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Infrastructure Victoria
Energy Transition Analysis

November 2024

Introduction

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Report objective:

Aurora Energy Research (Aurora) has been engaged by Infrastructure Victoria (IV) to conduct high-level analysis and support the testing of proposed policy interventions, offering insights to guide their strategy for decarbonising Victoria's power sector. Aurora's role involved developing multiple modelling scenarios to assess the impacts of varying sensitivities on key power sector indicators including wholesale electricity prices and power sector emissions. These sensitivities were determined in collaboration with IV across several workshops, discussed in Part 2 of this report.

Part 1 : Understanding Victoria's energy targets

The first section of the report presents a qualitative overview on the energy market in the state of Victoria (VIC), summarising current policies and challenges for Victoria.

Part 2: Scenario Modelling

This section of the report presents results of the scenario analysis. In total, 8 scenarios were analysed using the Aurora Energy Research in-house market model AER-ES AUS:

1. **Base Case – Targets Achieved** whereby announced state and federal renewable energy targets are achieved, and model inputs are primarily assumptions from the Australian Energy Market Operator (AEMO) 2024 Integrated System Plan (ISP) Step Change scenario.
2. **Status Quo scenario**, which does not enforce state renewable energy targets and diverges from Base Case with respect to offshore wind buildout and coal closures. Coal plant closure timings are aligned to current asset owner announcement dates in this scenario.
3. **Demand Increase scenario,** which consider higher energy demand than the Base Case. This higher demand is assumed across all segments, including residential, commercial and industrial activities.
4. **Slow Consumer Energy Resource (CER) / Distributed Energy Resource (DER) uptake scenario,** with lower levels of CER/DER uptake in comparison to the Base Case.
5. **Low Weather Year scenario** in comparison to Base Case with lower Variable Renewable Energy (VRE) generation across the National Electricity Market (NEM)[1], assuming unchanged Base Case capacity buildout.
6. **Delayed Victoria transmission buildout scenario**, incorporating a 2-year delay to Victoria Renewable Energy Zone (REZ) expansion timelines under AEMO's 2024 ISP Step Change Optimal Development Pathway and a 3-year delay of Marinus Link.
7. **Removal of Victoria offshore wind scenario**, re-allocating capacity from Base Case offshore wind development to alternate energy generation/supply in Victoria.
8. **Victoria's Accelerated Offshore Wind Buildout scenario (hypothetical)**, with Victoria hypothetically achieving state offshore wind targets earlier than announced (9GW by 2035 – 5 years earlier than legislated).

Report outputs:

Our analysis focuses on wholesale electricity power prices, which represent only part of the overall cost of electricity. Other significant factors influencing the final price paid by consumers include network infrastructure expenses and potential government subsidies. While these elements are not directly examined in this analysis, it's essential to acknowledge their substantial contribution to overall pricing.

All prices in this report are shown in real $A2023 values. All years in this report are in financial years, beginning 1st July and ending 30th June.

1) The National Electricity Market (NEM) is the interconnected power system covering Australia's eastern and southern states, including Queensland, New South Wales, Victoria, South Australia, and Tasmania. It operates as a wholesale electricity market where electricity is traded between generators and retailers, and it is managed by the Australian Energy Market Operator (AEMO).

Executive Summary

Aurora Energy Research (Aurora) has been engaged by Infrastructure Victoria (IV) to conduct high-level analysis and support the testing of proposed policy interventions, offering insights to guide their strategy for decarbonising Victoria's power sector.

Aurora has modelled multiple scenarios, developed in collaboration with IV, to assess how key assumptions impact Victoria's energy transition, including wholesale electricity prices and power sector emissions.

While the report focuses solely on Victoria's energy transition, coordination across the National Electricity Market (NEM) regions is crucial. Developments in Victoria will directly impact neighboring states, and vice versa, making collaboration across the NEM essential to a successful renewable energy transition.

It is also important to note that while wholesale electricity prices play a key role in the total cost to consumers, other factors such as network costs and government subsidies also impact the final price. Aurora's report has only considered wholesale market impacts in our analysis and in this report.

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Renewable energy generation is expected to play an increasingly important role as Victoria undergoes its energy transition. To build a reliable, affordable, and sustainable energy system, careful and strategic policy planning is crucial.

Aurora has modelled several potential decarbonisation pathways for Victoria up to 2050, considering eight scenarios that could help inform the energy landscape of the National Electricity Market (NEM). Each modelling scenario branches from the Base Case which is largely aligned to the Australian Energy Market Operator (AEMO) 2024 Integrated System Plan (ISP). The scenarios encompass a wide range of outturns across thermal outcomes, renewables deployment, and the need for flexible generation which provide insight into how Victoria's power system may evolve.

As Victoria's power sector transitions, several key insights have emerged:

- **Victoria's shift to renewable energy brings both challenges and opportunities.** As coal retires, renewable energy will play an increasingly important role in Victoria's energy mix. Victoria has seen significant increases of wind and solar generation; however even faster rates of buildout are required to achieve 95% renewables by 2035.
- The **timing of coal plant closures** is a key factor in Victoria's energy transition, with timely closures essential for meeting the state's renewable energy targets. To achieve these targets, coal plants will need to exit earlier than currently announced to make room for renewable energy deployment. However, if coal assets operate until the end of their technical life, this could lead to higher power sector emissions, as coal generation would reduce the need for renewable capacity.
- **Offshore wind development in Victoria** could play a key role in expanding local renewables supply. The Victorian Government has set a target of 9GW of offshore wind capacity by 2040, which, if achieved, would significantly strengthen Victoria's position as a net exporter of power to NSW. In this analysis, Aurora has not factored in potential support packages that may be required to bring offshore wind to market.
- **Major grid development is needed to accommodate a surge in renewables buildout**, however existing and potential future delays could adversely impact VRET progress. Transmission network augmentations will be key to unlocking renewable capacity in Victoria and around the NEM. If network upgrades are delayed, congestion and curtailment could limit the growth of renewable capacity, driving wholesale market prices higher in some years.
- **Rapid electrification will need to occur to meet decarbonisation ambitions**, which could challenge Victoria's ability to meet renewable energy targets. If electricity demand grows faster than renewable generation can commission, it is likely that additional firming will be required to fill the gap. More requirements for firming capacity will generally correlate with higher wholesale prices as higher marginal cost assets (like gas assets) would set market prices.
- **Consumer energy resources are expected to form a significant portion of supply in the market**, but headwinds from declining subsidies and increasing export costs may slow down progress. Lower uptake of rooftop solar and behind-the-meter batteries would shift focus to grid-scale utility assets to meet demand which may put pressure on existing network capacity. However, if electric vehicle adoption is also slower than expected, the overall impact on Victoria may be reduced.
- **Balancing electricity demand and supply** will require close attention to all of the above factors. If demand outpaces growth in renewable generation or transmission upgrades, wholesale prices are likely to rise, and reliance on gas plants would increase, particularly in years with lower renewable output. This could slow the clean energy transition and lead to higher emissions.

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I. Market overview

1. Summary of current policies driving renewable energy targets in Victoria
2. Challenges in meeting state targets

II. Market modelling scenarios

III. Appendix

Victoria's electricity market operates within a complex energy market regulatory framework, influenced by both state and federal policies

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Policies	Description
State government Interventions	▪ Targeting up to 9GW of offshore wind by 2040, however no support mechanism has been announced. ▪ Legislated Victorian Renewable Energy Target (VRET) of 50% by 2030, further announcement of 65% by 2030 and 95% by 2035. ▪ VRET2 auction winners announced, comprising six projects (623MW of solar, and up to 365MW of co-located batteries). ▪ Contract awarded to Neoen for 300MW System Integrity Protection Scheme (SIPS) battery to increase system security. ▪ Formation of VicGrid and $540m Renewable Energy Zone (REZ) Fund to strengthen grid connections in 6 REZs. ▪ Vic legislated storage targets of at least 2.6GW by 2030 and 6.3GW by 2035; 300MW grid-scale lithium-ion Victorian Big Battery (VBB) project near Geelong. ▪ Re-establishment of the State Electricity Commission (SEC), with its first investment being $245m in the Melbourne Renewable Energy Hub (MREH). ▪ Victorian Transmission Investment Framework (VTIF) final design paper released in July 2023, draft Victorian Transmission Planning Guidelines for consultation in 2024. ▪ **Household-specific**: Victoria gas connection ban in all new homes that require a planning permit from 1 Jan 2024; Victorian Energy Upgrades (VEU) program since 2009; Solar Homes program – a $1.3 billion, 10-year investment established in 2018; Zero Emissions Vehicle Subsidy (ended in June 2023).
Federal and joint government interventions	▪ **Federal**: Clean Energy Finance Corporation (CEFC), Australian Renewable Energy Agency (ARENA), Snowy 2.0, Australia's Treasury Laws Amendment (Prohibiting Energy Market Misconduct) Act 2019, 'Rewiring the Nation' to provide low-cost financing for transmission, Capacity Investment Scheme, Safeguard Mechanism. ▪ **Joint Federal and State**: Transmission support (Victoria to NSW Interconnector 'VNI' West early works underwriting, Marinus exploratory spending), the National Energy Transformation Partnership, 7-star rated new homes through the National Construction Code.
Big picture market design	▪ Post 2025 National Electricity Market (NEM) Design project. ▪ Australian Energy Market Operator's (AEMO) Integrated System Plan. ▪ There is currently no economic link between climate and energy policy e.g. fungibility of Large-scale Generation Certificates (LGCs) and Australian Carbon Credit Units (ACCUs), carbon price, etc. ▪ Renewable Energy Guarantee of Origin (REGO) certificates are to replace LGCs beyond 2030.
Ongoing market reform and rule changes	▪ Market price cap increases. ▪ Retailer Reliability Obligation. ▪ Wholesale demand response mechanism. ▪ Primary frequency response rule changes. ▪ Fast frequency response. ▪ Integrating Energy Storage Systems in the NEM. ▪ Enhanced Reliability Standard – AEMO's Interim Reliability Measure of 0.0006%. ▪ Minimum System Load. ▪ Administered Price Cap changes after the June 2022 market suspension.

Source: Aurora Energy Research

The expanded Federal Capacity Investment Scheme (CIS) is designed to support the investment of 32GW of capacity to facilitate Australia's energy transition

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Expanded CIS key objectives

- Achieve 82% renewable electricity by 2030 through the deployment of 23GW of renewables and 9GW of clean dispatchable capacity in the National Electricity Market (NEM).
- Address potential reliability/generation shortfalls as the coal fleet retires.
- Assisting each state and territory in achieving their specific renewable energy targets.

CIS mechanisms

- **Capacity Investment Scheme Agreements (CISAs):** financial contracts specifying a revenue ceiling and floor that aim to mitigate financial risk of projects and promote investment.
- **Renewable Energy Transformation Agreements (RETAs):** bilateral agreements between State/Territories and the Commonwealth to coordinate in achieving shared energy objectives.

Key uncertainties

Technology – Unclear how the capacity will be split across technologies (onshore/offshore wind, solar, different durations of dispatchable capacity).

Location – Allocation of capacity across states and within each state is uncertain after the initial tender round which targets a minimum capacity of 1.4 GW for Victoria, 2.2 GW for NSW, and 300 MW for both South Australia and Tasmania.

