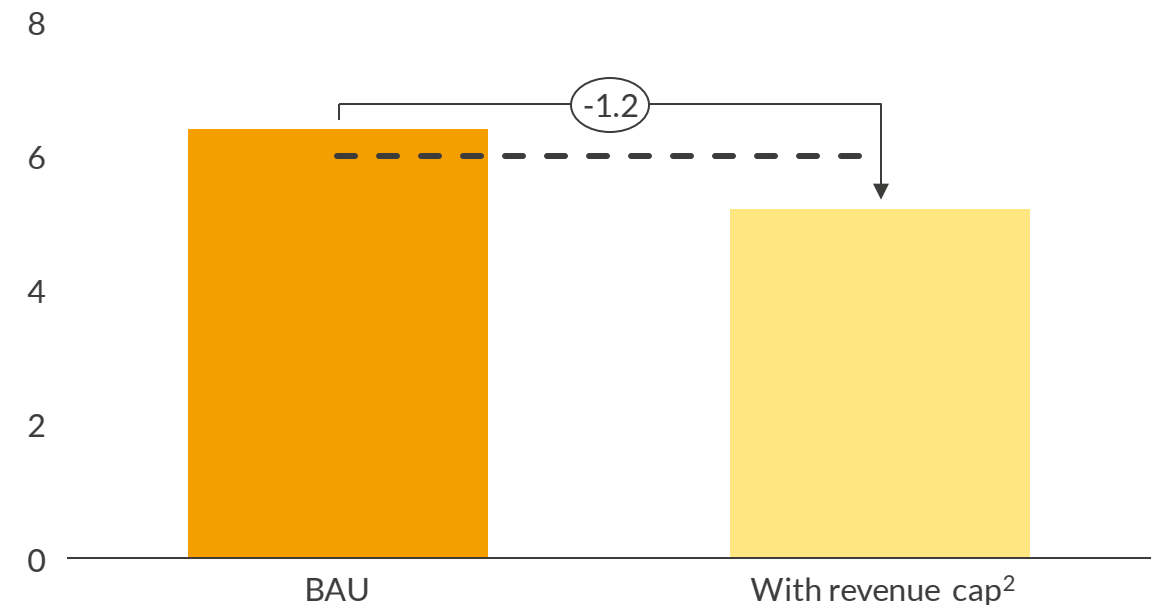
Expected revenue from Dutch revenue cap  
€bn



Estimated revenue benefit per household  
€/household, real 2022



Impact of revenue caps on project IRRs<sup>1</sup>  
%, shown for example merchant solar project in Netherlands (COD 2023)



— — Indicative Hurdle Rate

1) IRRs are for an unsubsidised project assuming COD at the start of 2023, asset lifetime of 30 years, and excludes Guarantees of Origins and imbalance costs 2) Revenues from assets larger than 1MW and earning revenues exceeding 130 €/MWh will be taxed at a 90% rate from 1 December 2022 to 1 July 2023



# Delivering the REPowerEU target could decrease power prices by 9% in the 2030s, but requires ~€800bn CAPEX investment



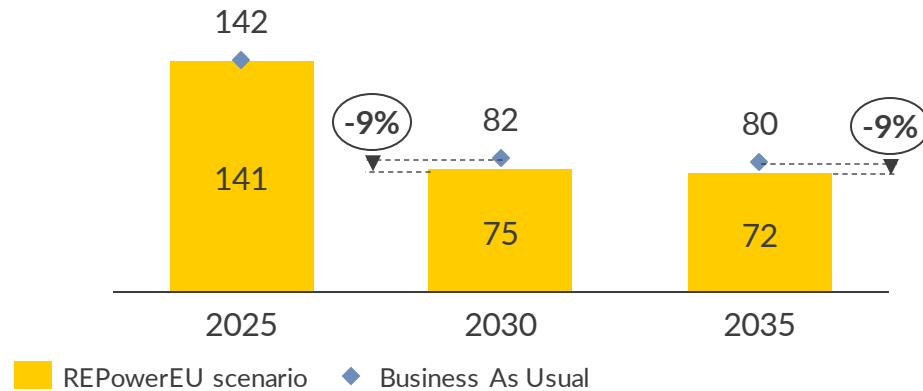
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1

