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ENERGY RESEARCH

Chilean Power Prices: Long-Term Forecast and Alternative Scenarios

Public Report

December 2024

Agenda

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I. About Aurora

II. Chilean market context

III. Aurora's modelling methodology

IV. Central & Alternative scenarios

Introducing the Aurora team

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Aurora provides market leading forecasts & data-driven intelligence for the global energy transition

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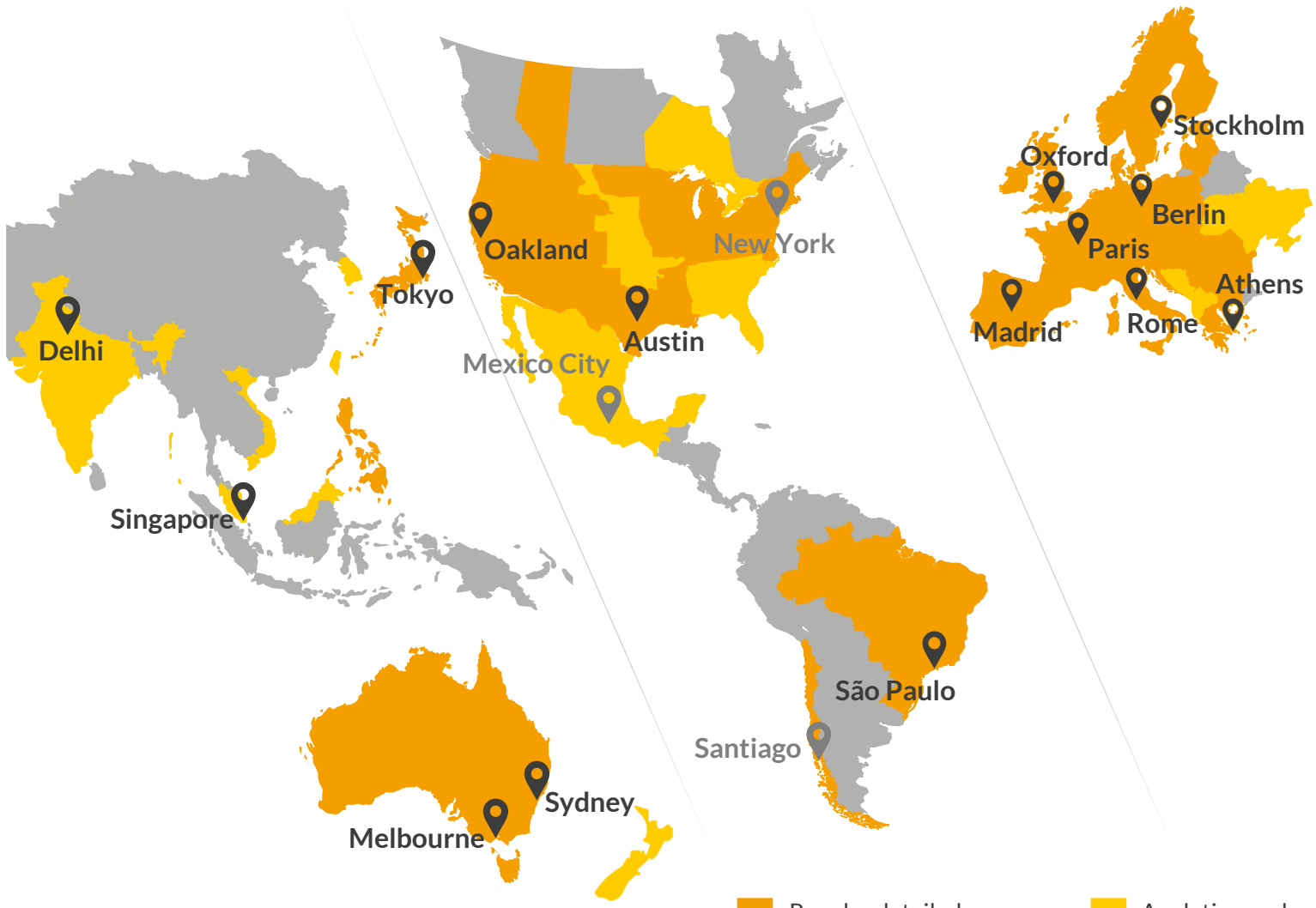
- Renewables & PPAs
- Storage
- Grid & Congestion
- Electric vehicles
- Hydrogen H_2
- Carbon CO_2
- Natural gas



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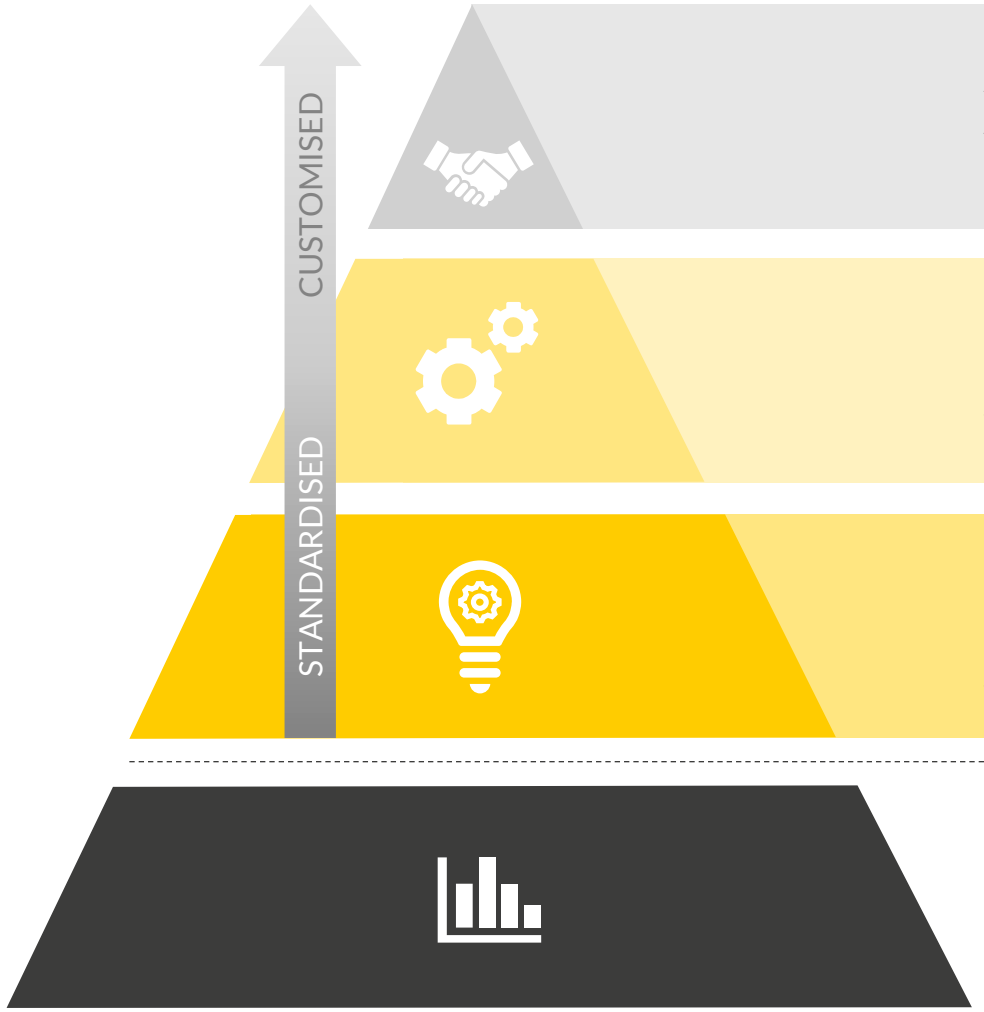

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Developed over 10 years, 70+ dedicated modellers

Source: Aurora Energy Research

Chile Power & Renewables Market Service upcoming releases

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Group meeting (GM) 1
Assumptions and scenarios

- Key long-term assumptions: demand, technology assumptions, commodities and planned capacity
- Modeling approach
- Identify key uncertainties aligned with proposed scenarios

Group meeting 2
Long-term forecast - central scenario

- Scenario results though 2060, including:
  - Aurora Central: installed capacity & generation mix; baseload & capture prices

Group meeting 3
Ancillary services and BESS revenues

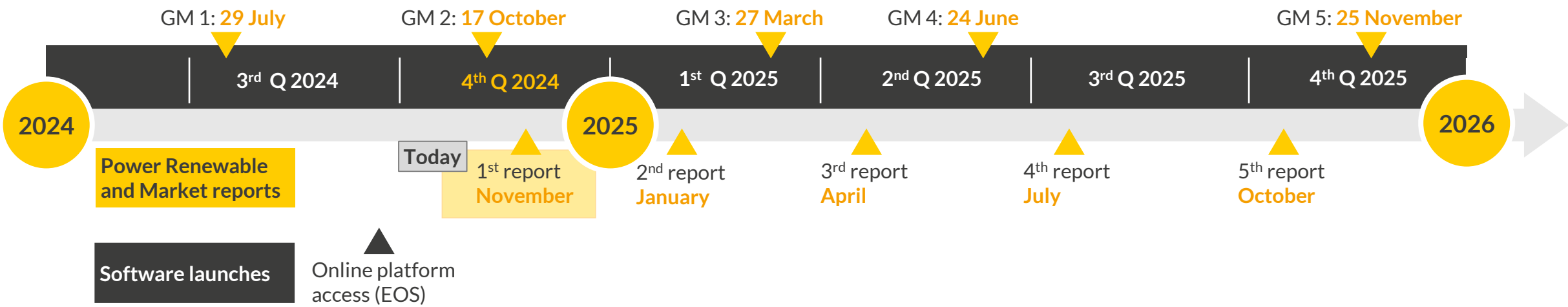
- Ancillary services market in Chile
- Market structure, regulation and the business case for storage
- Best practices across other international markets with high storage adoption

Group meeting 4
Regional prices and grid bottlenecks

- Location-specific project economics
- Impact of various grid expansion and renewables deployment scenarios on capture prices

Future subscriber group meetings

- Subscriber interest will drive future topic selection
- This may include deep dives into:
  - Hydrogen economics
  - Bid-based market design
  - PPA market