Grid and planning – Unclear how additional CIS capacity will coordinate with future network upgrades.

Post-2030 framework – CIS provides a framework to get to the national 82% target for 2030, but it is not clear what will drive investment after 2030.

2023

May 2023
The Capacity Investment Scheme (CIS) was formally announced in the 2023-2024 budget. Aimed to support 6GW of capacity

June 2023
The CIS expands on the existing LTESA 2 firming tender[1], procuring an additional 550MW to the original 380MW target

September 2023
The SA-VIC CIS tender was announced, targeting 2,400MWh equivalent clean dispatchable storage

November 2023
The CIS was expanded, targeting 23GW of renewables and 9GW of clean dispatchable capacity by 2030

November 2023
AEMO Services awarded 1,075MW / 2,980MWh of firming capacity LTESA contracts, counting towards the CIS targets

December 2023
CIS SA-VIC tender opens

29th February 2024
Expanded CIS design paper was released

25 March 2024
Submissions close for the expanded CIS design consultation paper

12th April 2024
WA CIS Design Paper released

31 May 2024
CIS Tender 1 - NEM Generation Stage A project bid commenced

CIS SA-VIC tender closed

1st July 2024
CIS Tender 1 - NEM Generation Stage A project bid closed

22 July 2024
CIS Tender 2 - WA Stage A: project bid commenced

Aug/Sep 2024
CIS Tender 1 - NEM Generation Stage B invitation to submit Financial Value Bid

Further tenders

1) Long-Term Energy Service Agreement

Source: DCCEEW

The Australian Government aims to achieve its targets for the National Electricity Market (NEM) through a series of 8 tender rounds

Concluded and ongoing tenders

As part of Stage 1 of the CIS, two pilot tender rounds have been launched with feedback from previous consultation rounds used to adjust current design parameters of the scheme.

NSW EIR Firming Tender:

- On 22nd of November 2023, the Federal Government announced the 6 successful NSW bids totalling 1075MW of capacity. All projects are targeting December 2025 to begin commercial operations.
- The successful bids include Akaysha Energy's 415MW 4-hour battery, AGL Energy's 500MW 2-hour battery, Iberdrola Australia's 65MW 2-hour battery and Enel X Australia's three virtual power plants totalling 95MW with at least a 2 hour dispatch duration.

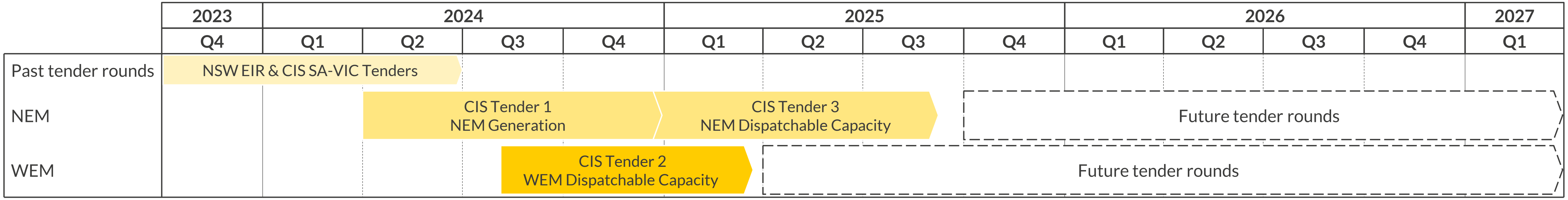
CIS SA-VIC Tender:

- The SA-VIC tender aims to procure 600MW/2400MWh of storage capacity by FY27 to address potential reliability shortfalls forecast in the 2023 ESOO.
- The successful bids include Energy Australia's Wooreen and Hallet batteries (400MW/1600MWh), Pacific Green's Limestone Coast West BESS (250MW/1000MWh), and ZEN Energy's Solar River project (170MW/653MWh BESS and 230MW solar farm).

Future tenders[1]

Stage 1 procured 1075MW of clean dispatchable capacity. The subsequent bi-annual tender rounds are expected to procure 23GW of renewable capacity and the remaining 7.9GW of clean dispatchable capacity.

Round	Specifics – NEM CIS Tenders
1	Tender timeline: 31 May 2024 – December 2024 Tender target: 6GW of renewable capacity; with at least 2.2GW allocated to NSW, 1.4GW to VIC, 0.3GW to SA and 0.3GW to TAS
3	Tender timeline: 13 November 2024 – Q3 2025 Tender target: 4GW/16GWh of dispatchable capacity
4+	Subsequent tenders aim to award CISAs for remaining capacity to all jurisdictions subject to outcomes of RETA negotiations with the Commonwealth



1) Tender schedule based on latest information available from AEMO Services as at November 2024

Source: DCCEEW

In 2024, the Federal Government awarded twelve unconditional feasibility licences for the 15,000 km^2 declared offshore wind region in Gippsland, VIC

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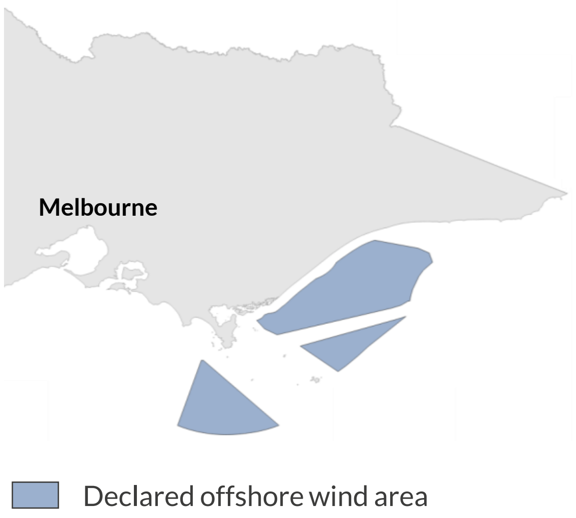
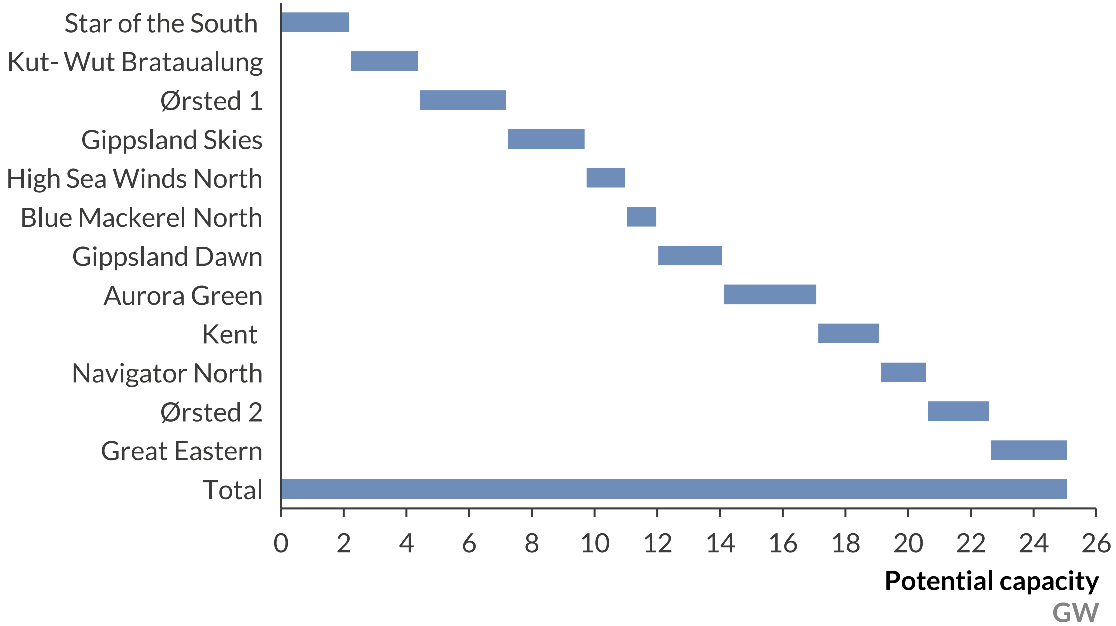
Gippsland declared offshore wind area - Victoria



Unconditional feasibility licence winners



Offshore wind areas - NEM	Gippsland	Southern Ocean	Hunter	Illawarra	Bass Strait
State	VIC	VIC	NSW	NSW	TAS
Date of declaration	9 December 2022	6 March 2024	12 July 2023	15 June 2024	-
Potential capacity	25GW	2.9GW	5GW	2.9GW	28GW
Status	Feasibility licences granted.	Open for feasibility licence applications.	Assessment of feasibility licence applications.	Open for feasibility licence applications.	Public consultation completed. Ministerial consideration of final area.

1) Offshore Wind Energy Implementation Statement 3, Victoria State Government

Source: DCCEEW, NEATS Public Portal, Australian Energy Council, Victoria State Government

Offshore wind development timelines in Victoria

- The Federal Minister for Climate Change and Energy announced the identification of six priority areas in Australia for offshore wind in August 2022.
- In May 2024, the Federal Government awarded the first six unconditional feasibility licences for the Gippsland declared offshore wind area, with six additional projects announced in July.
- Feasibility licence holders will now commence detailed environmental assessments and project development activities in advance of submitting a Commercial Licence application.
- The Victorian Government has indicated their intention to develop a support package for offshore wind, expected to be delivered via an auction process, with Expressions of Interest (EOIs) targeted to commence in Q4 2024, Requests for Proposal (RFPs) targeted to commence in Q3 2025, with contract negotiation and award expected in 2026[1].
- The State Government released the Victorian Offshore Wind Policy Directions Paper in March 2022, followed by Implementation Statements 1, 2, and 3 from late 2022 to 2023, outlining its strategy for developing offshore wind energy in the state.