Wholesale price, €/MWh (real 2022)



POWER PRICES



2

Average gas consumption for power (2025 – 2035), (TWh)



GAS CONSUMPTION

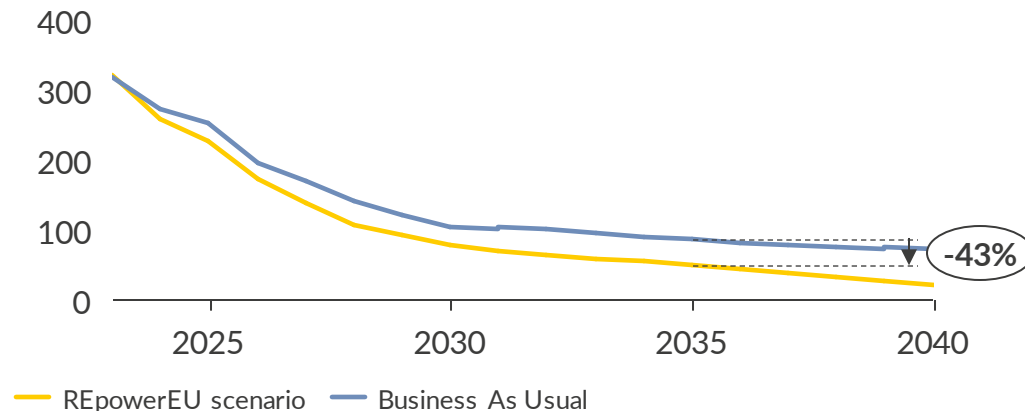


3

Total CO<sub>2</sub> emissions, M tonnes



CARBON EMISSIONS

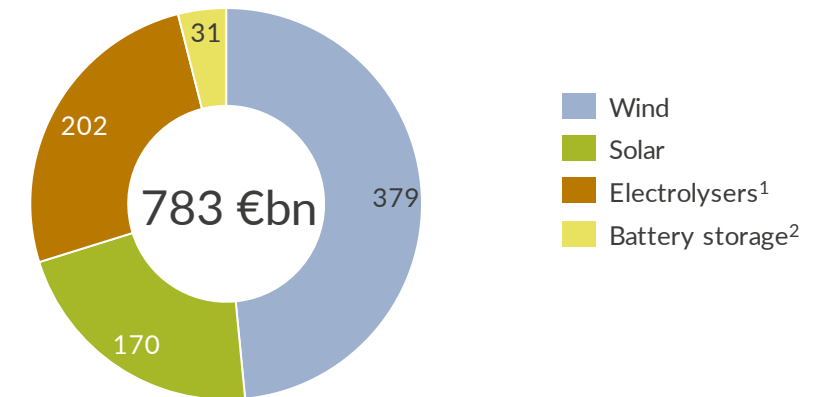


4

Total CAPEX investment 2023-2030, £bn (real 2022)















INVESTMENT COST



1) Depending on the load factor, REPowerEU target translates to 75-80 GW of electrolyzers by 2030. 2) Represents Aurora's estimate of 42 GW battery storage in Europe by 2030.