Bilateral follow-ups and engagement throughout

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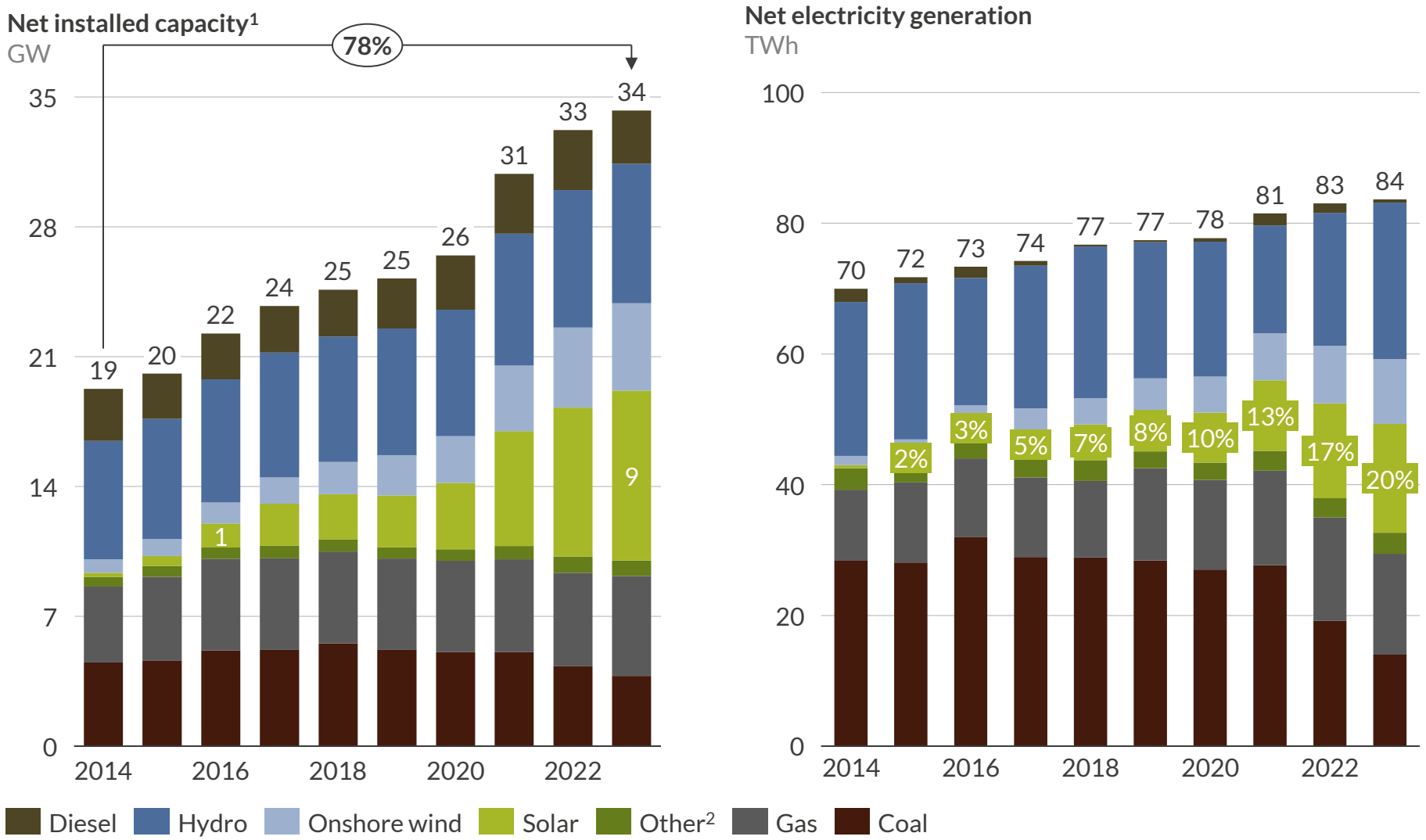
Renewable capacity in 2023 made up 67% of the capacity mix, with solar capacity increasing by 9 GW since 2015



- The total system capacity has grown by 78% since 2014 mainly driven by the expansion of renewables, particularly solar
- Solar capacity has grown at an average CAGR of 51% to above 9 GW of capacity, making up 26% of total capacity in Chile at the end of 2023
- Following the coal phase out announcement in 2019, a total of 1.5 GW of capacity has been taken offline
- Regarding the generation mix, since 2015 the penetration of ERNC[3] has increased from 5% to 41% in 2023
- Coal generation has been increasingly replaced by other sources dropping by 50% since 2015

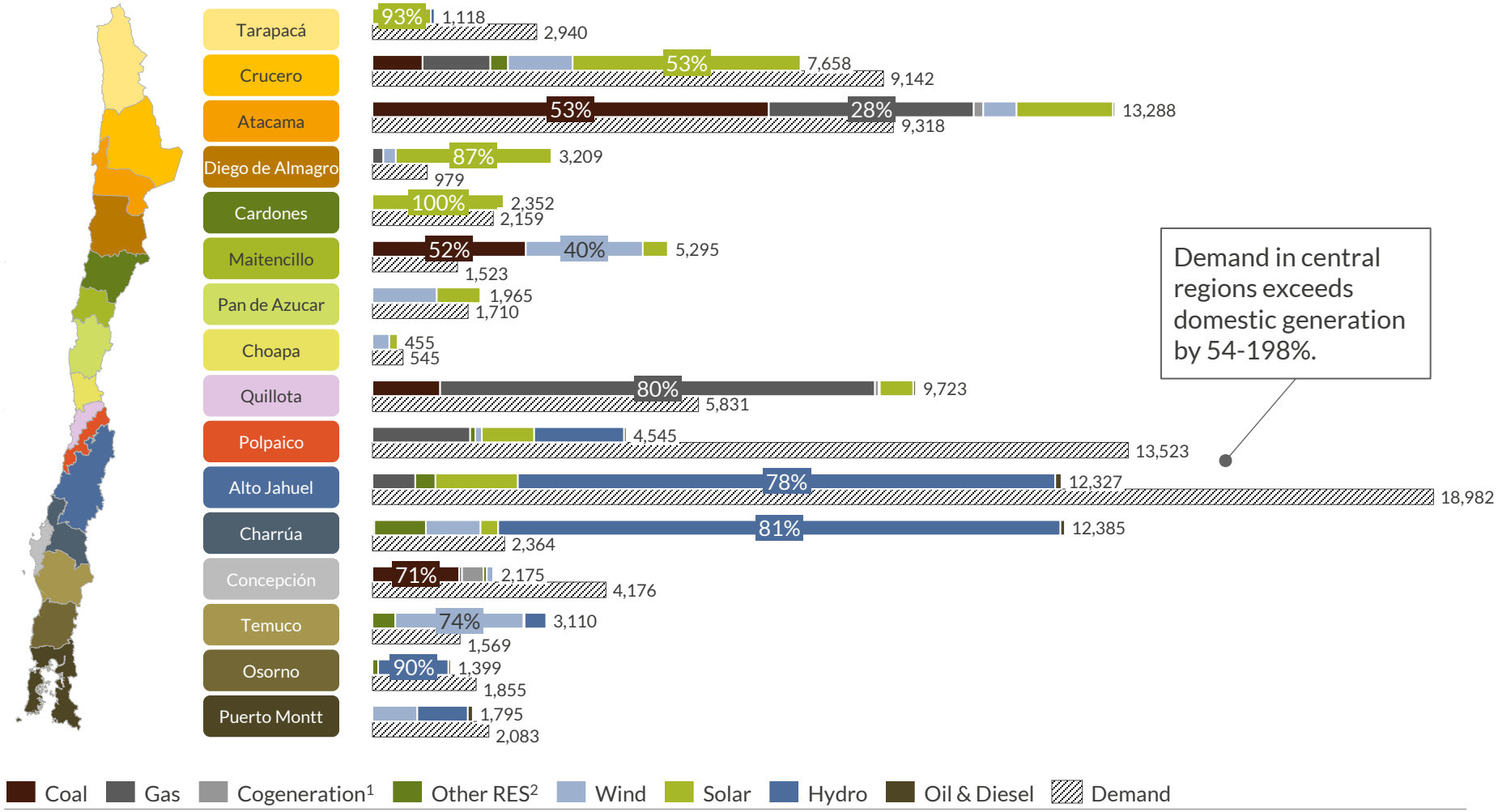
1) CEN data represents the capacity at the end of the respective year. 2) includes both renewable and non-renewable sources summed up by the CEN. 3) ERNC = non-conventional renewables (solar and wind)

Sources: Aurora Energy Research, CEN

Chile sees an unequal distribution of demand and generation; solar generation is concentrated in the north, hydro in the central regions

Generation vs demand in 2023 per Aurora nodal hub

GWh



1) Cogeneration includes petcoke. 2) Other renewables include biogas, biomass and geothermal.

Source: CEN

- In 2023, 72% of solar generation came from the northern regions between Tarapacá and Cardones, which benefit from high irradiance levels.
- Coal and gas are most relevant in Atacama and Quillota. Both regions generate over 80% of their hubs total generation using thermal sources.
- Wind generation is spread across the country with the largest hubs in Maintencillo and in the South of SEN (Temuco and Puerto Montt).
- 82% of SEN's total hydro generation in 2023 is in the center (Alto Jahuel and Charrúa), making up around 80% of the domestic hubs' generation. Osorno and Puerto Montt are also dominated by hydro.

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Our analysis of the Chilean power market uses our proprietary, in-house modeling capabilities with data from official sources

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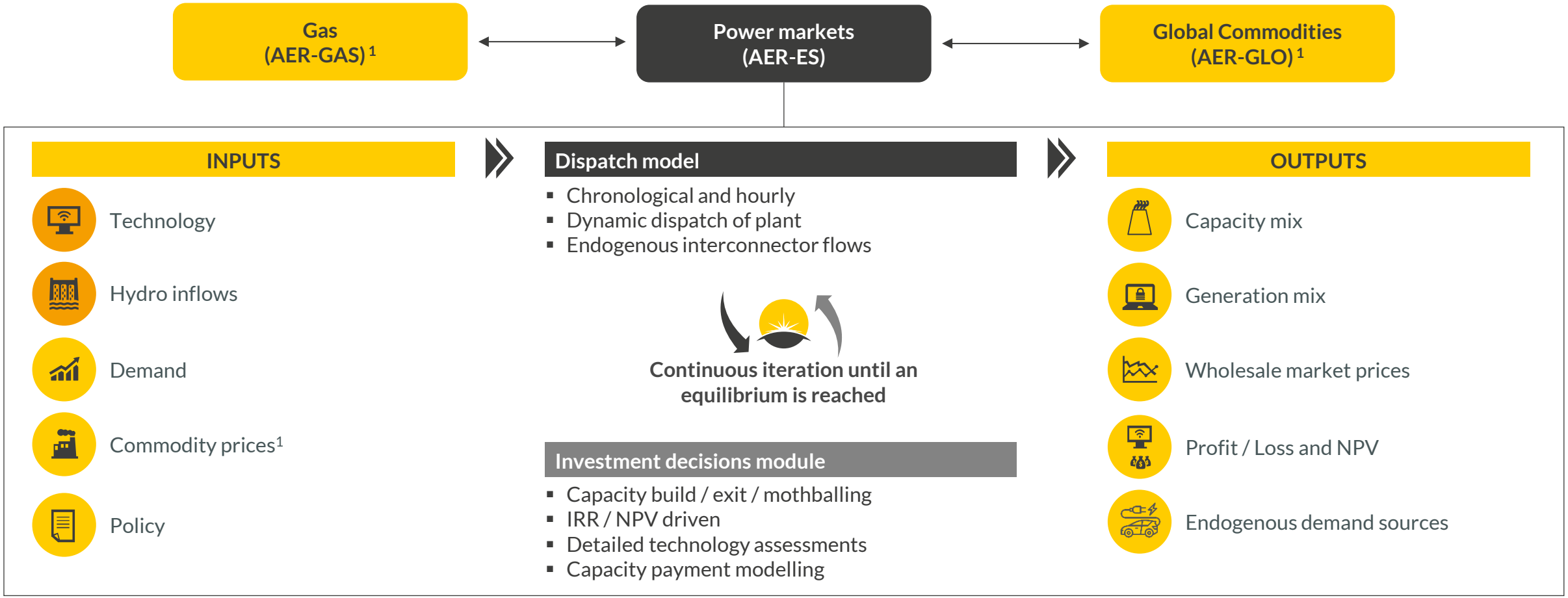

● Official assumptions[2] ● Modelled in-house

1) Gas, coal, oil (and carbon prices, if applicable) fundamentally modelled in-house with fully integrated commodities and gas market model. 2) Assumptions from Coordinador Eléctrico Nacional (CEN) and other key institutions.