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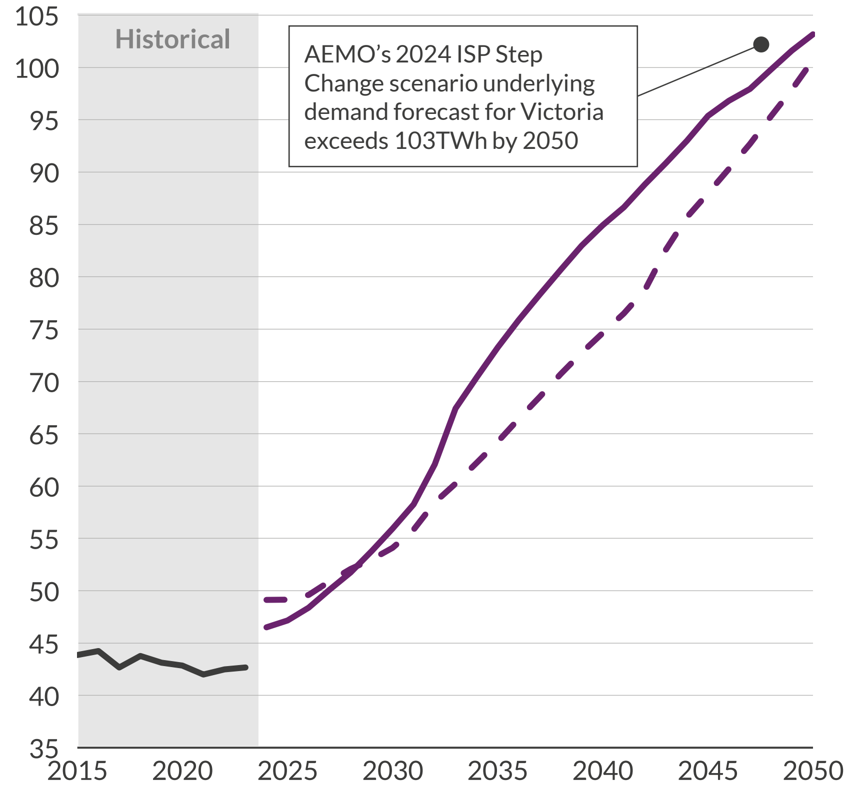
Rapid electrification will need to occur to meet decarbonisation ambitions, which could challenge Victoria's ability to meet renewable energy targets

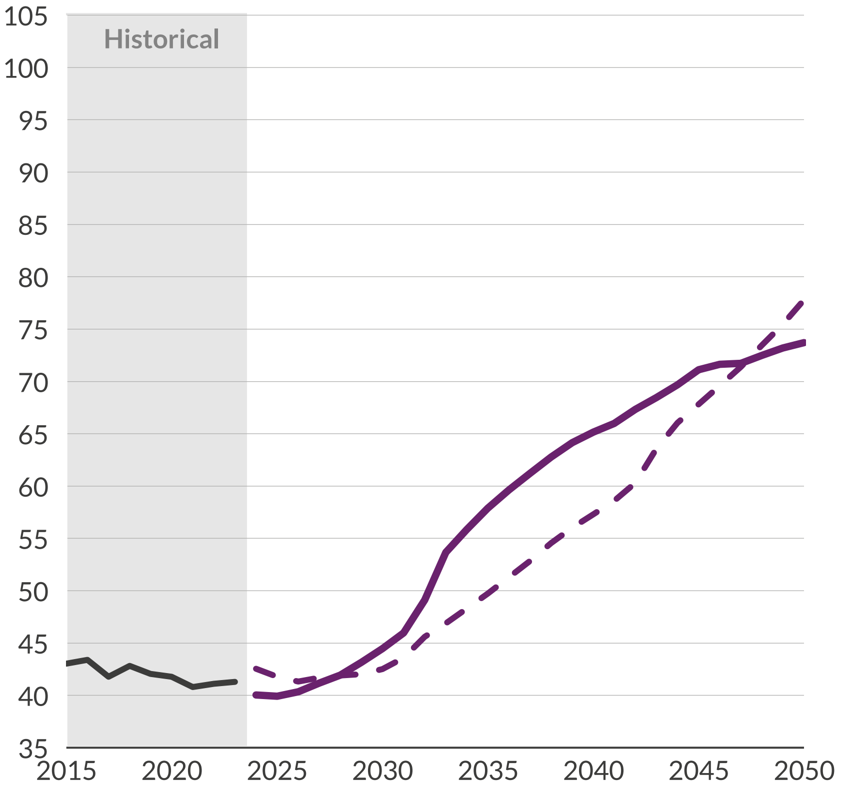
VIC Underlying demand[1]
TWh, Historical vs forecast



EV Energy Required
% of Underlying Demand, 2024 ISP (2030 to 2050)

4% | 10% | 15% | 19% | 23%

VIC Operational demand[2]
TWh, Historical vs forecast



EV Energy Required
% of Op. Demand, as per 2024 ISP (2030 to 2050)

6% | 13% | 20% | 26% | 32%

2024 ISP Step Change — 2022 ISP Step Change — History

Demand forecasts

- AEMO has revised its demand forecast upwards since the 2022 ISP and is now more bullish on demand growth.
- The Step Change scenario's higher demand outlook is driven by greater electric vehicle (EV) uptake, hydrogen production and electrification of industry to achieve net-zero ambitions in the medium-term.
- Victoria's Renewable Energy Target (VRET) aims for 65% renewable generation by 2030 and 95% by 2035, therefore further increases in demand may make these targets harder to meet.
- By 2050, EVs are forecast to increase electricity consumption by over 23TWh from 2025 levels under the Step Change scenario.
- The recently legislated New Vehicle Efficiency Standard (NVES) aims to bridge the policy gap to facilitate higher EV uptake.

1) Underlying demand includes commercial/industrial and residential demand and EV demand; 2) Operational demand is underlying demand net of rooftop solar and behind-the-meter (BTM) battery generation
Source: AEMO

Victoria faces significant electrification needs to replace gas usage, as it has the largest gas heating load among NEM states, largely driven by its climate

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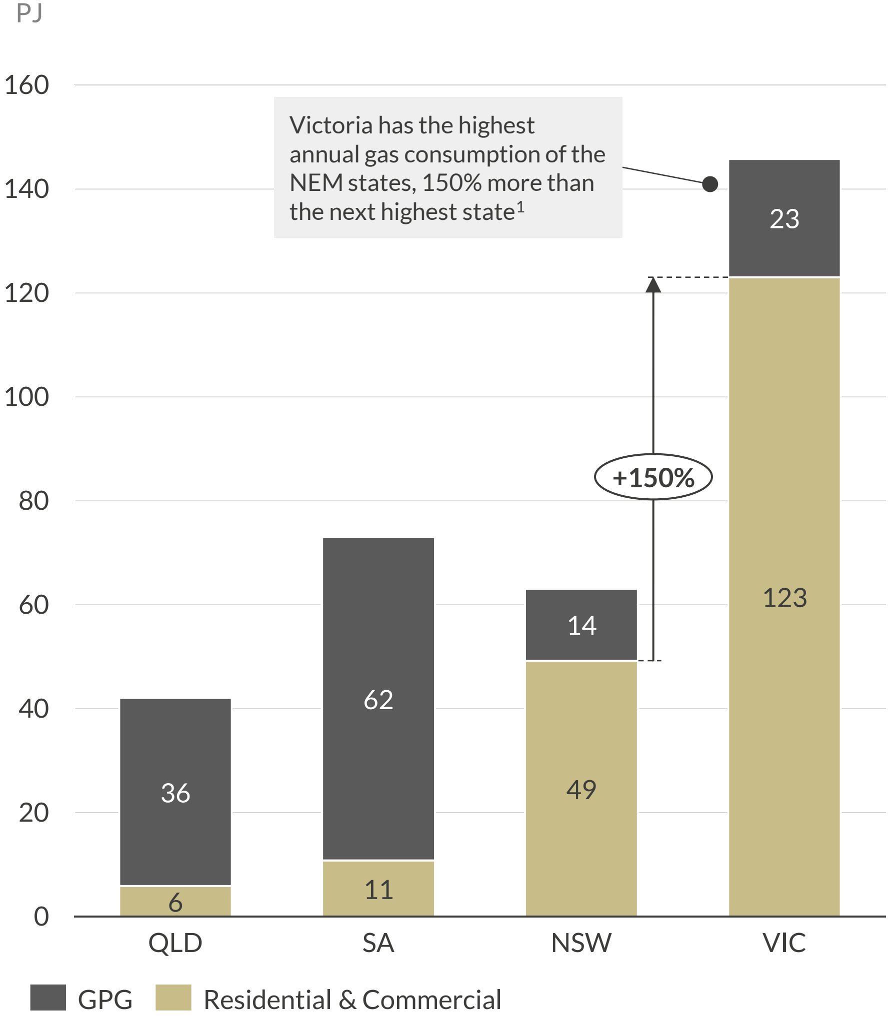
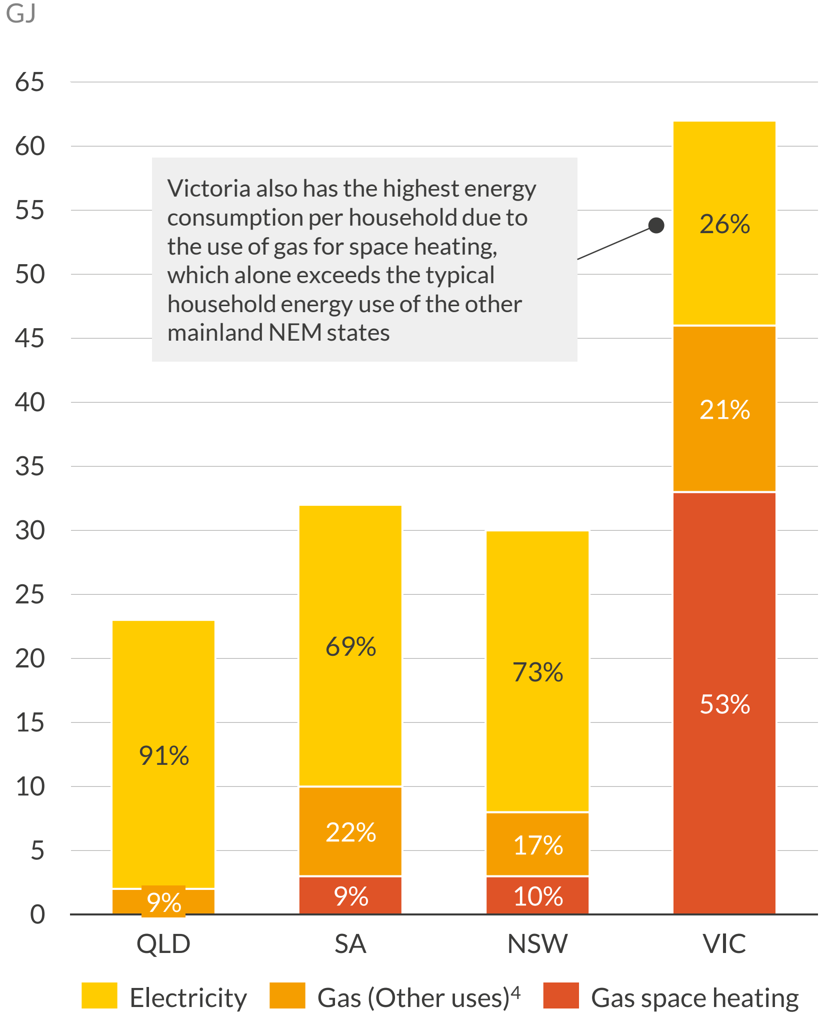
Annual gas consumption for GPG and residential & commercial [1]



Energy use by fuel and end use per household[1]



Gas usage in Victoria

- According to analysis from the Victorian Gas Substitution Roadmap, approximately 75PJ of gas was consumed by households for space heating in 2022. If the same demand for heat were to be supplied entirely by electric heat pumps this would result in 8TWh of additional residential electricity demand.[2] For reference, Portland aluminum smelter typically consumes ~4TWh per year.
- Since 2009, the State Government's Victorian Energy Upgrades (VEU) program has promoted energy efficiency, including space heating, water heating, and insulation. Electrifying household energy use in Victoria could cut annual energy bills by up to 20%, according to SECV estimates.[3]
- The recent ban on new gas connections in new-build homes within Victoria is expected to accelerate the shift towards electrification, aligning with the state's goals to reduce reliance on gas and transition to more sustainable energy sources.