# Europe faces significant barriers to delivering REPowerEU ambitions; particularly in competition with US Inflation Reduction Act



	Position in Aurora's European rankings	Permitting	Grid	Supply Chain	Attracting Capital
<b>Solar PV</b> 	 Great Britain 	<ul style="list-style-type: none"> <li>▪ Difficult for large projects – major delays and refusal rate increasing</li> </ul>	<ul style="list-style-type: none"> <li>▪ Long queues for grids</li> <li>▪ Constrained connections</li> </ul>	<ul style="list-style-type: none"> <li>▪ High polysilicon costs</li> <li>▪ Import dependent; China dominates OEM market</li> </ul>	<ul style="list-style-type: none"> <li>▪ CfD is low risk, but admin strike prices do not reflect recent cost increases</li> </ul>
<b>Offshore wind</b> 	 Germany 	<ul style="list-style-type: none"> <li>▪ Long permitting timelines</li> <li>▪ Ongoing legislation to improve this</li> </ul>	<ul style="list-style-type: none"> <li>▪ Grid expansion facing permitting and construction delays</li> </ul>	<ul style="list-style-type: none"> <li>▪ Uncertainty over auction evaluation criteria relating to supply chain</li> <li>▪ Turbine OEMs pushing for higher margins</li> </ul>	<ul style="list-style-type: none"> <li>▪ Higher financing costs (Europe wide)</li> <li>▪ Added risk of negative bids</li> </ul>
<b>Grid scale Batteries</b> 	 Spain 	<ul style="list-style-type: none"> <li>▪ Inconsistent approaches across communities to permitting for hybrid projects</li> </ul>	<ul style="list-style-type: none"> <li>▪ Lack of common understanding around grid charging for battery storage</li> </ul>	<ul style="list-style-type: none"> <li>▪ Import dependent; China dominates OEM market</li> <li>▪ US reshoring supply chain through Inflation Reduction Act</li> </ul>	<ul style="list-style-type: none"> <li>▪ CAPEX subsidies are attracting significant interest, but lack of remunerated primary reserve is still a barrier</li> </ul>
<b>Hydrogen</b> 	 France 	<ul style="list-style-type: none"> <li>▪ Framework not yet defined</li> <li>▪ Not a huge issue whilst projects remain small-scale</li> </ul>	<ul style="list-style-type: none"> <li>▪ Rising grid congestion</li> </ul>	<ul style="list-style-type: none"> <li>▪ Supply chain will have to ramp up very fast to reach EU targets</li> </ul>	<ul style="list-style-type: none"> <li>▪ Slow to deliver incentives relative to US under Inflation Reduction Act</li> <li>▪ Complexity of green H2 standards</li> </ul>

# Agenda

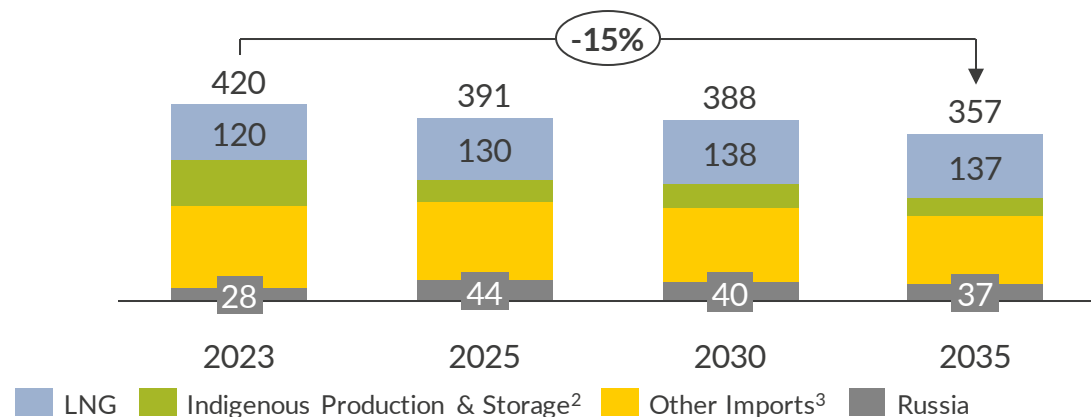
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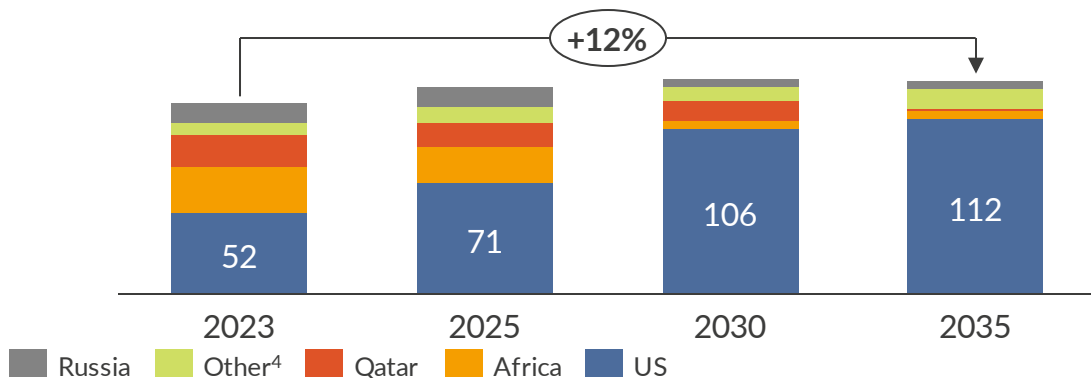
# Outlook for Russian gas is a major uncertainty for European gas markets; a complete halt further boosts need for LNG