Source: Aurora Energy Research

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Our modelling capabilities allow us to provide a range of alternative scenarios exploring market uncertainties, alongside Aurora Central view

	Scenario	Description
Focus of today's session	**Aurora Central**	Aurora's best view for the evolution of the Chilean power market until 2060 under the following considerations: – Aurora's internally consistent Central outlook for technological developments (e.g. CAPEX) and modelled commodity prices. – Incorporating currently stated policies, alongside a conservative view of future policy objectives and market developments.
	Low	▪ Considering a combination of the plausible range of individual market and policy factors, and their correlation, Aurora's Low scenario reflect realistic price deviations which equity and debt investors rely on for financing assets. ▪ We adjust commodities prices, demand and CAPEX to account for the lower downward risk in the lower risk in low scenario.
	Dry Hydrology	▪ Given the uncertainty surrounding hydro inflow levels, we have introduced a Dry Hydrology sensitivity alongside our Central scenario. This sensitivity assumes a P90 level based on 63 years of historical inflows data (1960–2022). This represents a 15% reduction of hydro generation compared to our Central scenario.
	Constrained transmission	▪ We have built a scenario to simulate the effect of delays in the expansion of transmission, considering the following context: – Chile is the longest country in the world, with the greatest potential for solar development in the Northern regions and most of the demand located in the center. Delays in expansion can create regional supply and demand imbalances leading to increased price spreads – This scenario assumes delays in already planned projects as well as only half of the transmission buildout of the Central scenario after 2036.

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Sources: Aurora Energy Research

In Aurora Central, prices converge after the connection of Kimal in 2031; long-term price difference across hubs estimated to be 8%

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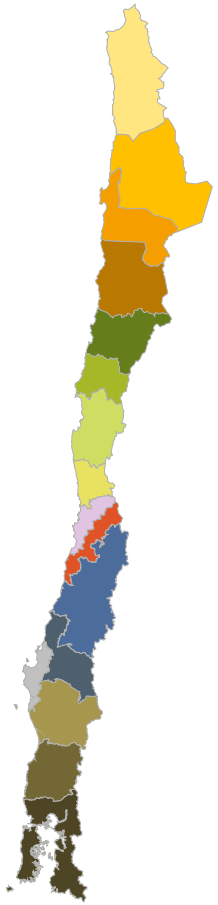
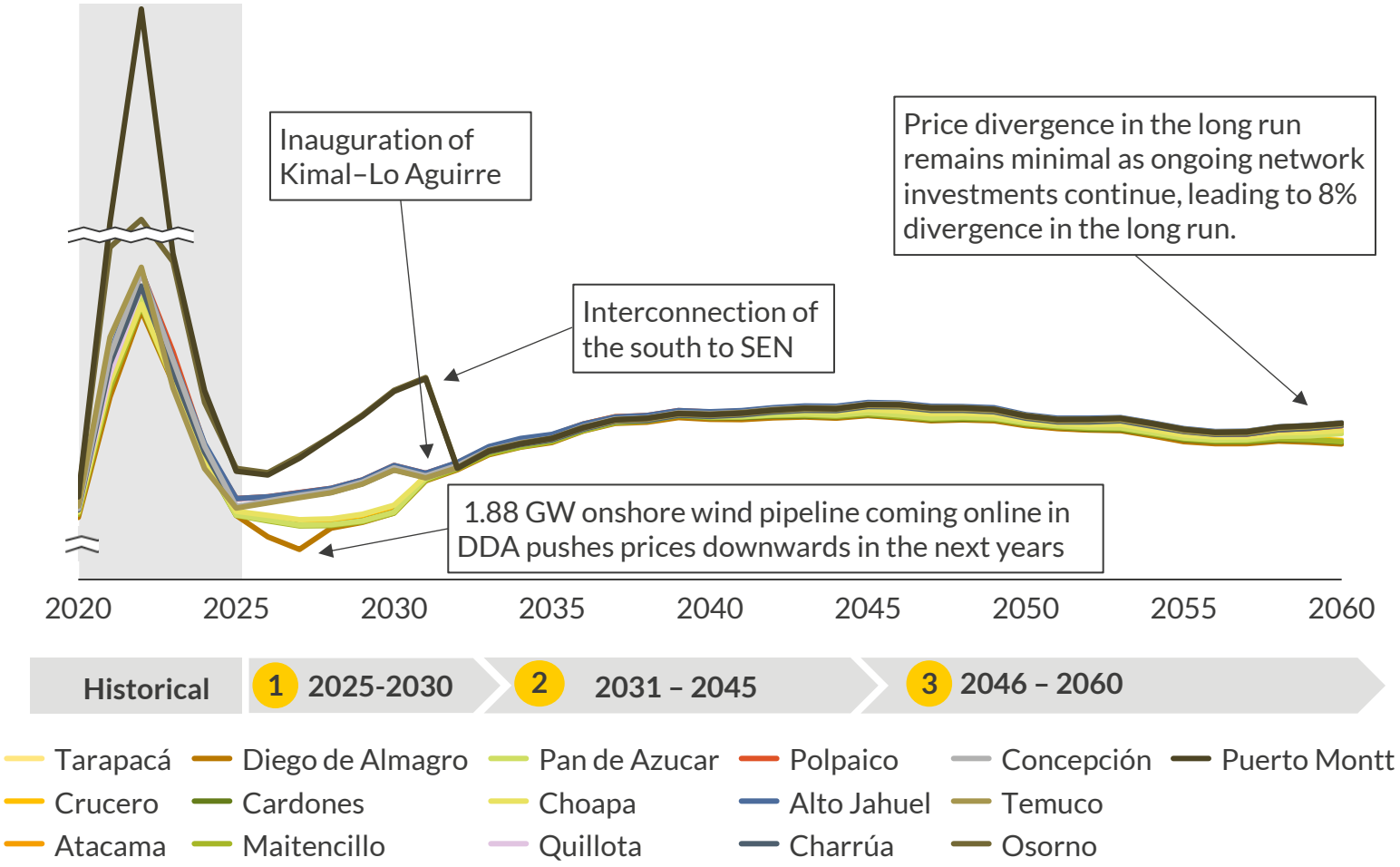
Baseload price per nodal hub in Chile
$/MWh (real 2023)





1) Equivalent of ~60% of current coal capacity

Source: Aurora Energy Research

Outlook for baseload prices

1. In the short term, baseload prices rise system-wide, driven by growing demand and the phase-out of 2 GW[1] of coal by 2031, with the south (Osorno and Puerto Montt) experiencing the sharpest increases due to limited renewables, lack of interconnection, and reliance on costly gas and diesel dispatch.
2. In the medium term, the three distinct price groups—low solar-driven prices in the north, moderate prices in the center, and high prices in the south—converge. The 2031 inauguration of Kimal-Lo Aguirre brings northern solar energy to the center, while the 2032 southern interconnection reduces costs in the south.
3. In the long term, price differences shrink to around 8% as economical expanded interconnections allow cheaper northern energy to flow to high-demand areas in the center, and to the south.

Solar and batteries drive Chilean capacity expansion, with 42 GW added in the next 35 years, leading to 89% carbon-free generation

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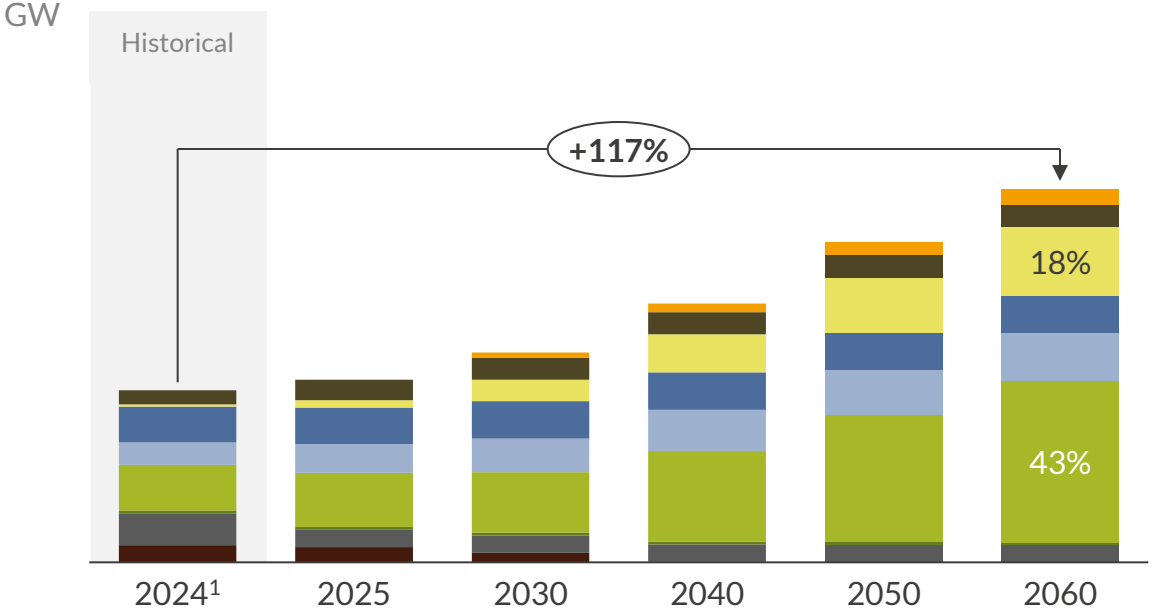
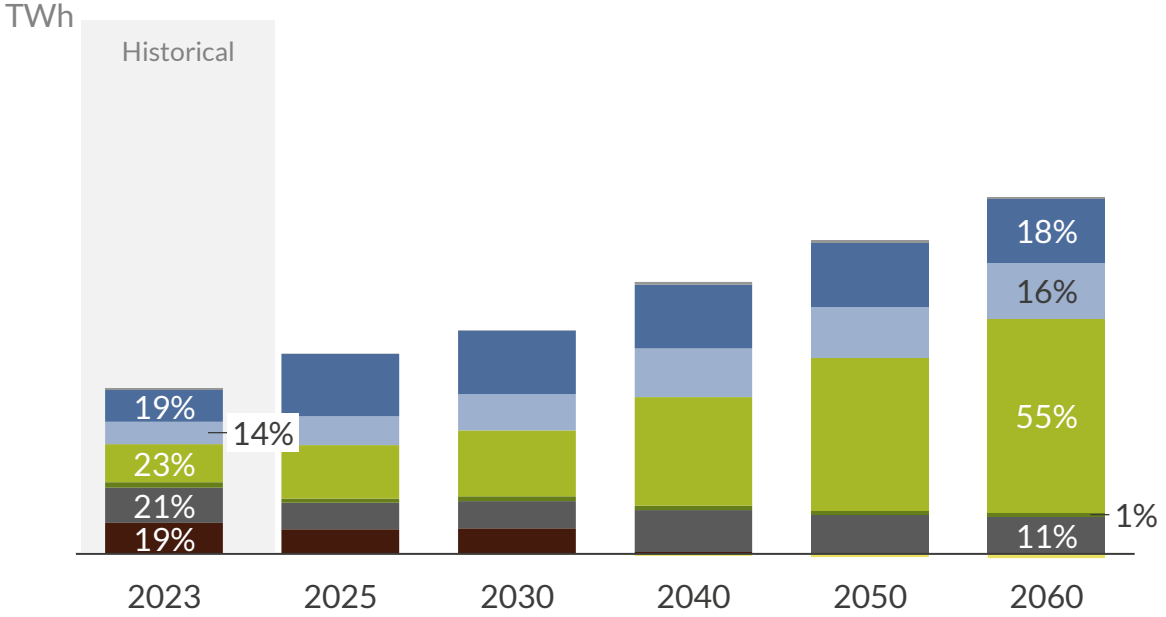
Installed capacity in Chile