1) GPG is gas-powered generation, 2018 Values shown – excludes industrial demand, such as for Liquefied Natural Gas (LNG) in Queensland; 2) Assuming gas heater thermal efficiency of 85% and a heat pump coefficient of performance of 3; 3) Analysis by the Victorian State Electricity Commission (SECV); 4) Primarily water heating and cooking

Source: Gas statement of opportunities(2023, AEMO) , Flame out (2020, Grattan Institute)

Increased BTM adoption can accelerate progress towards Victoria's renewable energy target (VRET) and storage goals, but strong policy support is crucial

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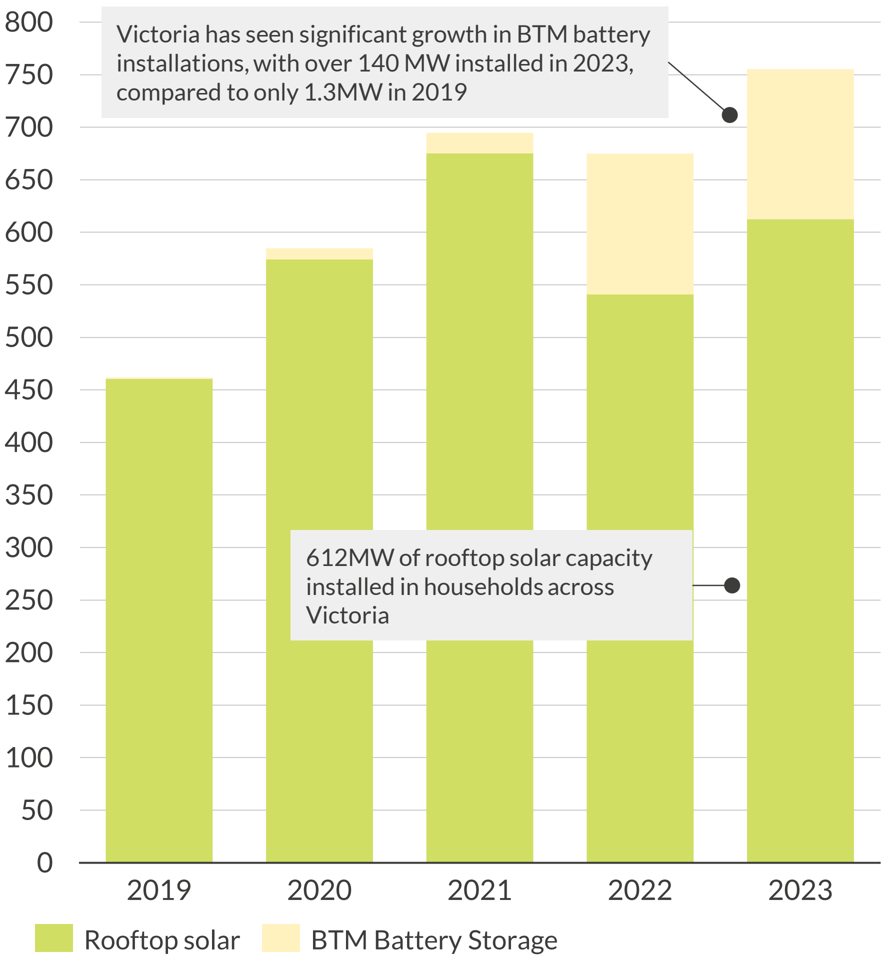
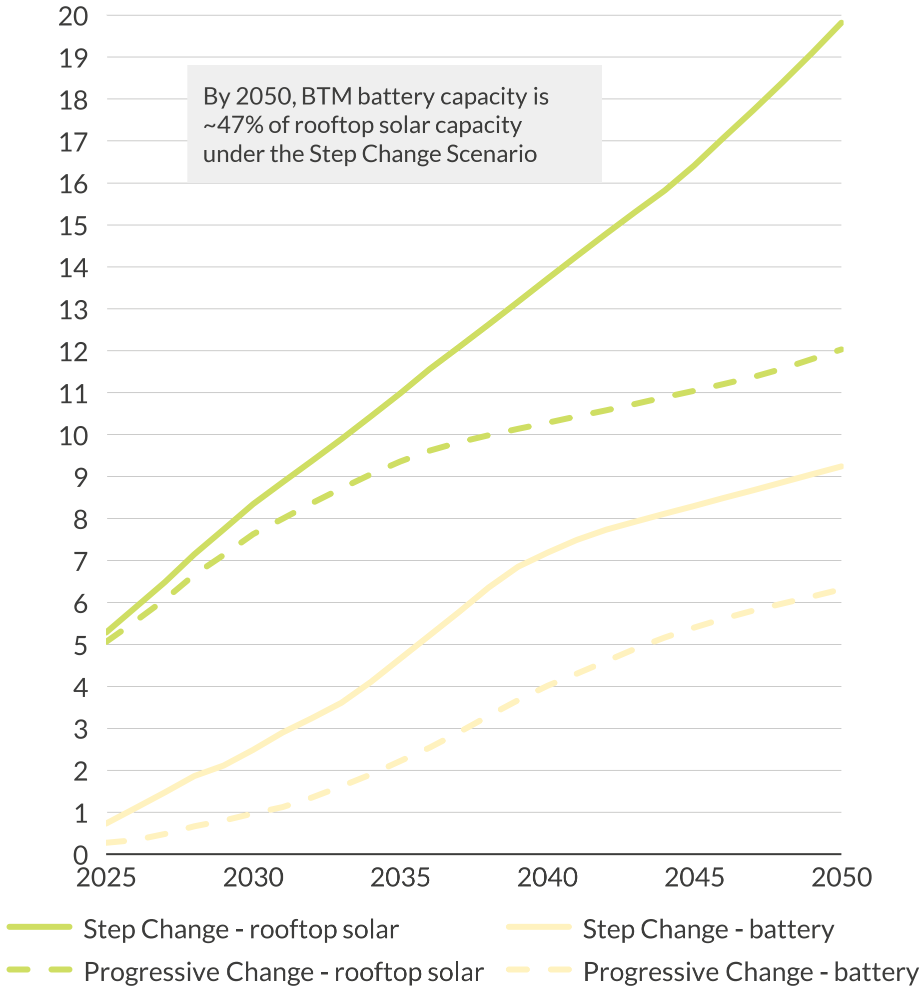
Annual[1] rooftop solar and behind-the-meter battery installations in VIC
MW, 2019 to 2023



VIC Rooftop solar and BTM battery capacity
GW, 2025 to 2050 under 2024 AEMO ISP



1) Data provided in calendar years

Source: AEMO

Rooftop solar in Victoria

- Victoria rooftop solar capacity additions have continued at pace, averaging over 600MW/year for the last four years[1].
- Solar uptake in Victoria has been driven by incentives like feed-in tariffs and small-scale technology certificates (STCs). The STC scheme is phasing out and set to expire in 2030 once the Renewable Energy Target is delivered. To further incentivise solar adoption, the Victorian government offers rebates through its Solar Homes Program.

Behind-the-meter (BTM) batteries

- Although BTM battery installations have historically been low, they have increased markedly over the last two years.
- Some of this growth can be attributed to the state government's *Solar Homes* program, which offers households an $8,800 interest-free loan towards battery installation costs.

Under AEMO's 2024 ISP, Victoria's coal assets will retire by 2035, creating a supply gap that requires rapid replacement by renewables and firming

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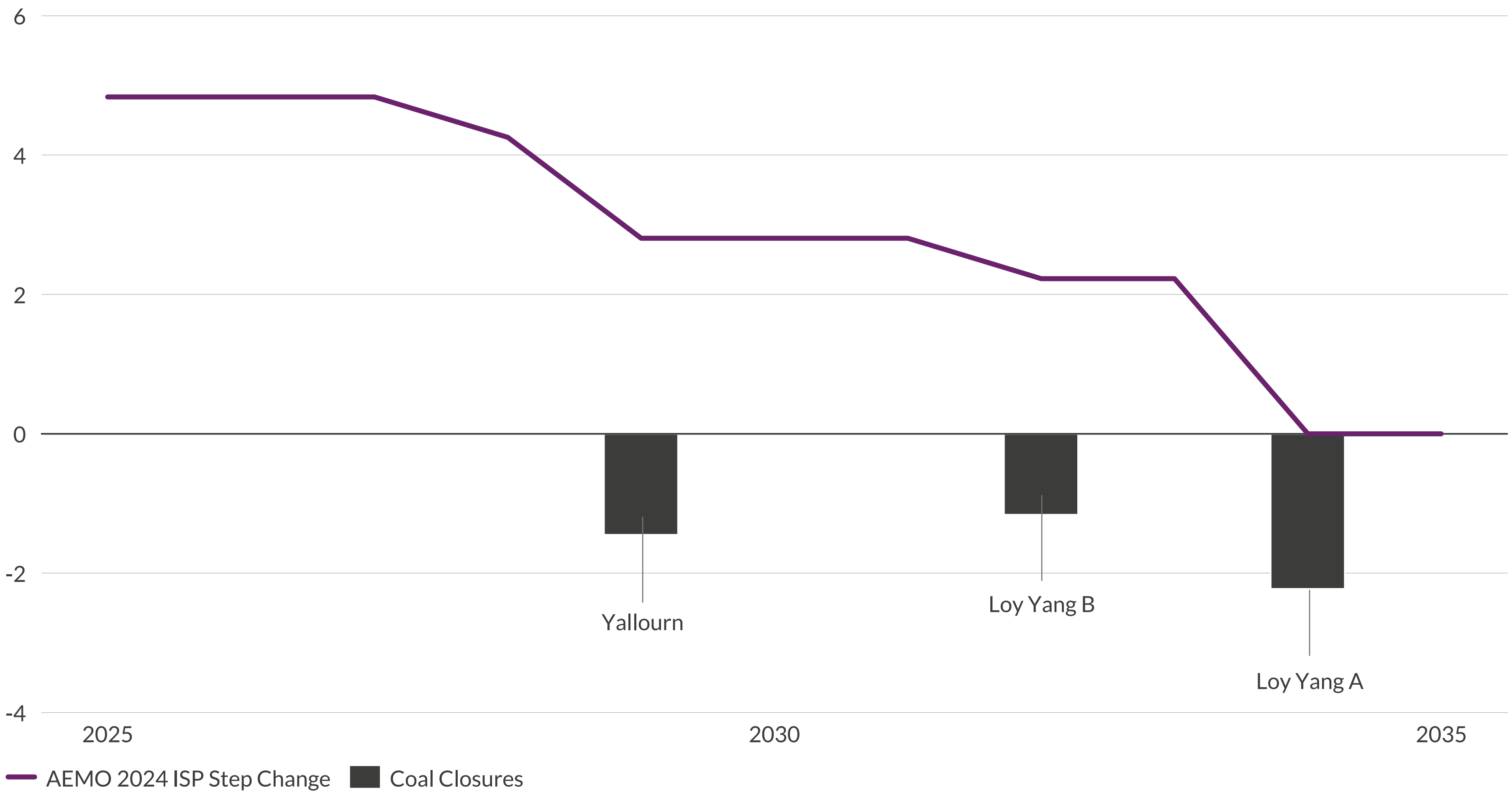
Coal capacity[1] in VIC, and scheduled coal plant retirements under AEMO's 2024 ISP
GW, 2025 to 2035



1) Line chart represents end-of-financial-year capacity, 2) 12-month recording of Victorian generation from August 2023-August 2024 from AEMO NEM data dashboard

Source: AEMO

Expected coal closures in Victoria

- Over the past 12 months, coal comprised ~67% of Victoria's electricity generation[2], according to AEMO. To meet Australia's net zero ambitions, all coal must exit the system by 2050.
- AEMO suggests an expeditated coal closure timeline two to three times faster than asset owner announcements to meet climate change ambitions. All coal plants in Victoria are seen to exit by FY34 under the AEMO 2024 ISP Step Change Scenario.
- Raised operating costs, reduced fuel security and greater renewable penetration, has additionally made coal asset ownership less favourable, increasing the likelihood of this more rapid timeline.
- Coal closures create a gap in supply for renewable capacity buildout to replace, in combination with firming technology. The rate of replacement required exceeds the levels we have observed historically.