## Aurora Central scenario – Assuming continued Russian gas imports

Forecast European annual gas balance - Central<sup>1</sup>, bcm

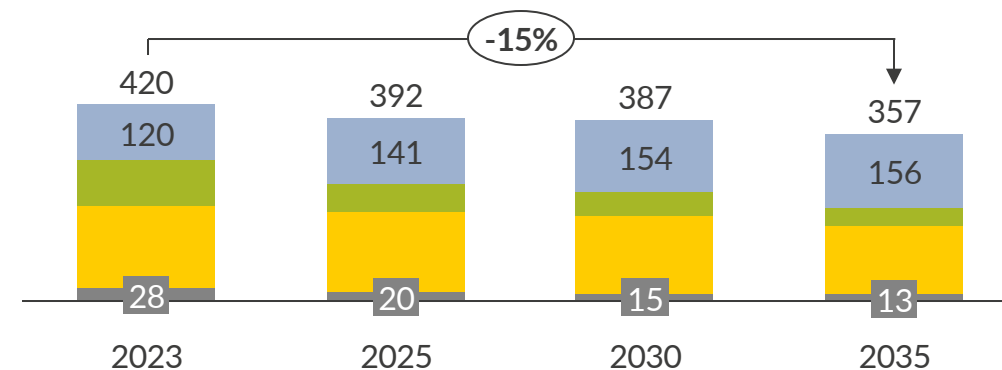


Forecast net European LNG imports by source<sup>1</sup>, bcm

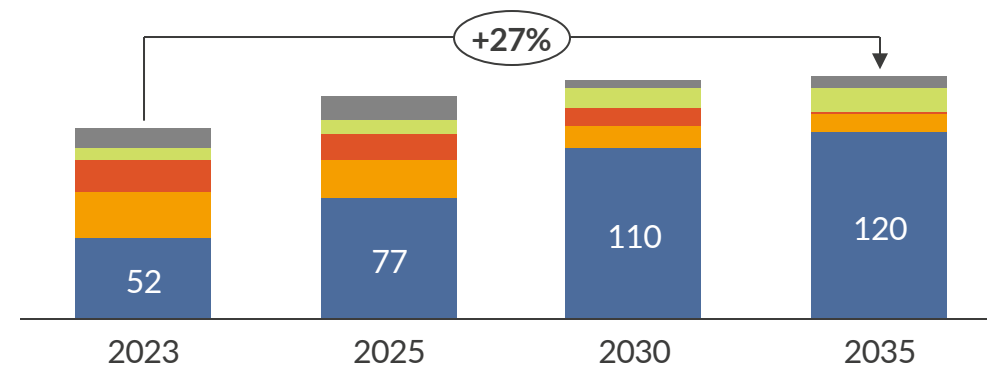


## Alternative scenario – Ukraine flows halt from 2025; only Russian gas remaining