Generation mix in Chile



- Installed capacity increases 117% (42 GW) within the forecast horizon, mostly driven by solar, batteries, and wind.
- Solar power increases its capacity by a factor of 3.4 leading to a total share of 43% in 2060, while wind capacity doubles compared to today's capacity.
- Battery capacity grows to 18% by 2060, facilitating shifting of intermittent solar generation in a solar-heavy system and ensuring security of supply.

- Total electricity production increase 114% in 2060 compared to 2023 levels, driven by growing demand over this period.
- Renewables will constitute more than 88% of total generation by 2060, with more than half of Chile's generation coming from solar PV.
- The share of thermal generation will decrease from 40% in 2023 to 11% by 2060, mainly driven by the coal phaseout by 2040.

DSR | Gas/ Oil peaker | Battery Storage | Hydro | Onshore wind | Solar PV | Other RES | Gas[2] | Coal

1) 2024 updated until July of 2024. 2) Gas includes OCG and CCG.

Source: Aurora Energy Research

88% of the batteries will be installed between Norte Grande and Norte Chico, combating solar intermittency

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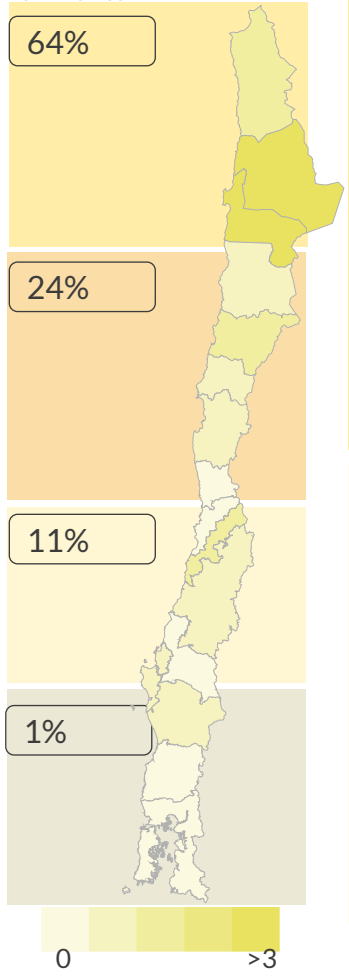
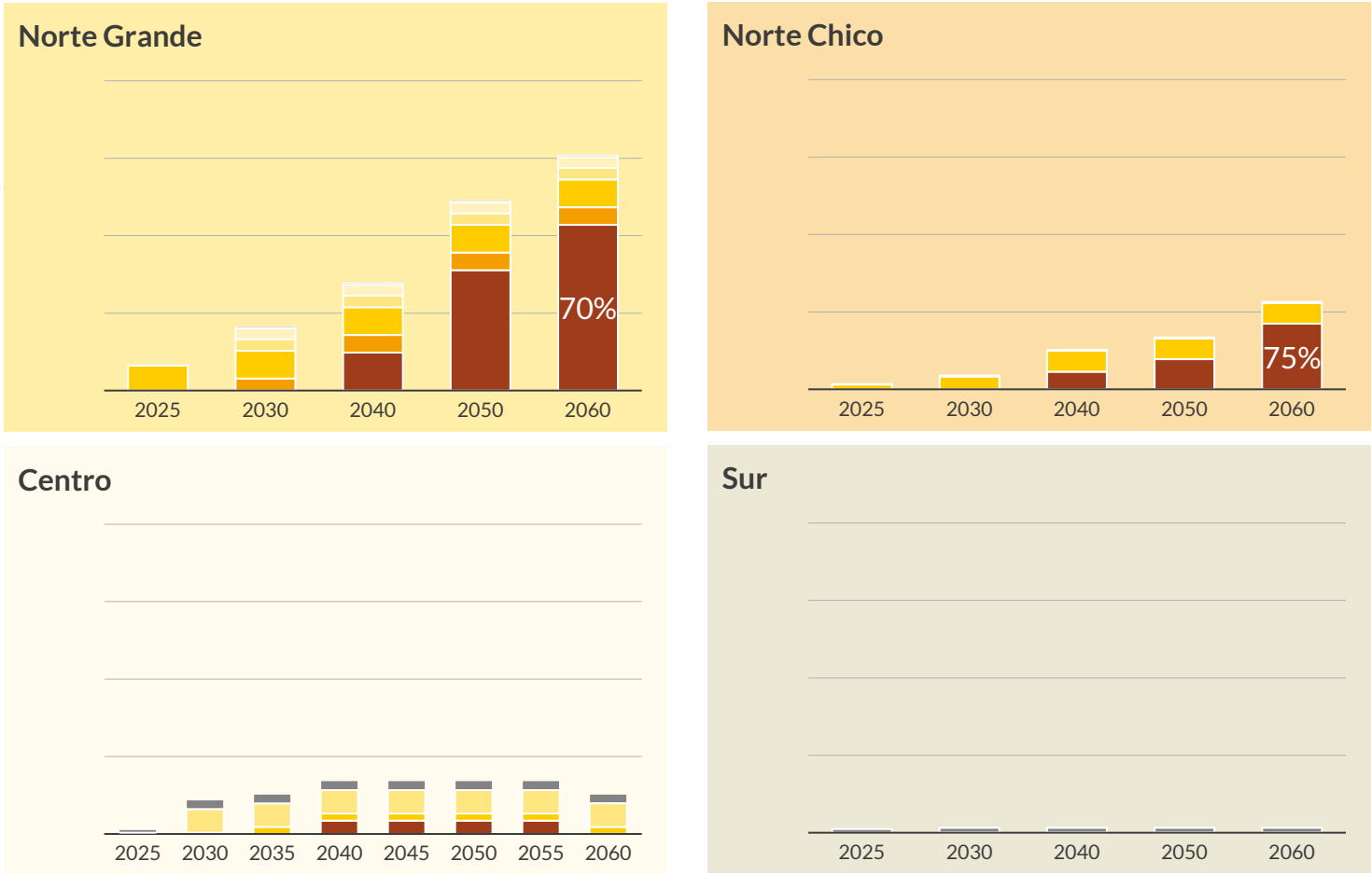
Installed battery capacity in 2060
% of total



Installed capacity of battery storage per duration
GW



- 8hr battery deployment is expected in the North, where most of the solar capacity is installed (88% of all capacity in 2060)
- In Norte Chico, between the solar-rich north and the demand-heavy center, the hub's coal phase-out and intermittency from adjacent hubs drive battery deployment in the 40s, compensating for the loss of firm capacity and helping manage intermittency.
- Centro also shows some 8h battery deployment after Kimal-Lo Aguirre and day prices become lower. Battery capacity decreases after the capacity built in the 2030s phases out.
- In the South, we expect a low share of batteries' buildout (1.4% of total), driven by relatively less intermittency and the existence of flexible hydro generation.

Source: Aurora Energy Research

In addition to the Central, Aurora Low is constructed using plausible deviations in electricity demand, commodity prices and renewable CAPEX

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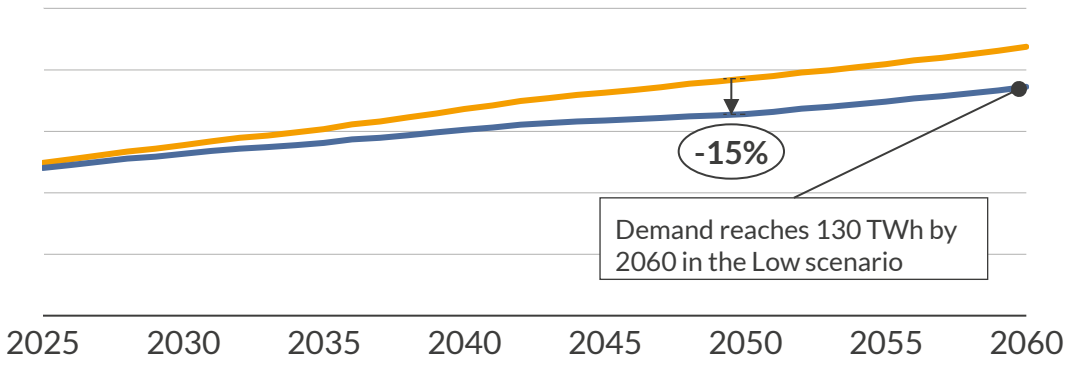
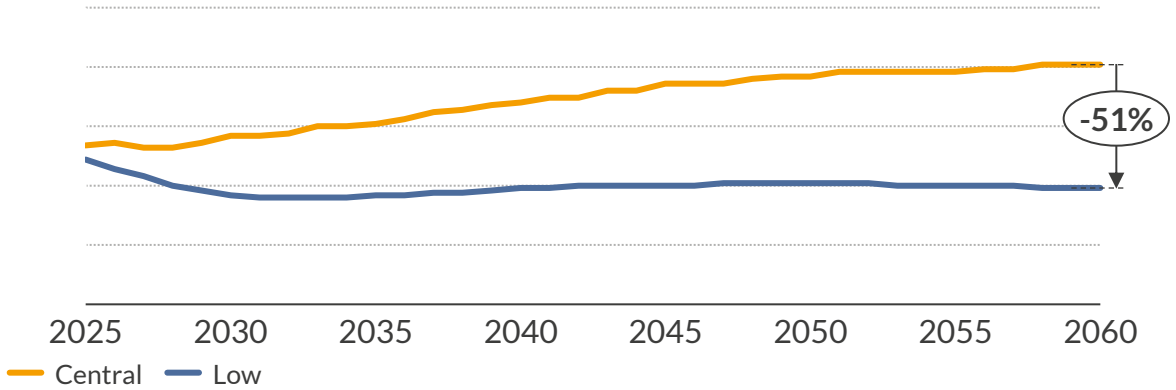
A Electricity demand

