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ENERGY TRANSITION SUMMIT WARSAW 2025

AURORA KEYNOTE:

INVESTING IN POLAND'S ENERGY SECURITY: OPPORTUNITIES & SOLUTIONS

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System security of supply relies on the ability to respond to changes of the demand which is not covered by RES

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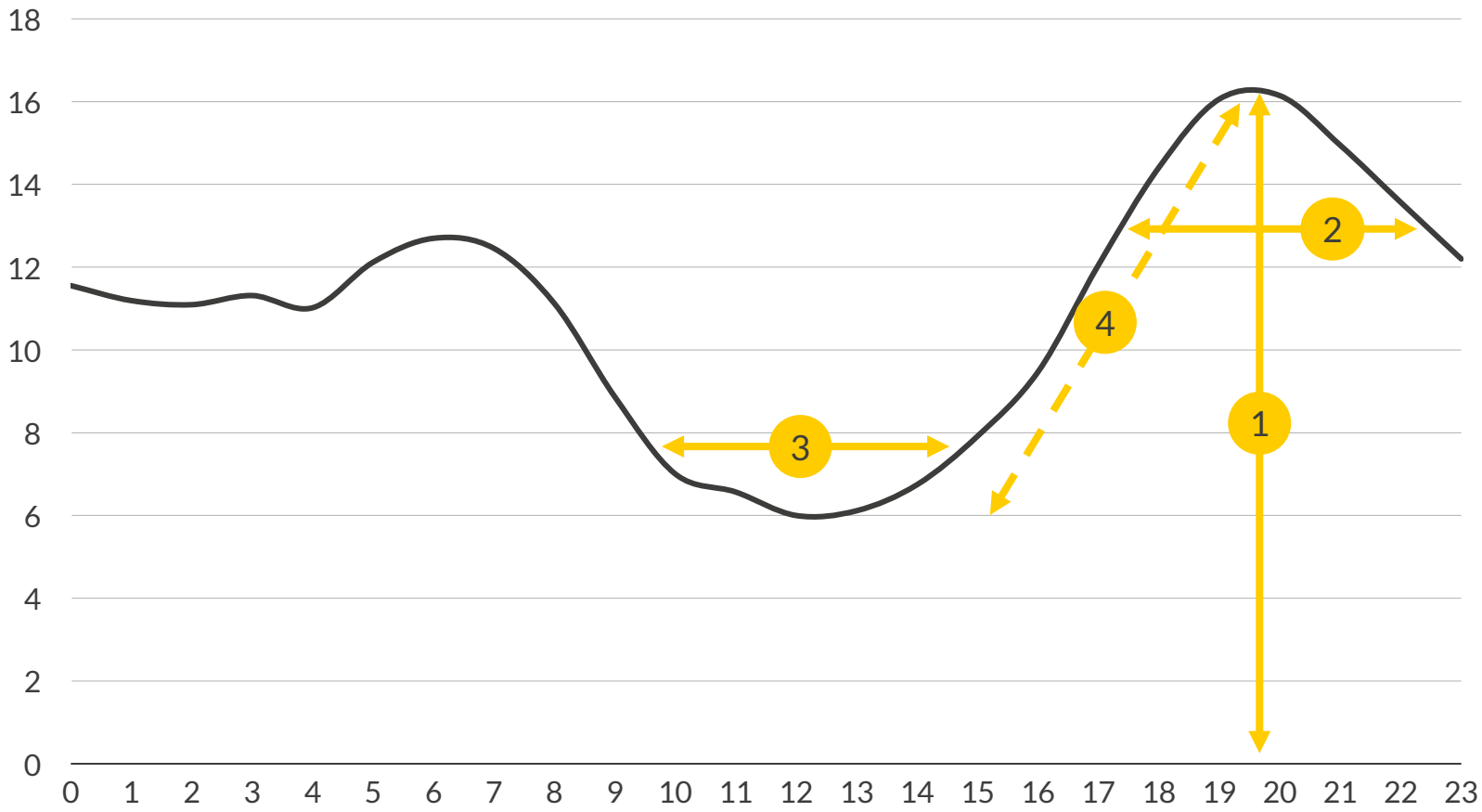
Average hourly residual demand in 2030

GW



1. How much capacity to dispatch?
2. What is the duration of the capacity event?
3. Was charging possible beforehand?
4. How fast does it need to ramp?