Victoria has seen significant increases of wind and solar generation; even faster rates of buildout are required to achieve 95% renewables by 2035

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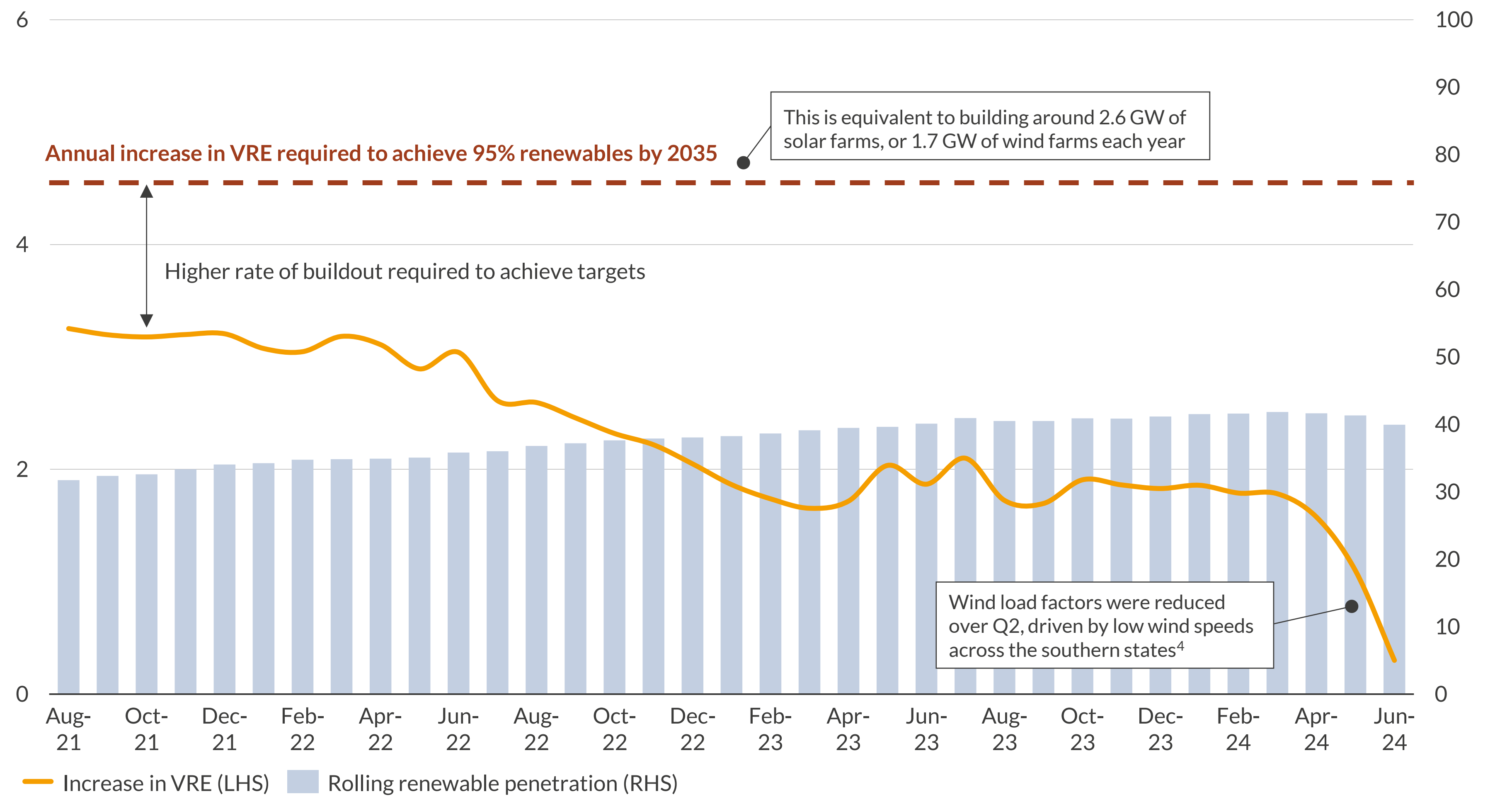
Historical VIC 12-month rolling increase in Variable Renewable Energy (VRE)[1]
TWh, 2021 to 2024

VIC 12-month rolling renewable penetration[2]
%



1) Calculated by taking the difference of the sum of utility wind, solar and rooftop PV generation over the last 12 months and the same sum of the previous 12-month period; 2) 12 month rolling penetration of utility wind, solar, rooftop PV and hydro generation; 3) Clean Energy Australia Report 2022 ;4) Quarterly Energy Dynamics Q2 2024; 5) Assuming average consumption of ~4.5MWh p.a.
Source: AEMO

Variable Renewable Energy in VIC

- Generation from variable renewable energy increased by ~3TWh/year between CY2021 and CY2022.
- Onshore wind accounted for roughly two thirds of the increase in this period, reinforcing Victoria's position as Australia's top wind energy state in CY2021, representing almost a third of the nation's total wind generation[3].
- The rate of new wind and solar capacity installations will need to scale up to achieve state renewable targets and to meet higher demand.
- Under AEMO 2024 ISP assumptions, VRE generation needs to increase by ~4.5TWh each year to reach Victoria's 95% renewables target by 2035. This would require about 2.6 GW of solar farms (assuming a 20% capacity factor) or 1.7 GW of wind farms (assuming a 30% capacity factor) each year, illustrating the substantial renewables buildout needed for the energy transition.

Major grid development is needed to accommodate a surge in renewables buildout, however existing and potential future delays could adversely impact VRET progress

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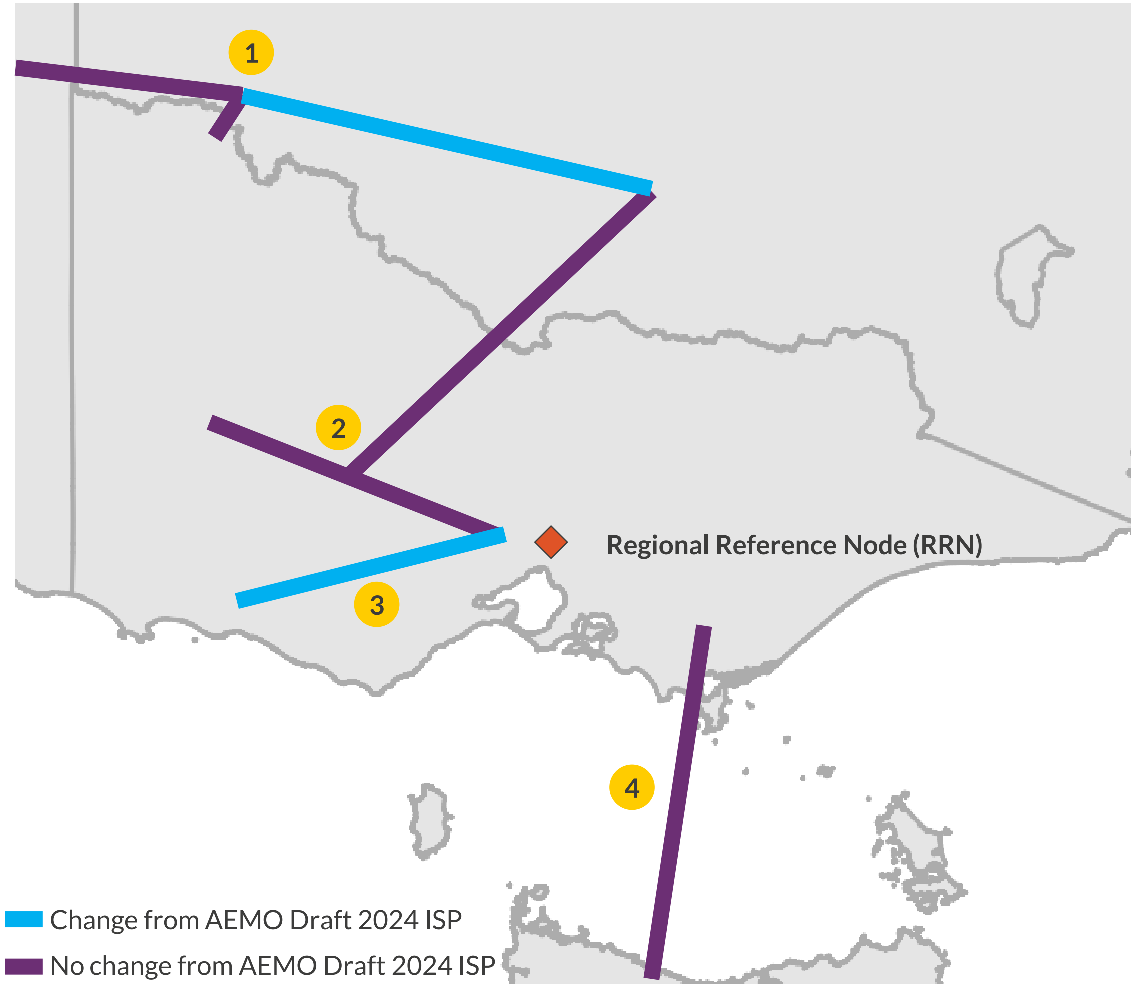
Outlook of future NEM transmission upgrades directly impacting Victoria[1]

AEMO 2024 Final Integrated System Plan (ISP) vs 2024 Draft ISP



1 Project Energy Connect (PEC)

- This new 330kV interconnector facilitates flows between South Australia and New South Wales, feeding into Victoria via Red Cliffs. Stage 1 (150MW) is expected to commission in FY25. Stage 2 (800MW NSW-SA, 100MW VIC-SA) has been delayed by one year to FY28 from Draft ISP timings.
- With Stage 1 going ahead, further delays to Stage 2 would restrict flow from VIC to NSW and SA, limiting the generation capability for renewable generators in north-western Victoria.

2 Western Renewables Link (WRL) & VNI West

- WRL is a planned 500 kV transmission line from Bulgana in Western Victoria to Sydenham in Melbourne's North-West. It aims to integrate Victoria – New South Wales Interconnector West (VNI West) into the Victorian grid and ease network constraints.
- This upgrade is expected to unlock renewable energy generation, reduce congestion and improve existing asset utilisation in Western Victoria, a key Renewable Energy Zone (REZ).
- Recent project updates include relocating the North Ballarat terminal station to Bulgana, and upgrading a line section to 500 kV. The development of WRL and VNI West continues to evolve – proposed project changes may have a significant impact on renewables buildout in Western Victoria.