Annual electricity demand
TWh



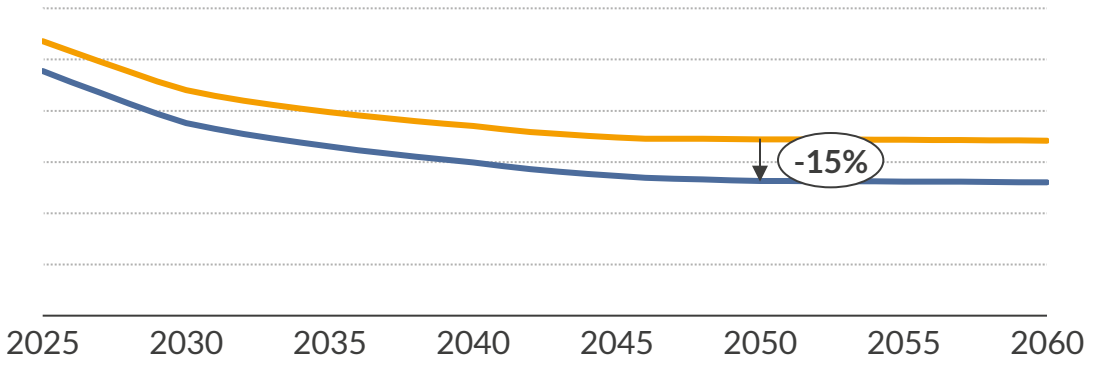
B Commodities prices (gas)

Gas prices
$/MMBtu (real 2023)

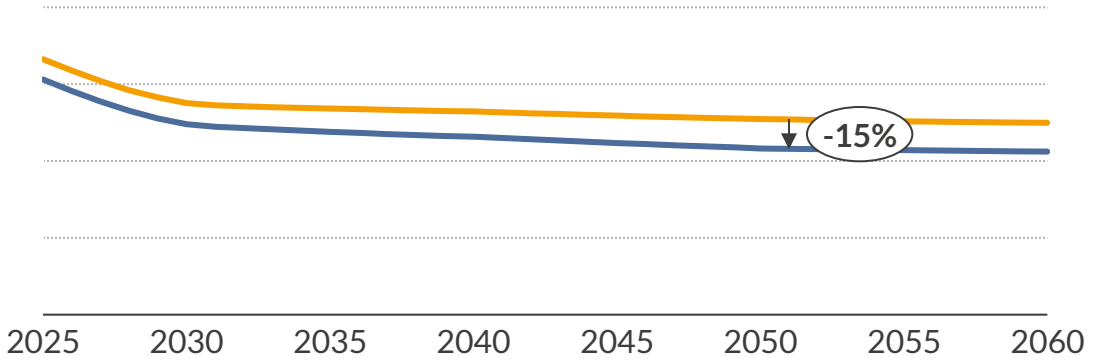


C CAPEX (solar PV and onshore wind of northern regions)

Solar PV CAPEX
$/kW (real 2023)



Onshore wind CAPEX
$/kW (real 2023)



Sources: Aurora Energy Research

In response to the decreased demand and lower capture prices, 18 GW less solar PV, batteries, and wind enter the Chilean market by 2060

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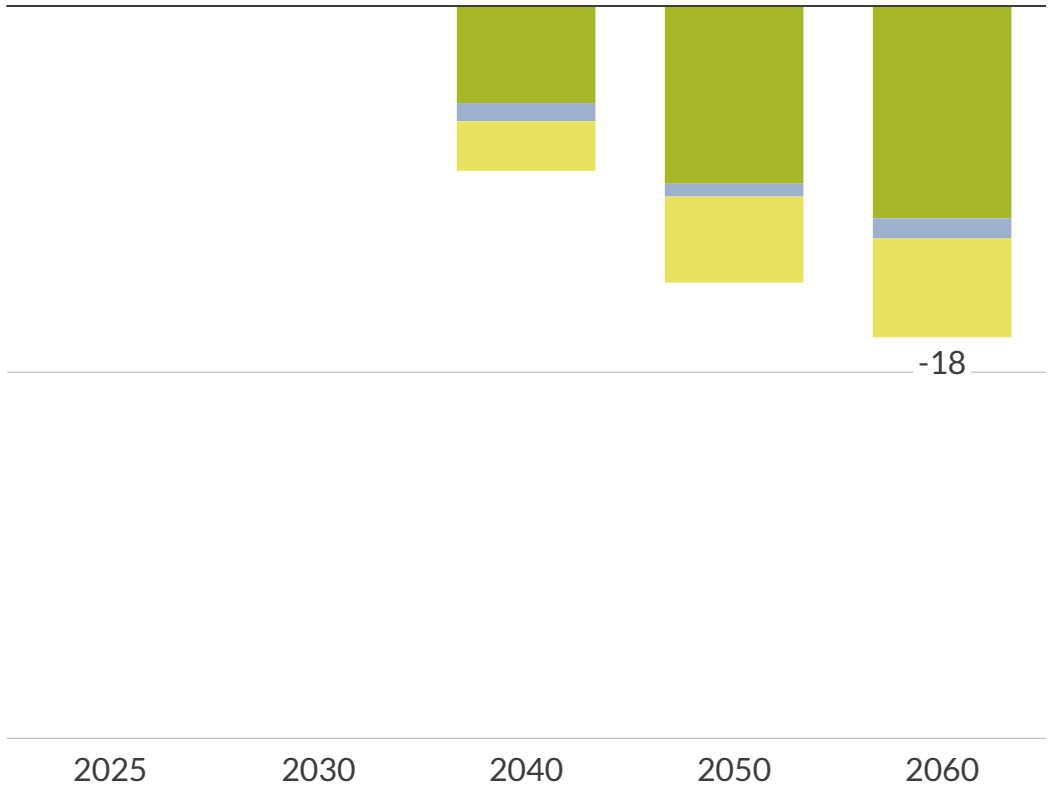
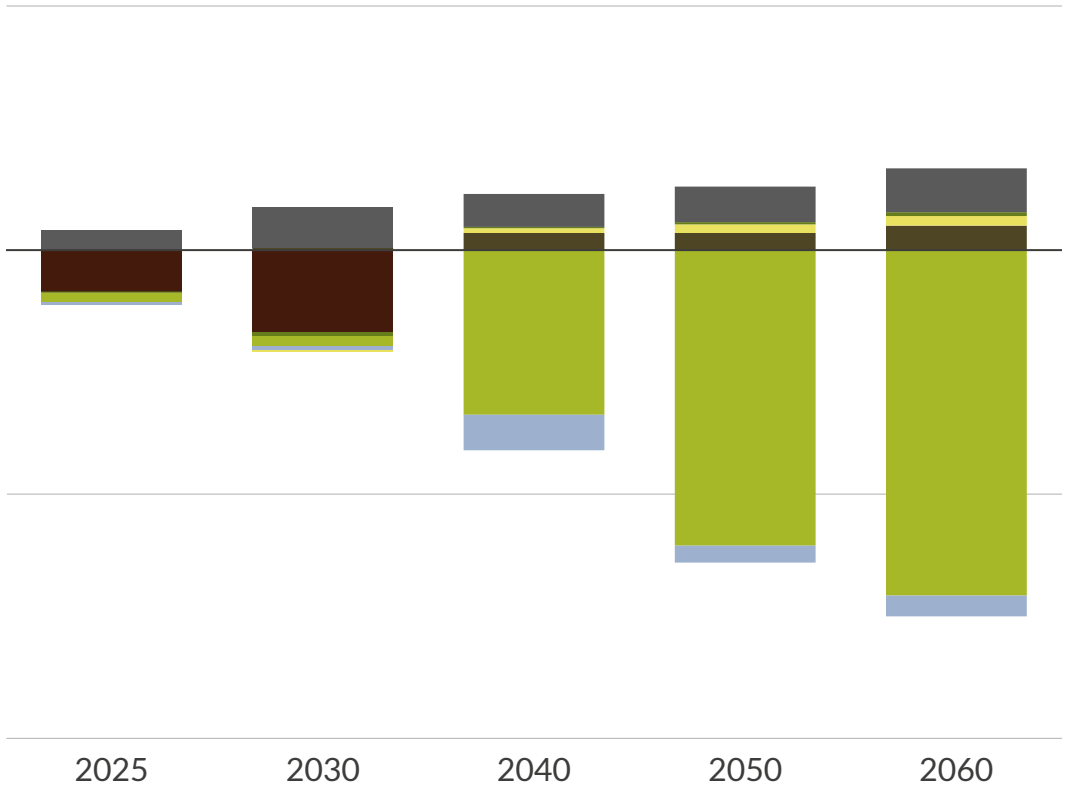
Installed capacity compared to the Central Case
GW