Sources: Aurora Energy Research

By 2030, we expect three main types of scarcity events occurring in Poland depending on the season

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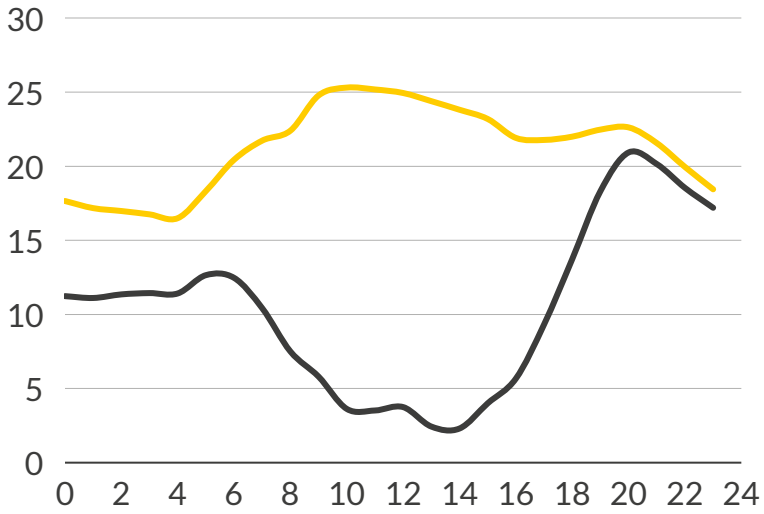
Hourly total and residual demand in 2030 – example days

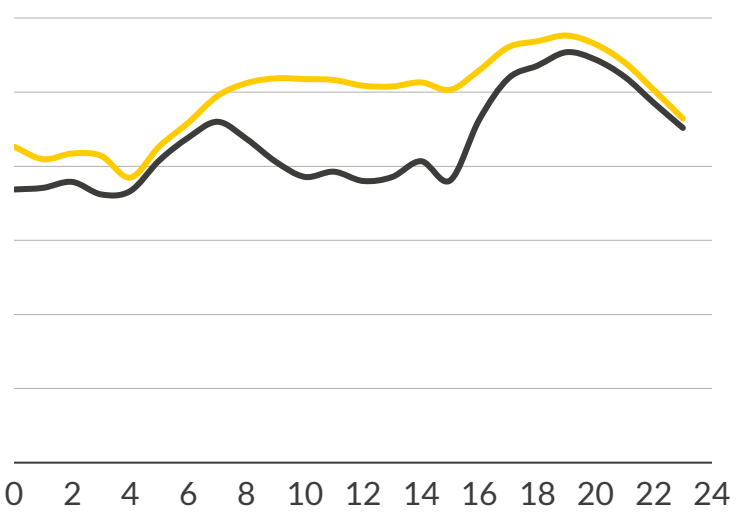
GW

Rapid ramp up event



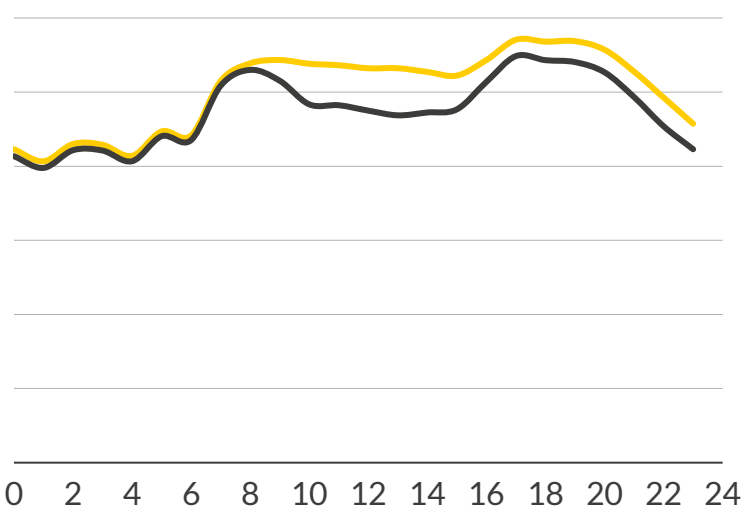
- Rapid increase in residual demand, can occur in summer when RES generation decreases in the evening
- Perfect for **fast-responding**, flexible **BESS** to satisfy it