3 Western Victoria Grid Reinforcement (WVGR)

- This network augmentation will enhance the South-West Victoria REZ capacity expansion. The project's commissioning timeline has been brought forward by one year to 2034 in the Final 2024 ISP, compared to the Draft version. This is expected to alleviate regional network congestion sooner.

4 MarinusLink

- MarinusLink is a proposed underground and undersea interconnector between TAS and VIC.
- Recent negotiations between the Commonwealth and state governments have secured funding for the first 750 MW link (Stage 1) of the project, firming its commissioning timeline for FY31. However, the timeline for Stage 2 remains less definite as funding negotiations are still underway. The AEMO ISP projects a commissioning date in FY33 for the second cable.

1) Refer to Appendix for details on project status according to AEMO 2024 Final ISP

Source: AEMO, DCCEEW

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II. Market modelling scenarios

1. Base Case – Targets Achieved scenario
2. Status Quo scenario
3. Demand Increase scenario
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5. Low Weather Year scenario
6. Delayed Victoria Transmission Buildout scenario
7. Removal of Offshore Wind in Victoria scenario
8. Victoria's Accelerated Offshore Wind Buildout scenario (hypothetical)

III. Appendix

Aurora has modelled several potential decarbonisation pathways for Victoria up to 2050, considering eight scenarios that could help shape the energy landscape

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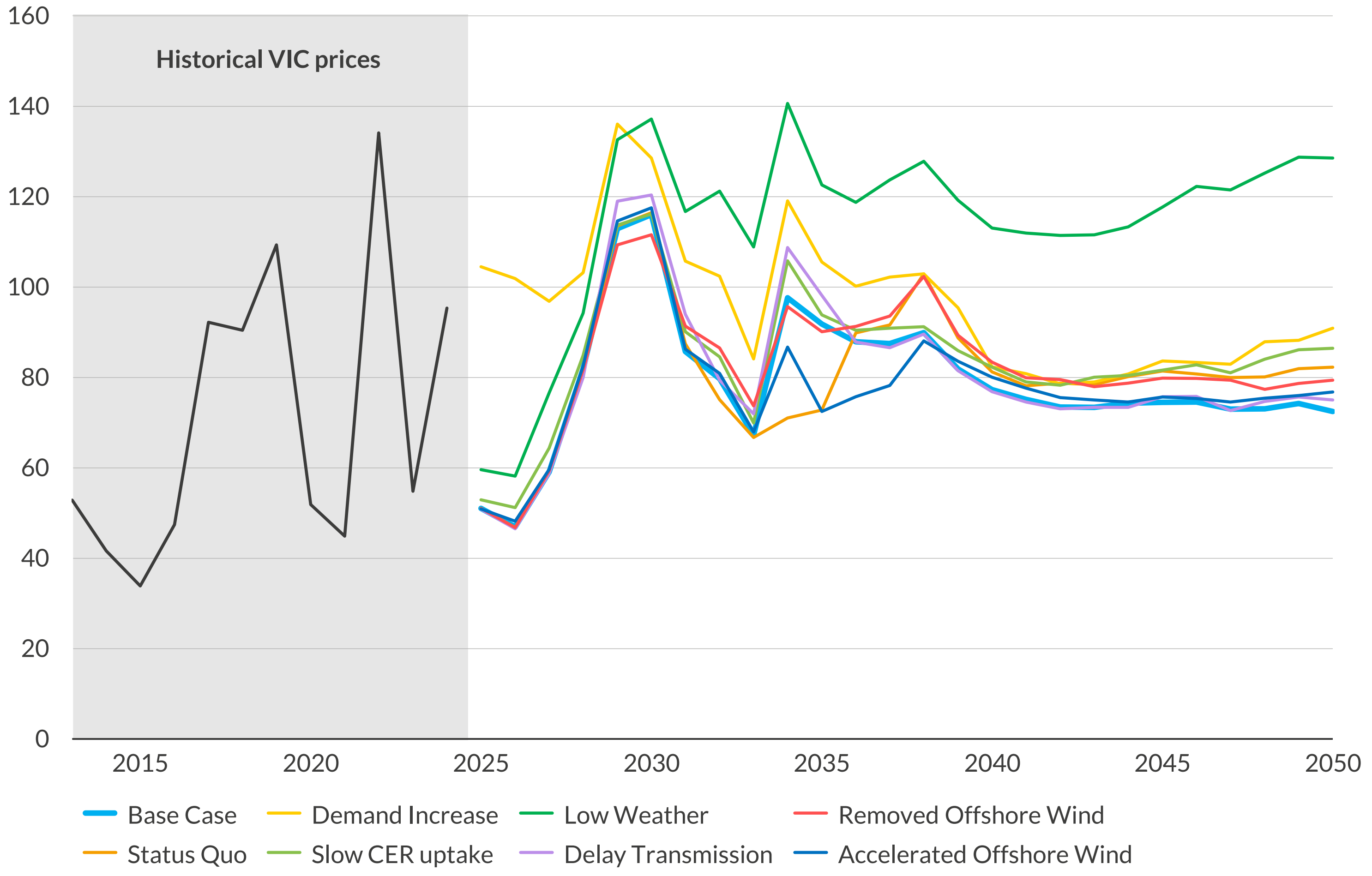
Overview of Scenarios

Scenario		Description
Base Case – Targets Achieved	[BC]	Announced state renewable energy targets are achieved, using Australian Energy Market Operator (AEMO) 2024 Integrated System Plan (ISP) assumptions
Status Quo	[SQ]	Does not enforce state renewable energy targets and largely aligns to AEMO 2024 ISP assumptions, diverging with respect to coal closures and offshore wind buildout
Demand Increase	[S3]	15% increase of Base Case residential, commercial and industrial demand across the NEM
Slow CER/DER Uptake	[S4]	Lower levels of CER/DER uptake in the NEM, in comparison to the Base Case as per AEMO Progressive Change Scenario
Low Weather Year	[S5]	Low Weather Year scenario in comparison to Base Case with lower Variable Renewable Energy (VRE) generation, assuming unchanged Base Case capacity buildout
Delayed VIC Transmission	[S6]	Incorporating a 2-year delay to Victoria Renewable Energy Zone (REZ) expansion timelines under AEMO 2024 ISP and a 3-year delay of Marinus Link
Removal of VIC Offshore Wind	[S7]	Re-allocating capacity and investment from Offshore wind under Base Case to alternate energy generation/supply
VIC Accelerated Offshore Wind	[S8]	Victoria achieving state Offshore Wind targets earlier than announced – 9GW by 2035, 5 years earlier than legislated

VIC Time-weighted average (TWA) price, scenario comparison

$A/MWh, Historical vs forecast[1]



1) Historical prices in nominal terms, forecast prices in real 2023

Source: Aurora Energy Research

Each modelling scenario branches from the Base Case which is largely aligned to the Australian Energy Market Operator (AEMO) 2024 Integrated System Plan (ISP)

Model input sensitivities are varied across scenarios and compared against the Base Case which primarily uses inputs from the AEMO's 2024 ISP Step Change Optimal Development Pathway (ODP), the least cost path to the National Electricity Market (NEM) energy future of net zero by 2050 according to AEMO

			Variations to Base Case – Blank cells indicate alignment with Base Case assumptions						
		Base Case – Targets achieved	**Status Quo**	**Demand Increase**	**Slow CER/DER Uptake**	**Low Weather Year**	**Delayed VIC Transmission**	**Removal of VIC Offshore Wind**	**VIC Accelerated Offshore Wind**
Policy	**Offshore wind buildout targets**	Assumed to meet targets on time	2GW by FY34					No offshore wind	Achieve earlier (hypothetical)
	Renewable electricity penetration targets met	Assumed to meet targets on time	Not assumed, determined by model	Not assumed, determined by model	Not assumed, determined by model	Not assumed, determined by model	Not assumed, determined by model	Not assumed, determined by model	Not assumed, determined by model
	Gvt. subsidies / support mechanisms	Increased government support	Status quo – as per current state		Lower levels of intervention		Lower levels of intervention	Lower levels of intervention	
	Carbon pricing	Green Certificates only							
Supply	**Coal plant closures**	AEMO 2024 ISP Step Change ODP 'Early exits'	Coal closures in VIC as per asset owner announcement dates						
	Variable Renewable Energy (VRE) buildout	AEMO 2024 ISP Step Change ODP	2GW offshore wind by FY34; economic solve	Offshore Wind buildout according to current VIC target timings; economic solution for generation technology capacity build (excluding offshore wind)				No offshore wind; economic solve	Earlier offshore wind (hypothetical); economic solve
	Transmission buildout	AEMO 2024 ISP Step Change ODP					Delay to VIC REZ expansions and Marinus Link		
	Commodity prices (coal and gas)	Aurora Central 2024							
	Weather year[1]	FY2016 - median weather year				5% reduction to reference year VRE generation			
Demand	**Expected energy demand growth**	AEMO 2024 ISP Step Change ODP		Increase AEMO 2024 ISP Step Change ODP Demand by 15%					
	Distributed Energy Resources (DER) / Consumer Energy Resources (CER)	AEMO 2024 ISP Step Change ODP			Uptake as per AEMO 2024 ISP Progressive Change Scenario				
	Electric Vehicle (EV) uptake	AEMO 2024 ISP Step Change ODP			As per AEMO 2024 ISP Progressive Change				

1) Aurora's weather year approach uses a single reference year, providing a consistent view of weather impacts on energy generation. In contrast, AEMO's rolling weather year approach uses multiple historical weather years to capture a broader range of variability – see Appendix for details on representative weather year analysis

Source: Aurora Energy Research

The scenarios encompass a wide range of outturns across thermal outcomes, renewables deployment, and the need for flexible generation

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		Base Case	Status Quo		Demand Increase		Slow CER/DER Uptake		Low Weather		Delayed VIC Transmission		Removal of VIC Offshore Wind		VIC Accelerated Offshore Wind	
VIC Demand by 2035		Unit	Unit / % to BC		Unit / % to BC		Unit / % to BC		Unit / % to BC		Unit / % to BC		Unit / % to BC		Unit / % to BC	
Base Demand [TWh][1]		59	59	[0%]	68	[+15%]	59	[0%]	59	[0%]	59	[0%]	59	[0%]	59	[0%]
VIC Supply by 2035																
Thermal	Cumulative[2] thermal generation [TWh]	198	241	[+22%]	204	[+3%]	199	[+0.2%]	201	[+1.3%]	198	[-0.1%]	198	[-0.1%]	199	[+0.1%]
	Cumulative[2] emissions [Mt-CO_2]	234	283	[+21%]	239	[+2%]	234	[+0.2%]	236	[+0.9%]	234	[0%]	234	[-0.1%]	234	[+0.1%]
	Long-term gas price [$/GJ]	15	15	[0%]	15	[0%]	15	[0%]	15	[0%]	15	[0%]	15	[0%]	15	[0%]
	Long-term coal price [$/GJ]	3.5	3.5	[0%]	3.5	[0%]	3.5	[0%]	3.5	[0%]	3.5	[0%]	3.5	[0%]	3.5	[0%]
VRE[3]	Solar capacity [GW]	3.9	3.3	[-15%]	5.1	[+32%]	3.3	[-14%]	3.9	[0%]	4.0	[+3%]	4.4	[+13%]	2.8	[-29%]
	Rooftop solar capacity [GW]	9.6	9.6	[0%]	9.6	[0%]	8.7	[-10%]	9.6	[0%]	9.6	[0%]	9.6	[0%]	9.6	[0%]
	Offshore wind capacity [GW]	4	2	[-50%]	4	[0%]	4	[0%]	4	[0%]	4	[0%]	0	[-100%]	9	[+125%]
	Onshore wind capacity [GW]	9	9.3	[+3%]	10.4	[+15%]	8.7	[-6%]	9	[0%]	8.7	[-3%]	13.8	[+54%]	8.3	[-8%]
Flexible	Battery capacity [GW]	3.3	3.3	[0%]	3.3	[0%]	3.3	[0%]	3.3	[0%]	3.3	[0%]	3.3	[0%]	3.3	[0%]
	BTM battery capacity [GW]	3.5	3.5	[0%]	3.5	[0%]	0.8	[-78%]	3.5	[0%]	3.5	[0%]	3.5	[0%]	3.5	[0%]