Generation compared to the Central Case
TWh

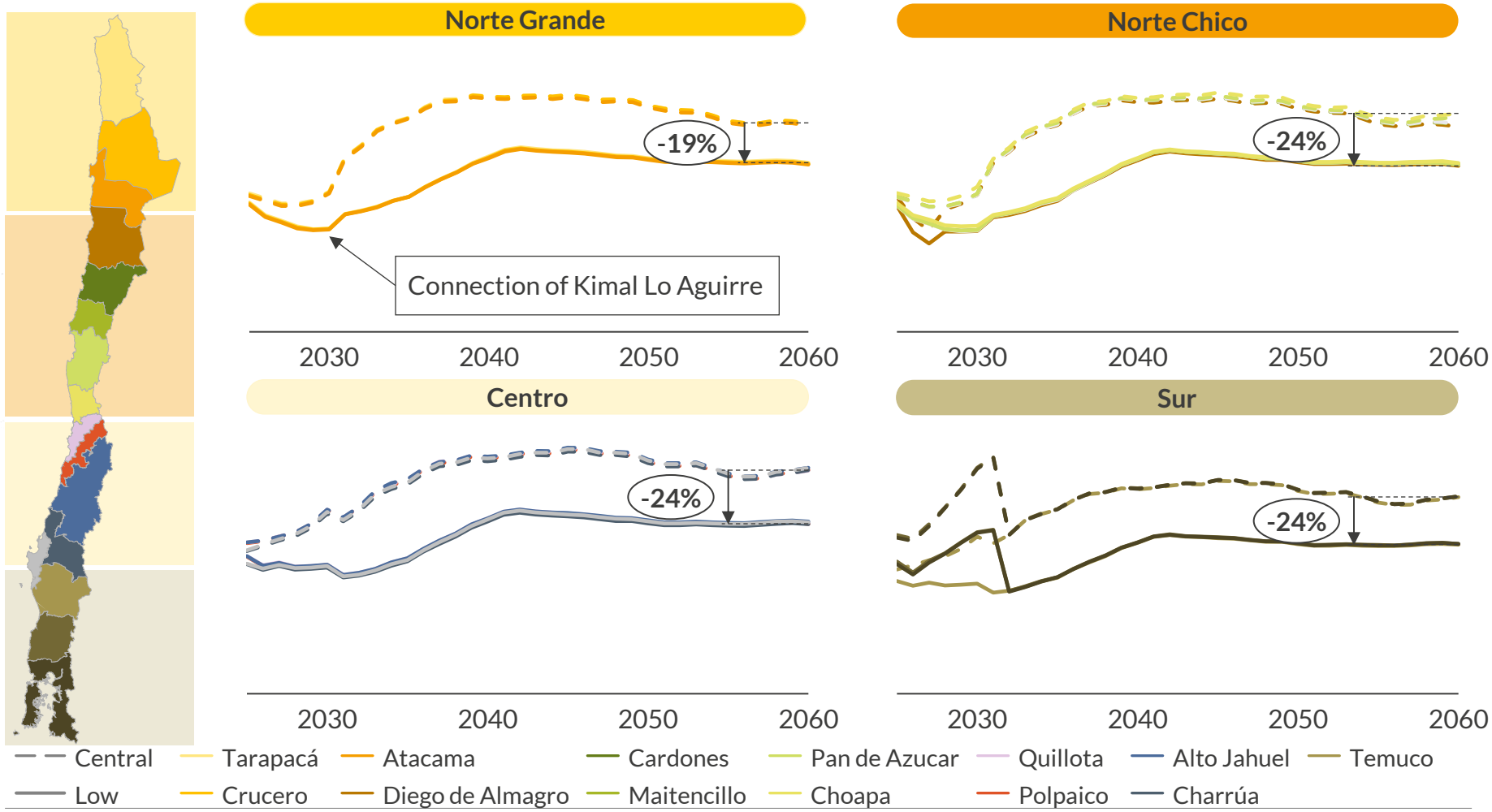


Gas / oil peaker | Battery storage | Hydro | Onshore wind | Solar PV | Biomass/ other RES | Gas CCGT | Coal

Source: Aurora Energy Research

In the Low scenario, baseload prices are on average 22% lower than in the Central in 2060

Baseload prices by nodal hub for scenarios Central and Low
$/MWh, real 2023[1]



Sources: Aurora Energy Research

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- In the Low scenario, baseload prices do not follow the same pattern as in the Central scenario, as in the short-term the lower demand leads to a prolonged oversupply of capacity until late 30s.
- In the long-term prices are ~19-24% lower as due to lower demand, low CAPEX, and lower commodity prices.
- Norte Grande is the region with the least price divergence between scenarios, as it experiences the largest decrease in installed capacity in the Low scenario compared to the Central scenario: 72% of the solar PV capacity reduction occurs in this region, allowing the region to adjust and avoid oversupplying the system, which has faced a decline in demand in the Low scenario.

In the Low scenario, solar capture prices are 25% lower on average as a response to reduced demand and lower gas prices

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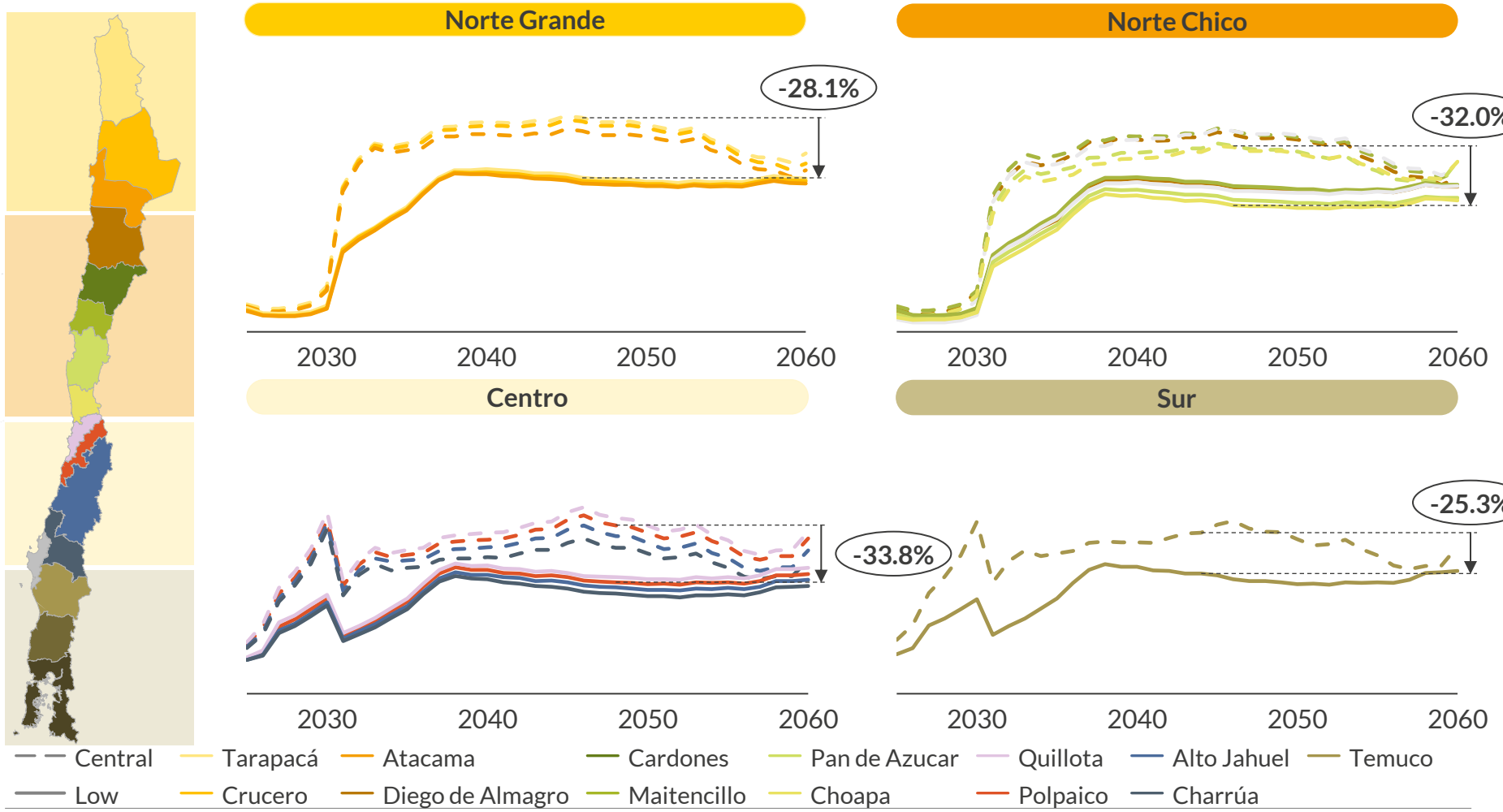
Generation-weighted average solar prices by price hub for scenarios Central and Low
$/MWh, real 2023



- In the Low scenario, generation-weighted average solar prices diverge from the pattern seen in the Central, as baseload prices follow a different trend.
- In both scenarios, generation-weighted average solar prices align with the pattern of baseload prices, except for the price shocks resulting from interconnection upgrades in the Central scenario. These shocks are not observed in the Low scenario, as the additional interconnections are deemed unnecessary in this case.

Sources: Aurora Energy Research

Generation-weighted average wind prices are on average 21% lower in the Low than in Central by 2060

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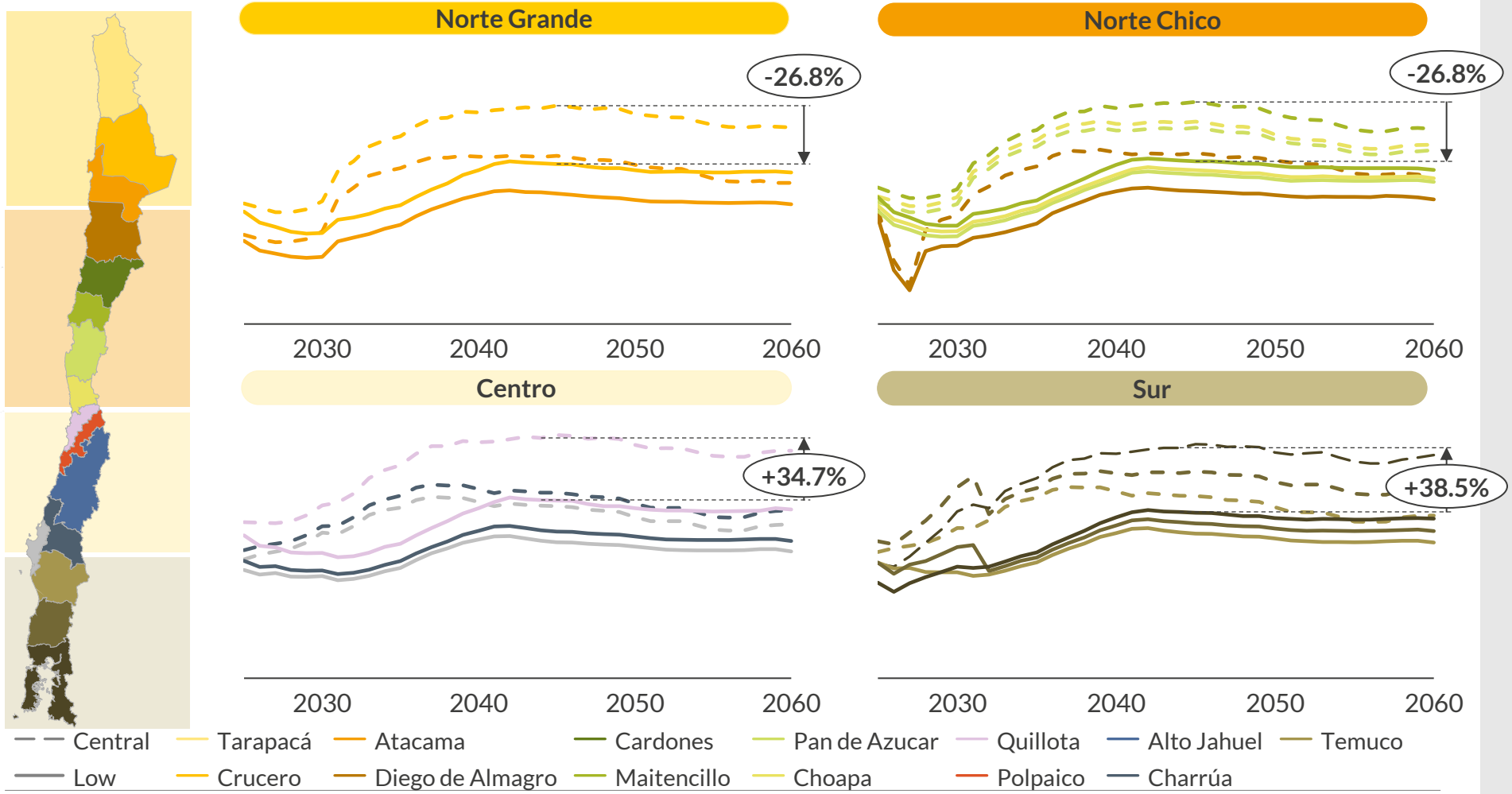
Generation-weighted average wind prices by price hub for scenarios Central and Low
$/MWh, real 2023



- In the Low scenario, generation-weighted average wind prices diverge from the pattern seen in the Central scenario, as the baseload prices follow a different trend.
- Capture prices in the Low scenario continue to follow the pattern of baseload prices, whereas in the Central scenario, they decrease due to the cannibalization effect of the increased installed capacity.