comes via Turk Stream

Forecast European annual gas balance - Alternative<sup>1</sup>, bcm



Forecast net European LNG imports by source<sup>1</sup>, bcm

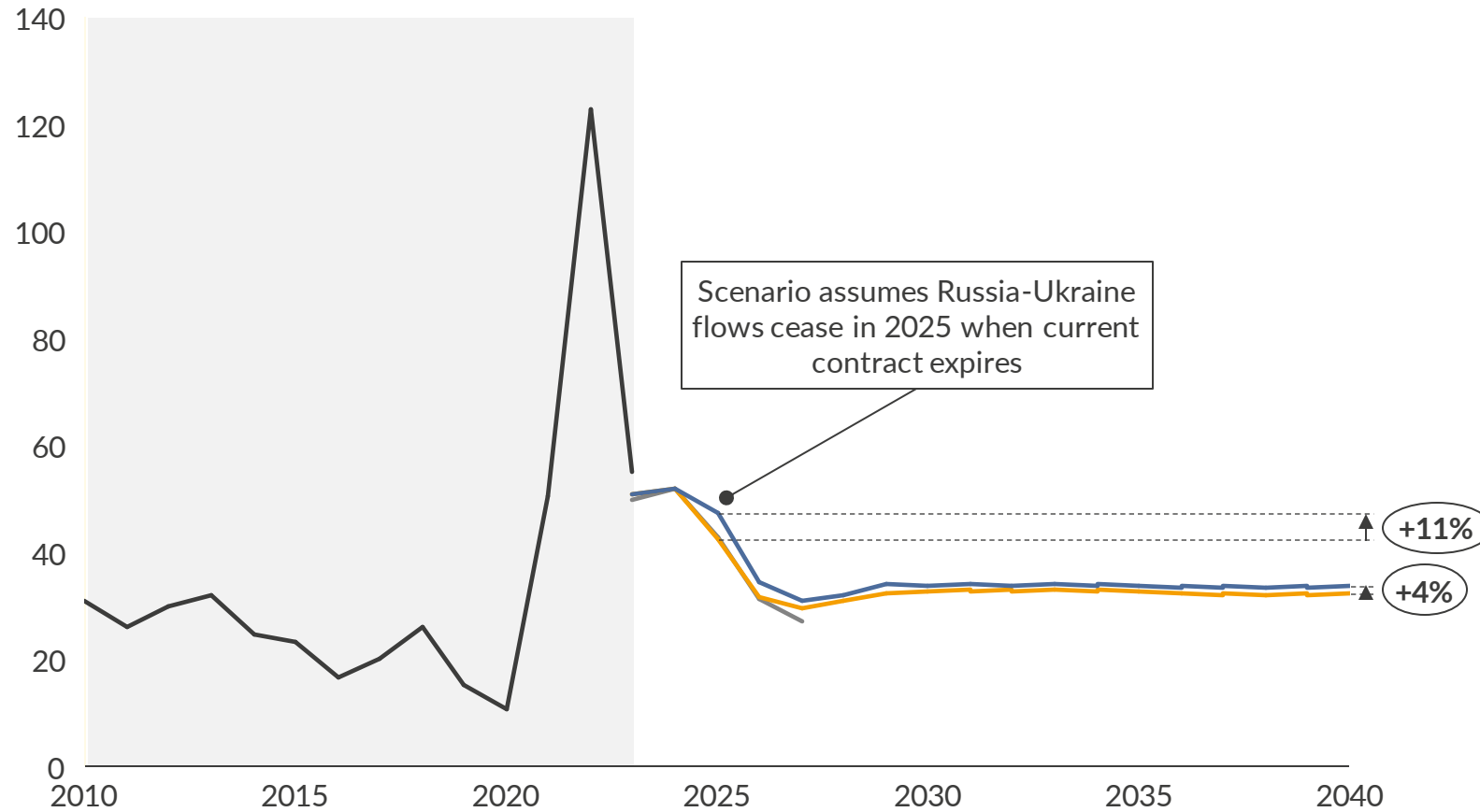


1) Includes EU27, GB, and Switzerland 2) Includes Norway, Azerbaijan, and Africa 3) Includes Ukraine and Belarus 4) Includes Norway, Canada, and Trinidad and Tobago