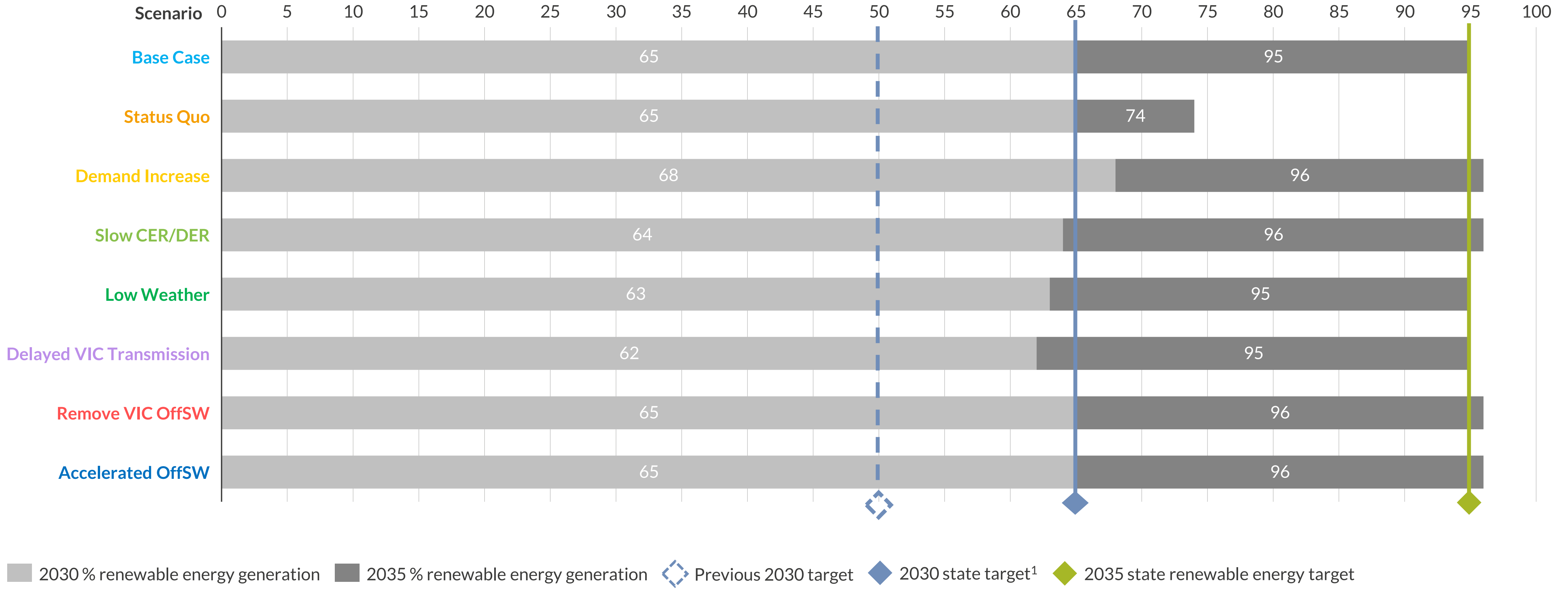
1) Base demand comprises residential, commercial and industrial demand; 2) Cumulative for the years 2025 to 2035 – thermal generation includes coal and gas-fired power plant generation; 3) Differences in Variable Renewable Energy capacity build-out from AEMO ISP primarily stem from modelling approaches—AEMO's model minimises total system cost, while Aurora's focuses on NPV-driven plant economics

Source: Aurora Energy Research

Coal closure timelines significantly impact progress towards meeting state renewable targets, with the Status Quo scenario falling short of FY35 targets by over 20%

VIC forecast renewable generation scenario comparison, FY30 vs FY35

Forecast renewable electricity Variable Renewable Energy (VRE) penetration (%) in Victoria[1]



1) State targets are based on a percentage of electricity generated in Victoria - VRE penetration percentage is calculated by taking the sum of utility-scale wind, solar, and rooftop PV generation in Victoria and dividing it by the total electricity generated within the state (excludes electricity imports)

Source: Aurora Energy Research

Victoria's transition to a renewable energy-dominated grid is expected to face significant network congestion challenges, particularly in the North-West region

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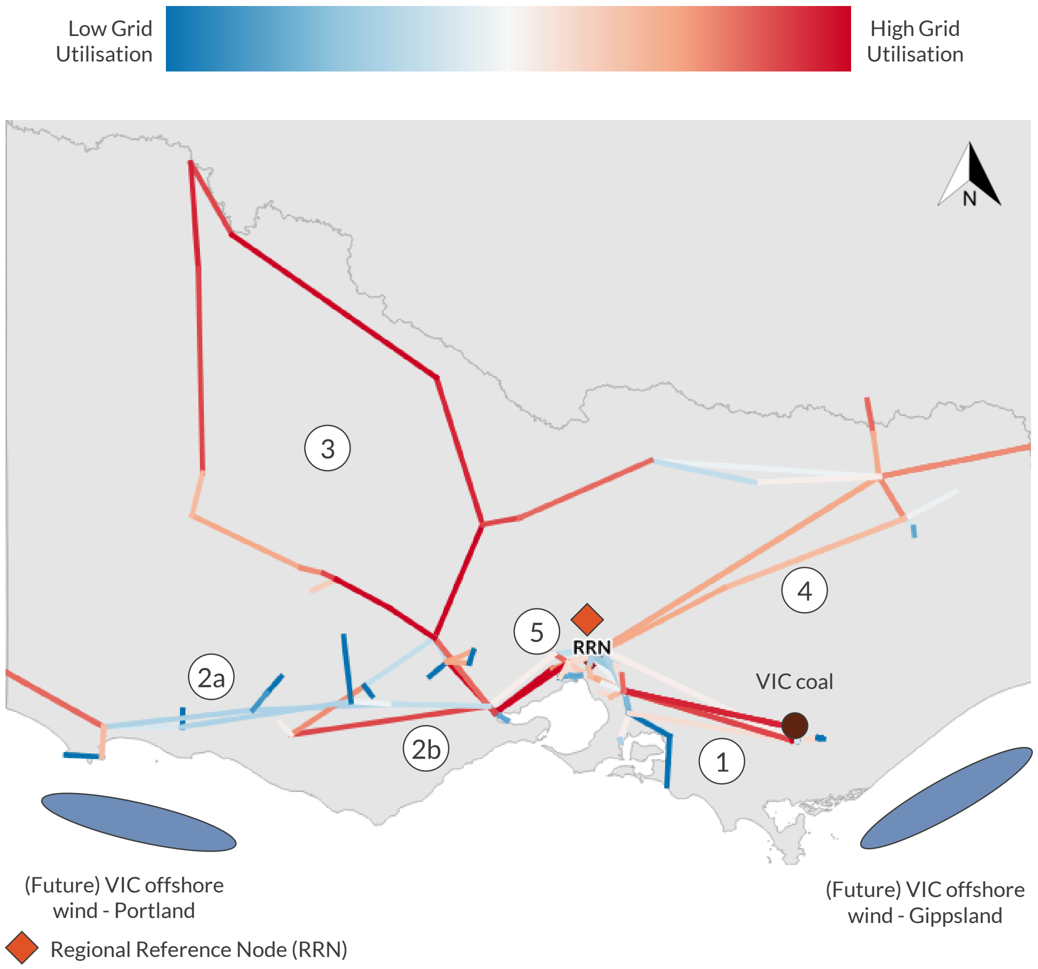
Grid utilisation[1] heatmap, VIC
Base Case, FY25



Grid utilisation[1] overview
Base Case, FY25 to FY50

Low Grid Utilisation → High Grid Utilisation

	Key Region	Base Case			Comments on transmission line utilisation
		FY25	FY35	FY50	
1	South-East Victoria				Prior to coal phase-out, transmission lines towards the RRN are highly utilised to transfer thermal baseload generation. Utilisation rates may temporarily decrease as the grid transitions to more renewable energy. However, these rates are expected to increase over time as renewable energy generation expands, though not to pre-coal levels due to the intermittent nature of renewables.
2a	South-West VIC REZ V4 (A)				The addition of Portland offshore wind and retirement of Victorian coal could lead to increased network congestion in the region as electricity flows toward Melbourne. However, headroom is available to accommodate the increased flow in the area.
2b	South-West VIC REZ V4 (B)				As VRE buildout in South-West Victoria accelerates, this region is expected to experience high levels of congestion. The commissioning of the Western Victoria Grid Reinforcement network augmentation in the 2030s will alleviate congestion by allowing generation to flow along high voltage transmission into the long-term.
3	North-West Victoria				Despite near-term network upgrades, unique geographic constraints and increased reliance on renewable energy following coal phase-out are expected to create persistent congestion challenges in the region. Even with large-scale offshore wind development in Southern Victoria, the North-West region's high renewable energy penetration and limited transmission capacity will likely make it a congestion hotspot without substantial additional infrastructure investments.
4	North-East Victoria				The north-eastern corridor is projected to experience consistent levels of congestion and line utilisation, reflecting the ongoing flow of electricity to NSW. Victoria will likely maintain its role as a net exporter of power to NSW, relying on thermal generation in the near term and transitioning to offshore wind in the long term.
5	Central Victoria / RRN				High line utilisation towards Melbourne is expected to be sustained across the forecast, as the central Victoria region remains a key demand load centre.

Offshore wind sensitivities and grid impact

- *Without offshore wind buildout* Regions 1 and 2 are expected to experience lower network utilisation due to the exit of coal in the long-term. To compensate, Victoria's reliance on renewable generation in North-West Victoria (Region 3) will most likely increase to compensate for the absence of coal, worsening congestion.
- *Accelerated offshore wind development* could benefit Victoria in the medium term by utilising southern networks (Regions 1 & 2) more efficiently. However, long-term impact is expected to align with Base Case.