Sources: Aurora Energy Research

Given the relevance of hydro and shift in hydro conditions, we modeled a dry hydrological scenario representing the P90 over the past 63 years

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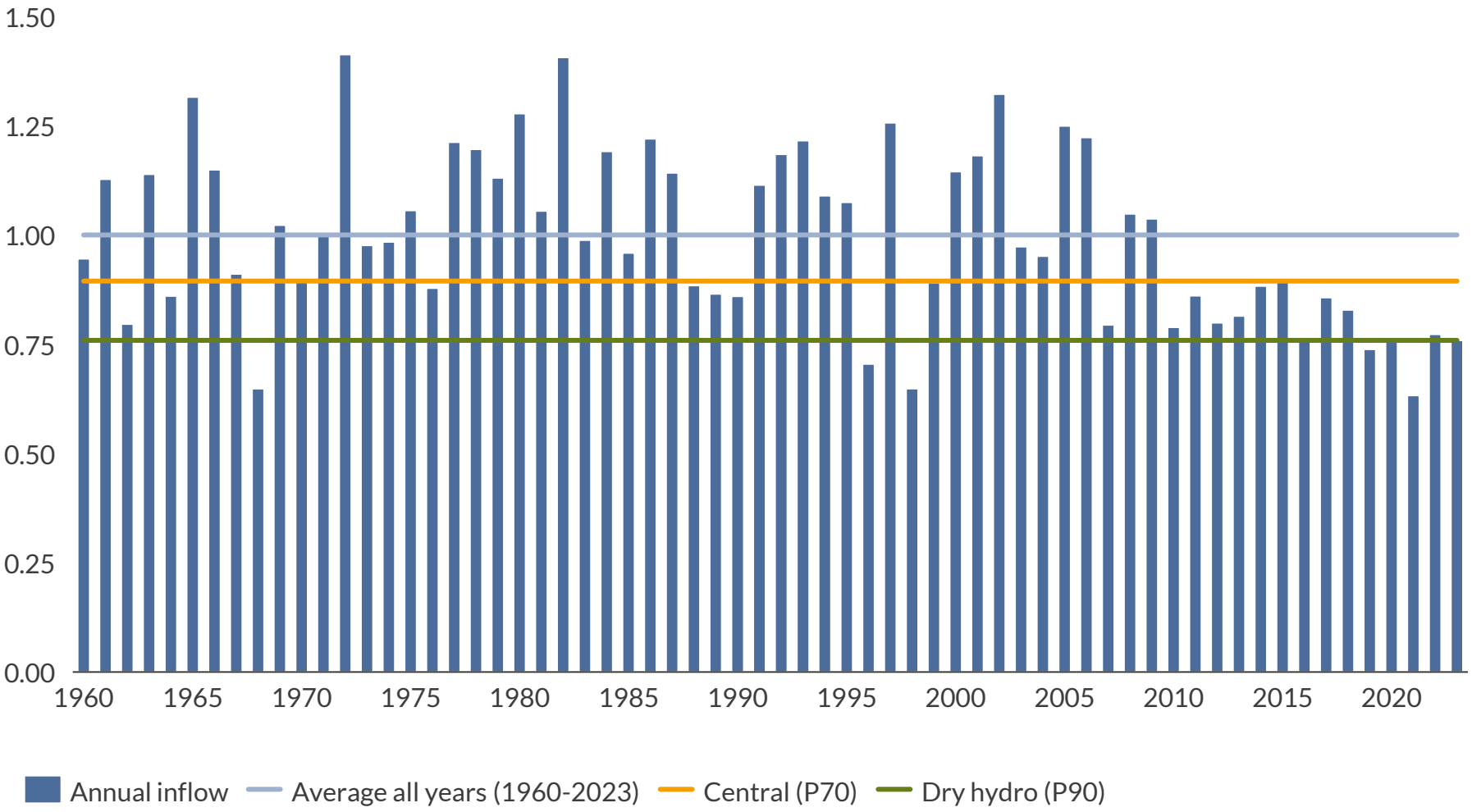
Annual inflows[1]

Ratio normalized to the average historical inflow[2]



1) Data from Long-term operation or *Programación 5 años* (PLP), except 2023 data which was taken from CNE. 2) Considering the historical period of 1960-2022, so the last 63-years average. 3) Looking at generation data from the last 10 years.

Source: Aurora Energy Research

- In our Central scenario, we assume a P70[2]. In contrast, our dry hydro scenario is equivalent to a P90[2] resulting in 14% less hydro generation compared to our central.
- Over the past decade in Chile, yearly hydro generation has contributed 20–34% of total electricity production, significantly influencing wholesale market prices.
- Considering that the last decade has been drier than historical averages and factoring in increasing weather uncertainty, we included a more conservative P90 scenario to better account for variations in hydro availability.

In our dry hydrology scenario, hydro generation is mainly replaced by coal and gas in the short term while solar plays a bigger role at the end of the horizon

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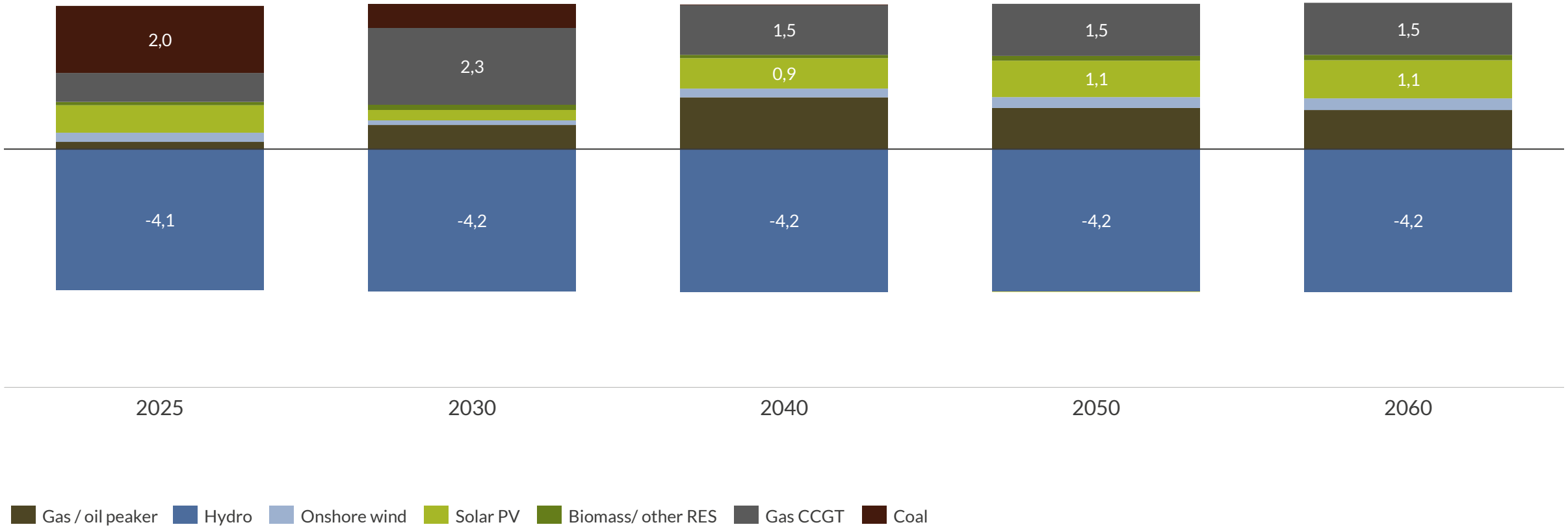
Generation compared to the Central Case

TWh



In the Dry Hydro sensitivity, baseload prices in 2060 are 22% higher than Central, with the South specifically impacted in 2030