Long duration peak demand



- The peak demand in early spring/late autumn starts earlier and sustains for an **extended duration** due to evenings coming early
- Demand can be covered by various dispatchable assets, mainly conventional

Extended maximum demand



- Typical for winter **days-long** scarcity period (*kalte dunkelflaute)*, almost to the level of the system's achievable capacity with **no charging window** limiting BESS
- Requires **all dispatchable capacities,** including DSR

Hourly residual demand Hourly total demand

Sources: Aurora Energy Research

BESS's availability is limited depending on scarcity duration and preceding charging periods

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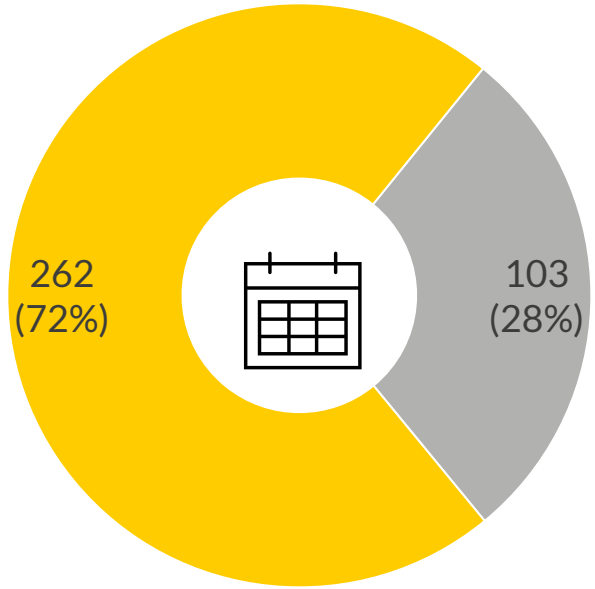
Days with significant[1] demand for dispatchable capacity in 2030

days (%)