# Loss of Russian supply through Ukraine would push up prices in the mid 2020s; market then rebalances with high LNG dependence

## Natural gas prices in Europe<sup>1</sup>

€/MWh (real 2022)



## Key uncertainties





-  Further reduction in Russian piped gas supply
-  Tightness of the global LNG market
-  Recovery of Chinese economic activity and gas demand
-  Cold winter temperatures intensifying storage withdrawals

— Historical — Futures<sup>2</sup> — TTF April 2023 Central — TTF April 2023 Alternative (no flows through Ukraine)

1) For years 2023-2027, the prices shown take into account current futures prices for the years in question, with declining weights. 2) A rolling 14-day average as of 01/03/2023.

# Gas prices present high uncertainty and impact on power price outlook, whilst renewables deployment is also a big driver

## Impact of key risks on European power price outlook

Fundamental drivers	Impact on power prices	Level of uncertainty	Key indicators (relative to Aurora Central/ BAU)	
			Bullish factors	Bearish factors
Gas price		HIGH	<ul style="list-style-type: none"> <li>Complete halt in Russian supply               <ul style="list-style-type: none"> <li>Cold winters</li> </ul> </li> <li>Increased demand from Asia               <ul style="list-style-type: none"> <li>Delays in LNG terminals</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>De-escalation of Russian conflict               <ul style="list-style-type: none"> <li>Mild winter weather</li> <li>Fuel switching</li> </ul> </li> <li>Depressed demand</li> </ul>
CO <sub>2</sub> prices		MEDIUM	<ul style="list-style-type: none"> <li>Stricter decarbonisation policies</li> <li>Increased gas-to-coal switching</li> </ul>	<ul style="list-style-type: none"> <li>Supply increases</li> <li>Poor economic outlook</li> </ul>
RES deployment		MEDIUM	<ul style="list-style-type: none"> <li>Grid constraints</li> <li>Supply chain costs increase               <ul style="list-style-type: none"> <li>Permitting delays</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Permitting reforms</li> <li>Increased subsidies</li> </ul>
Demand		LOW	<ul style="list-style-type: none"> <li>Rapid electrification of heat and transport</li> <li>Green hydrogen production</li> </ul>	<ul style="list-style-type: none"> <li>Major energy efficiency upgrades</li> <li>Consumer behaviour changes</li> </ul>

# Key takeaways

- 1** Europe has coped with a substantial reduction in Russian gas supplies. Demand reduction has been crucially important, albeit that some of this has been driven by temporary factors. LNG has and will continue to play an important role, with prices settling above pre-crisis levels.
- 2** Delivering the REPowerEU plan would cut energy prices, emissions and gas usage. But this is by no means certain – requiring €800 bn CAPEX investment and much faster capacity deployment than previous years. Europe must overcome barriers to deployment and compete with other markets such as the US to attract capital and supply chains.
- 3** It is risky to fundamentally reform market rules during a crisis. The last year has seen intense discussion of market reforms. Many ideas have fallen by the wayside or become redundant as prices have fallen and the market remained intact. But this process creates huge uncertainty for investors, which can have a lasting impact on confidence.
- 4** Aurora expects the gas market to remain tight for next two years but then restabilise in the late 2020s. Europe could withstand a further cut in Russian supplies, albeit this would keep prices higher for longer. Gas prices continue to present the biggest impact and uncertainty for power prices in the medium term.

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