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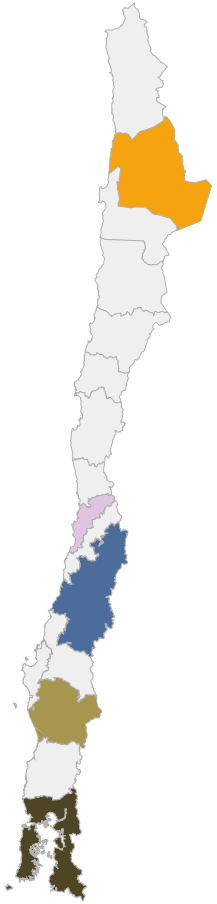
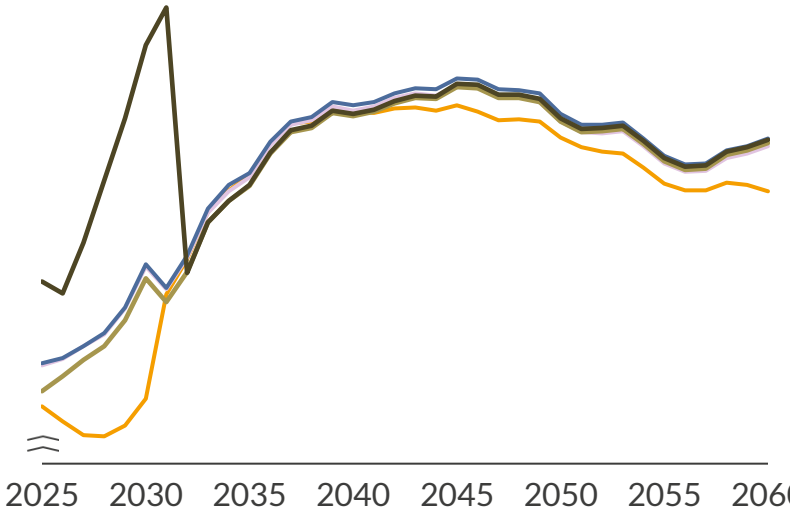
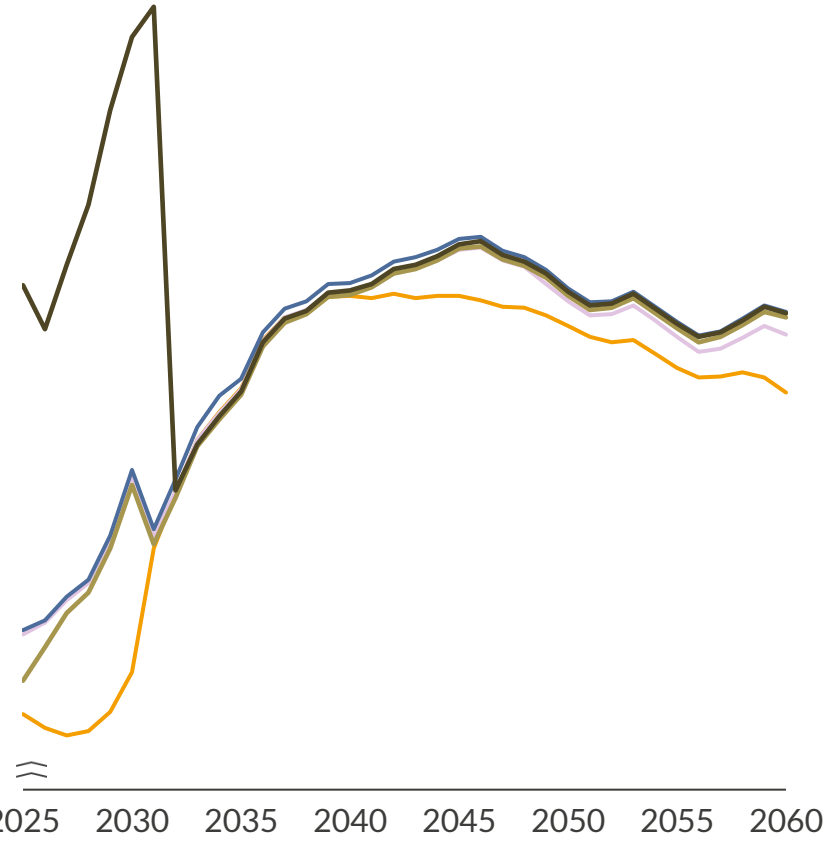


Central – Baseload Prices
$/MWh (2023 real)



Low Hydro – Baseload Prices
$/MWh (2023 real)



Crucero Quillota Alto Jahuel Temuco Puerto Montt

- Switching from a P70[1] to a drier hydro P90[1] scenario reduces annual hydro generation enough to raise baseload prices by on average 22% by the end of the forecast as this hydro generation is replaced by more expensive gas plants.
- All regions are affected, but central and southern regions are more heavily impacted until Kimal becomes operational, with price increases of up to15% in central regions and up to 40% in Osorno and Puerto Montt compared to the Central scenario.

1) Considering the historical period of 1960-2022, which is equivalent to last 63-year average.

Source: Aurora Energy Research

In the Dry Hydro case, solar capture prices rise 27% in 2060; hydro-reliant regions see greater interconnection impact

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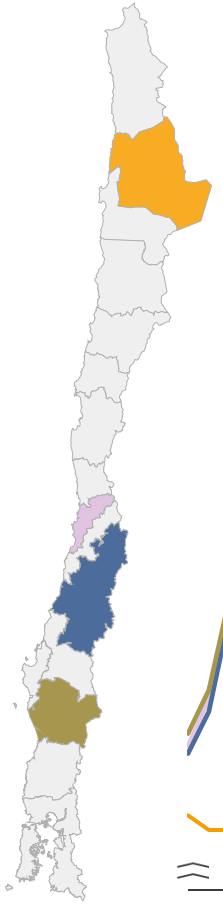
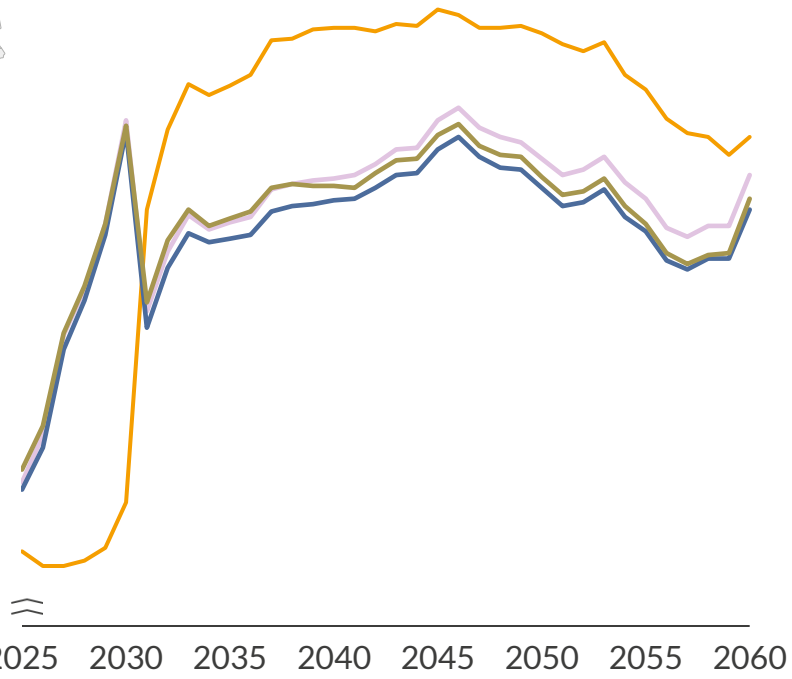
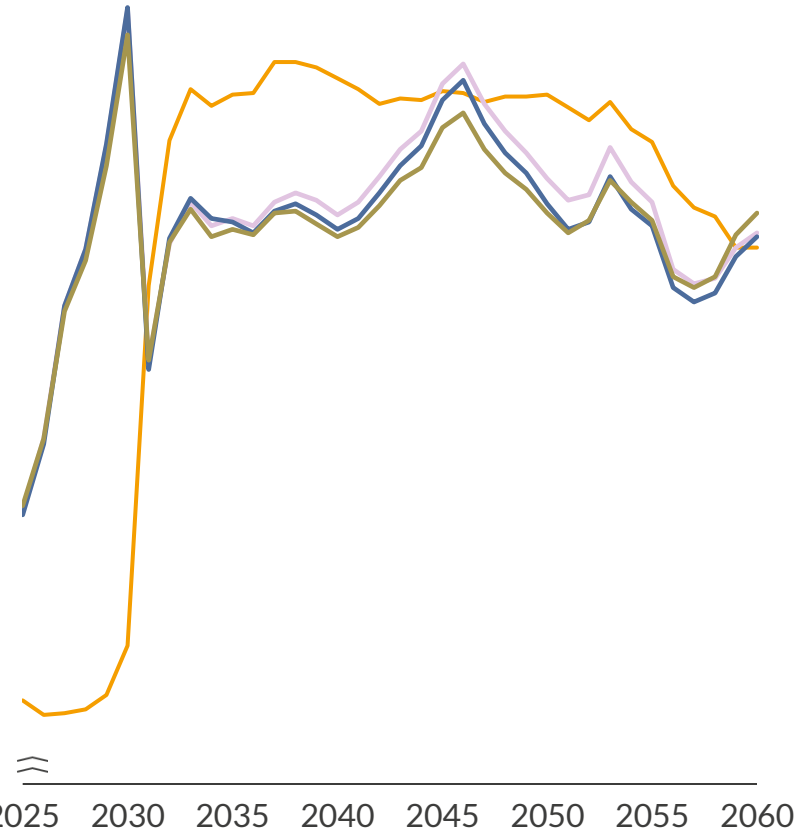


Central - Solar generation-weighted average prices
$/MWh (2023 real)



Low Hydro - Solar generation-weighted average prices
$/MWh (2023 real)



Crucero Quillota Alto Jahuel Temuco

- The increase in baseload prices also leads to an increase in capture prices, which differs depending on the nodal hub.
- The impact is most pronounced in central and southern regions (south of the Quillota hub), with increases up to 12% before Kimal-Lo Aguirre becomes operational.
- Interconnection expansion continues to affect these nodal hubs more heavily as more than 99%[1] of the hydro generation of the system is located here.
- Prices in central and southern hubs increase until 2047, when a northern-to-central upgrade becomes operational, and peak again in early 50s before the next upgrade comes online.

1) Looking at generation data from 2023.

Source: Aurora Energy Research

Transmission expansions in the 2030s are key to raising solar capture prices, in all Aurora scenarios renewables are set to dominate generation in 2060

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1. In our **central scenario** short term prices are expected to differ between solar heavy northern regions, high demand central regions and badly connected southern regions, mainly due to supply/demand imbalances. Overall, **short term prices are expected to rise** with coal phasing out and being replaced by more pricy sources, in the **mid to long term prices will converge** once the HVDC line Kimal Lo Aguirre comes online in 2031 enabling renewable power exports from north to south.

2. In our **low scenario** we expect **18 GW less of solar, wind and battery buildout** compared to central. We assume a lower demand which leads to a short-term oversupply of capacity leading to less build along with lower commodity prices that reduce prices in peak hours. This leads to a **decrease of 19-24% in long-term baseload prices** compared to the central scenario with a significant impact on renewable capture prices.

3. Our **dry hydrology sensitivity** assumes the same capacity build as in central, however a P90 for hydro inflows is assumed as opposed to a P70 we assume in our central, meaning dryer hydrological conditions. This leads to 15% less hydro generation which is then replaced by more expensive coal and gas generation. **Baseload prices are expected to be 22% higher on average** while capture prices for solar and wind are mainly impacted in southern, hydro focused regions.

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Forecast Reports & Data

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Take an in-depth look back at the past month's technology and market updates

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Forecast reports and data in interactive formats and market long-term price projections with scenarios to match your business needs

Interactive EOS Platform

Comprehensive data and content provided on a web-based, interactive platform with company-wide access; Explore scenarios through EOS, our dynamic online platform featuring a full library of reports and datasets

Strategic Insights

3 Group Meetings

Three Group Meeting roundtable events in **Santiago** with key market participants such as developers, investors, financiers, utilities, operators, and government officials

Upcoming Schedule:

October 2024: Long-term forecast

March 2025: Ancillary services and BESS revenues

Strategic Insight Reports

In-depth, thematic reports on topical and timely issues in your market

Analyst Support

Biannual workshops and support from our bank of analysts, including native speakers and on-the-ground experts

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