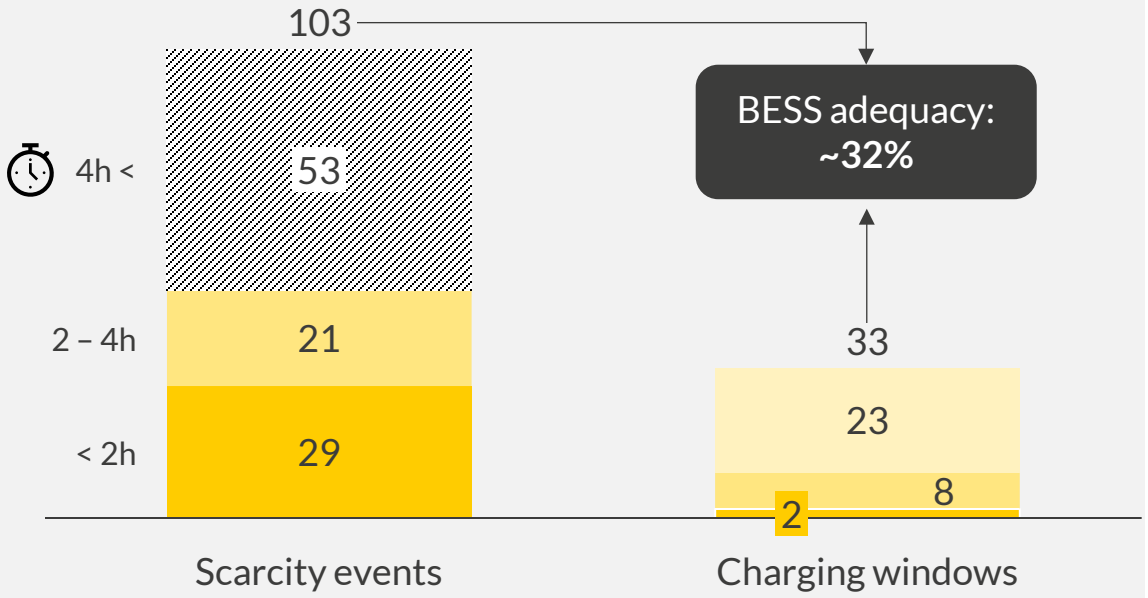


- We expect significant demand for the dispatchable capacity in the peak demand period during approx. 28% of days in 2030.
- In the year with extreme weather conditions, this can increase up 38%

Days with significant demand | Other days

Duration of scarcity events and correlated charging windows

of



- Typical 2 and 4h duration BESS are developed in Poland, leaving the system exposed to scarcity longer scarcity periods in more than half of the cases.
- Only 1 out of 3 scarcity events are preceded by stable charging opportunities, guaranteeing BESS's readiness.

4h < | 2 – 4h | < 2h

1.) Significant demand for the dispatchable power is when less than 10% of total demand is satisfied with variable RES.

Sources: Aurora Energy Research

Up to 15GW of the capacity gap could occur in 2035 as reinvestments only partially cover the coal closures

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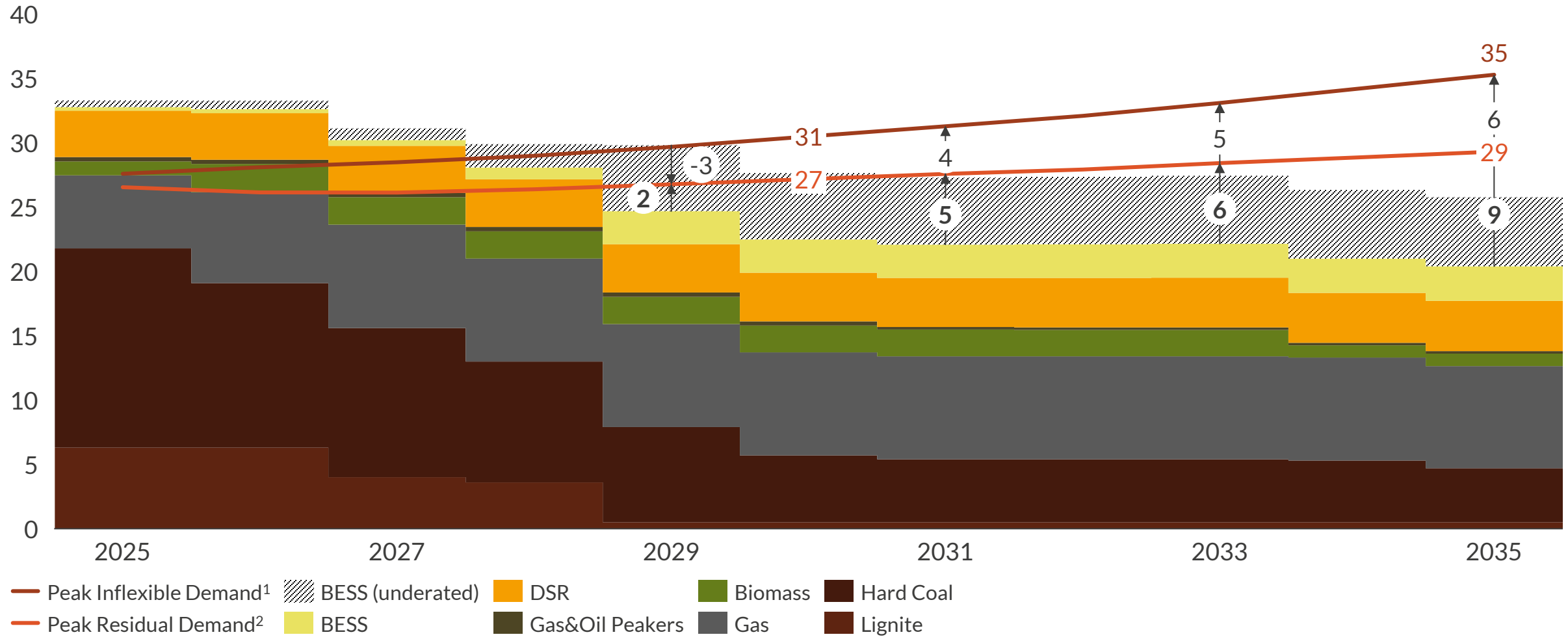
Total currently installed and planned capacities and demand[1,2]



1) Peak inflexible demand is the component of demand that cannot be shifted by more than 12 hours; 2) Peak demand not covered by renewable generation.

Sources: Aurora Energy Research

No technology is a fit-for-all solution and all provide challenges to overcome, requiring planning and choices to provide a sustainable mix

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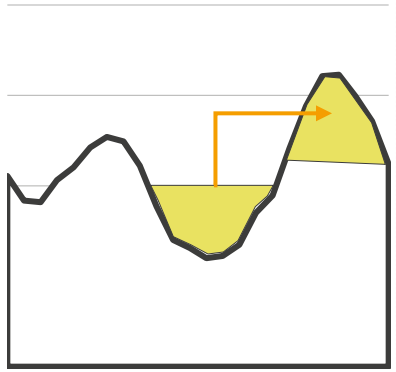
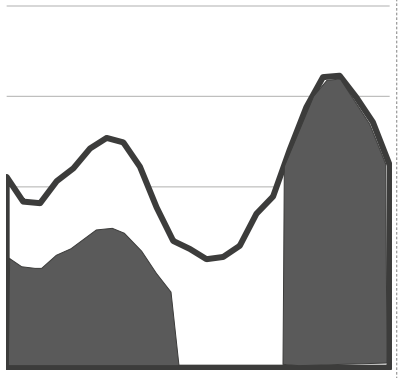
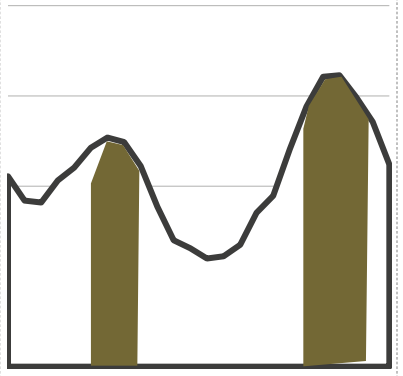
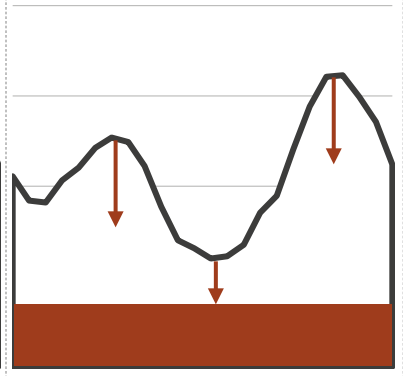
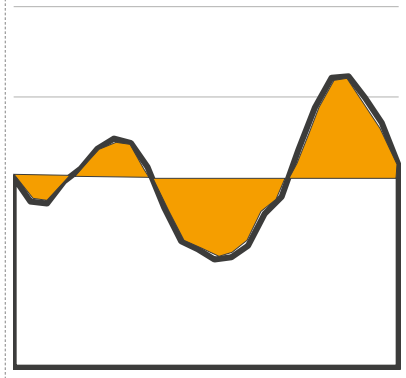
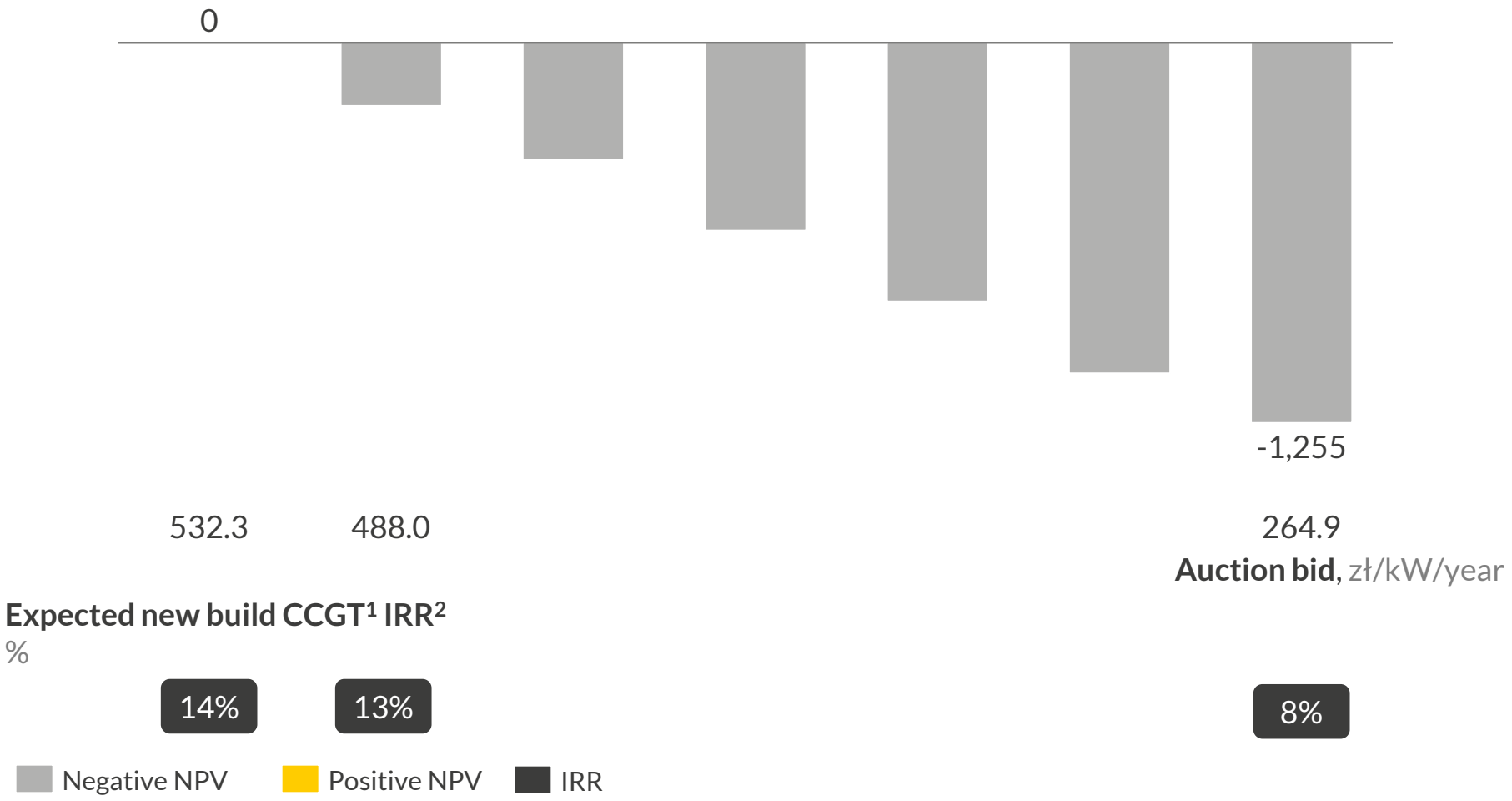
Technology		BESS	CCGT	OCGT and peaking	Nuclear	DSR
Response	Fast	✓	!	✓	✗	✓
	Duration	✗	✓	✓	✓	✗
						
Main challenge		▪ Limited duration ▪ Requires charging before scarcity ▪ Returns diminish quickly with ancillary services saturation	▪ Environmental impact and dependence on gas ▪ Significant investments require strong financing support	▪ Environmental impact and dependence on gas ▪ Prolonged operation impacts the economics	▪ Long project investment timing ▪ New technology in Polish context ▪ High costs and complex financing structures	▪ Constraints for application due to, e.g. industrial operation or EV charging patterns ▪ Requires aggregation and financial incentives

Sources: Aurora Energy Research

CCGTs could not acquire enough support from CM due to BESS bidding lowering the strike price in recent auctions

Expected new build CCGT[1] NPV based on the secured contract price in T-5 CM auction for 2029
zł real'2023/kW



- CCGT would have to bid into CM above the maximum price to achieve positive NPV.
- Expected project IRR[2] at 2029 CM strike price is 8% compared to our discount rate assumptions of 14% for new CCGT in Poland.
- Despite CM auctions 2026 and 2025 ending at the maximum price level, not many CCGT secured the CM contract. Due to increasing BESS participation, the opportunity to secure such highly priced contracts might not repeat soon.

1) Typical 600MW+ class unit, with 57% efficiency; 2) real, pre-tax.

Sources: Aurora Energy Research

The gas peakers are cheaper to build and profit well from ensuring the security of supply due to their flexibility

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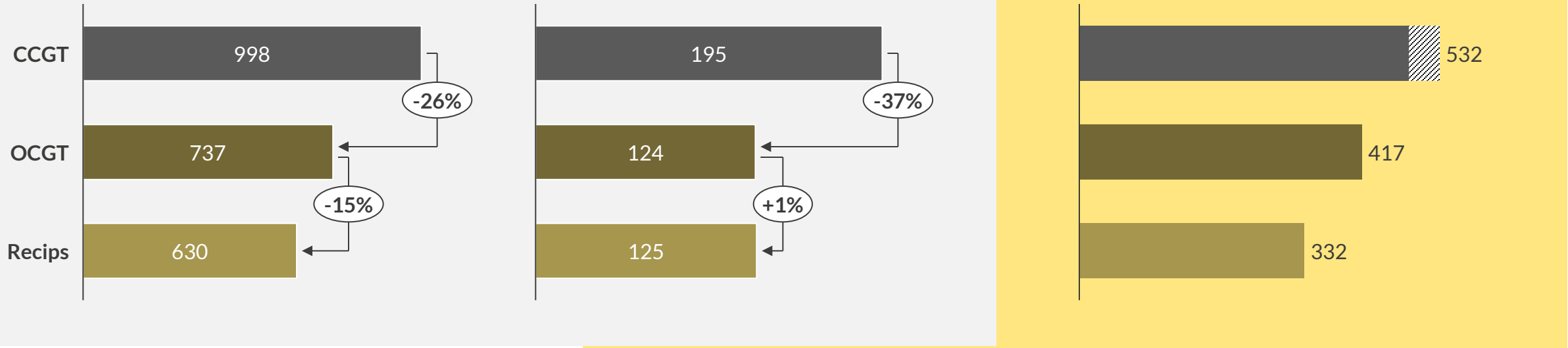
CAPEX
€/kW, real 2023

Expected lifetime average gross margins[1]
zł/kW, real 2023

Capacity market price to breakeven NPV
zł/kW/year, real 2023



- OCGT and reciprocating gas engines need less CM support and make better investment opportunities due to their lower costs and viable gross margins. The cost-competitiveness compared to CCGT increases further when the future H2-retrofitting is considered.
- These peaking plants provide flexibility in power generation, ensuring a reliable supply while being easier to construct than larger and more complex energy units.
- Simpler gas units have a higher emission intensity due to worse efficiency. However, as they operate as peaking units, their lifetime emissions are lower by 85-88% than CCGTs.

CCGT OCGT Recips

1) Including FOM and other costs; over 30 years lifetime;

Sources: Aurora Energy Research

Key takeaways

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1. Up to **15GW of the capacity gap** could occur in 2035 as current reinvestments only partially cover the coal closures

2. Ongoing **BESS procurement answers the need for fast-response capacity** in the system. However, other solutions are also required due to BESS's limited availability.

3. CCGT**s require high subsidies that cannot be acquired from the CM**, as other competing capacities lowered the strike price in recent auctions.

4. The **gas peakers are cheaper to build than CCGT**, ensuring the security of supply due to their flexibility in a profitable manner.

Thank you for your attention!

If you found the presentation interesting::

1. Panel discussion to follow.
2. **Save the date:** More insights on 12 March 2025 during Aurora's Subscribers Group Meeting: *Plugging the gap - Security of supply in Poland.*

Today's speaker:

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