1) Utilisation is defined as the annual average power flow on a line (in absolute values) as a proportion of the total line rating

Adequate energy reserve capacity from local dispatchable generation and flexible storage will be essential for maintaining grid stability in Victoria

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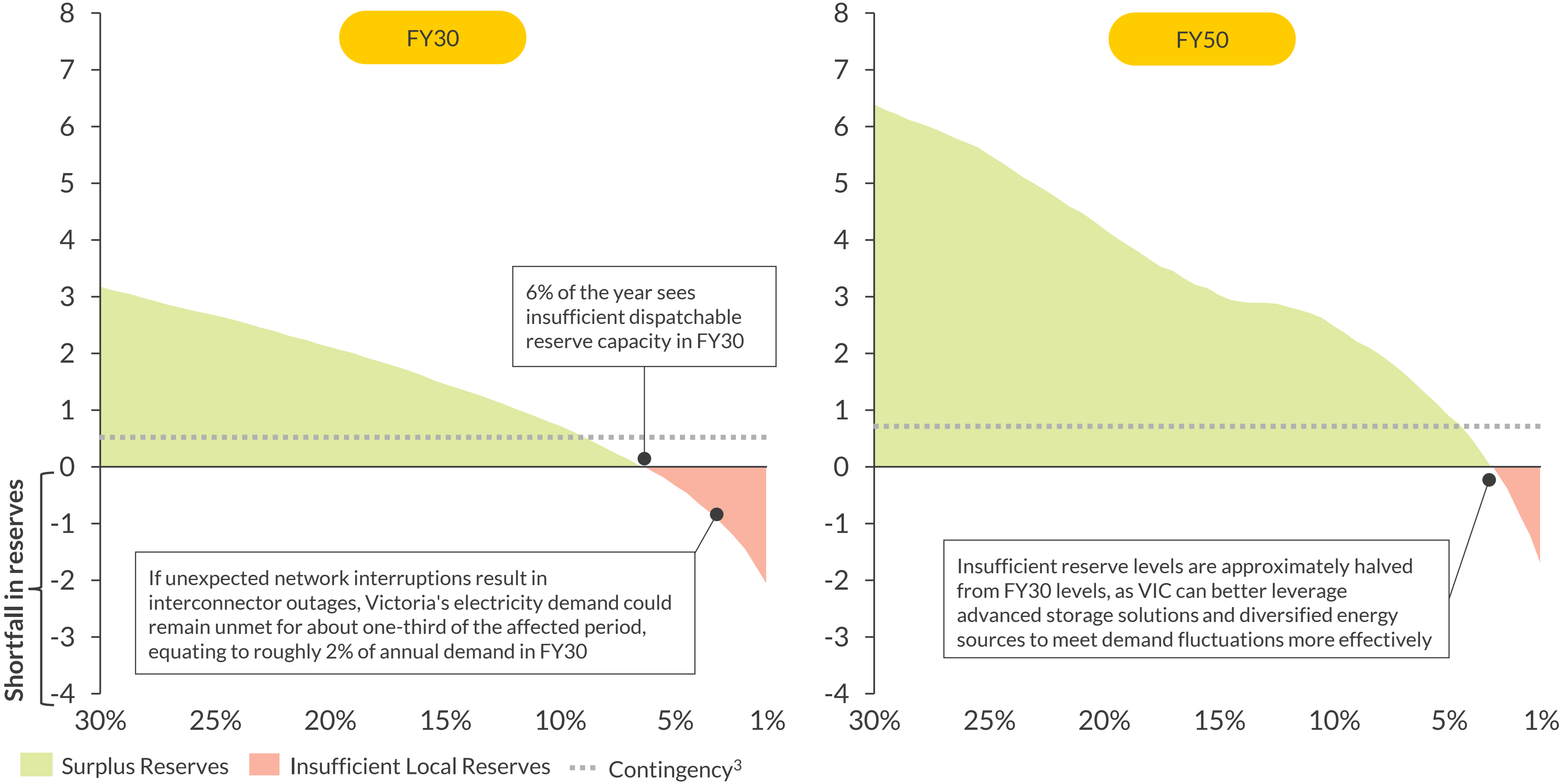
Outlook on VIC Energy Reserves – Base Case

Nameplate GW, FY30 vs FY50

VIC Energy Reserves = Dispatchable Reserve Capacity[1] in VIC – Residual VIC demand[2]



1) Calculated as available generation capacity LESS actual generation capacity of dispatchable technologies i.e. coal, batteries and gas peakers; 2) Calculated as operational energy demand net of power production from VRE technologies i.e. solar, offshore wind and onshore wind; 4) Operational demand is the amount of electricity demand met by the grid

Changes in Reserves from FY30 to FY50

- In the short-term, Victoria is solely reliant on interconnectors 6% of the year under the Base Case, as local energy reserves are insufficient to meet residual demand and unexpected disruptions.
- As Victoria's grid-scale and behind-the-meter battery capacity expands, Victoria's reliance on electricity imports from neighbouring states reduces by approximately 50% in FY50.
- With the increase in renewable capacity, batteries and other storage technologies play a crucial role in balancing supply and demand, thereby further reducing dependency on interstate electricity imports.

Notes

[1] Dispatchable Reserve Capacity represents the amount of power generated within Victoria that can be quickly ramped up or down to match demand fluctuations.

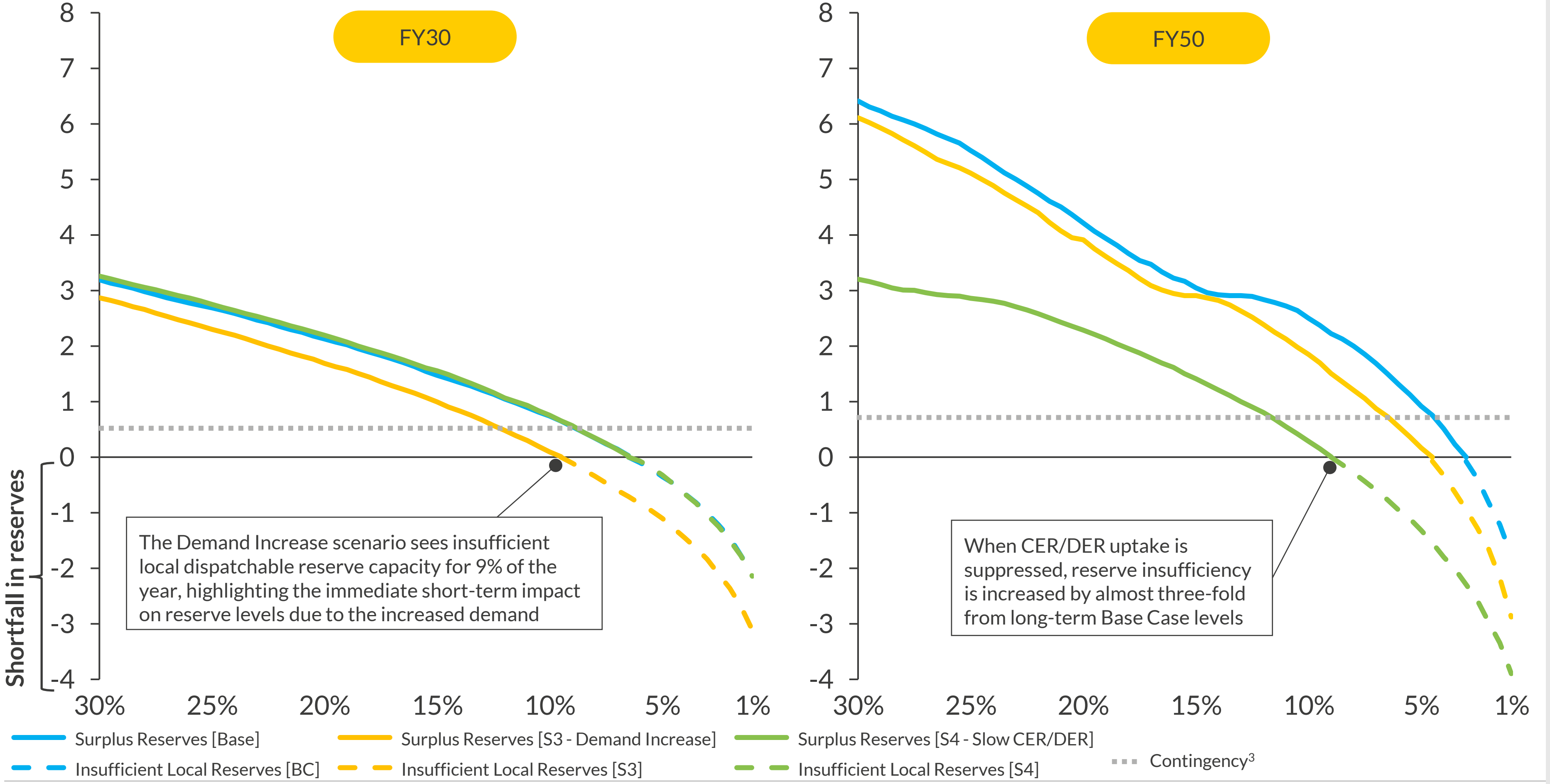
[2] Residual Demand is the portion of operational electricity demand[4] in Victoria that cannot be met by Variable Renewable Energy (VRE) sources like solar and wind. This remaining demand is ideally fulfilled by local dispatchable resources such as traditional coal and gas power plants, batteries, pumped hydro storage, and virtual power plants (VPPs).

[3] Contingency is noted to account for potential disruptions that could affect power generation (i.e. the largest generating unit) or transmission.

Victoria may increasingly rely on electricity imports to balance electricity supply and demand, particularly when local generation and storage are limited

Outlook on VIC Energy Reserves – Base Case, Demand Increase Case and Slow CER/DER Uptake case
Nameplate GW, FY30 vs FY50

VIC Energy Reserves = Dispatchable Reserve Capacity[1] in VIC – Residual VIC demand[2]



1) Calculated as available generation capacity LESS actual generation capacity of dispatchable technologies i.e. coal, batteries and gas peakers; 2) Calculated as operational energy demand net of power production from VRE technologies i.e. solar, offshore wind and onshore wind; 4) Operational demand is the amount of electricity demand met by the grid

Comparison of Scenarios: Reserves

- As local generation struggles to keep pace with the elevated demand in the short-term [S3], particularly during peak periods or when renewable generation is low, the grid increasingly depends on importing electricity from neighbouring states.
- In the long term, the Slow CER/DER Uptake scenario [S4] diverges significantly from the Base Case, driven by reduced behind-the-meter generation, lower storage capacity, increased reliance on interconnectors, and missed opportunities for demand response, all straining the grid's ability to balance supply and demand.

Notes

[1] Dispatchable Reserve Capacity represents the amount of power generated within Victoria that can be quickly ramped up or down to match demand fluctuations.

[2] Residual Demand is the portion of operational electricity demand[4] in Victoria that cannot be met by Variable Renewable Energy (VRE) sources like solar and wind. This remaining demand is ideally fulfilled by local dispatchable resources such as traditional coal and gas power plants, batteries, pumped hydro storage, and virtual power plants (VPPs).

[3] Contingency is noted to account for potential disruptions that could affect power generation (i.e. the largest generating unit) or transmission.

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III. Appendix

The Base Case scenario has been designed to ensure that Victoria meets its state renewable energy and generation targets in line with government goals

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Under Base Case, a requirement to meet updated Victoria's Renewable Energy Targets (VRET) of 65% by 2030 and 95% by 2035 is enforced, along with Victoria's legislated offshore wind energy generation targets of 2GW by 2032, 4GW by 2035 and 9GW by 2040

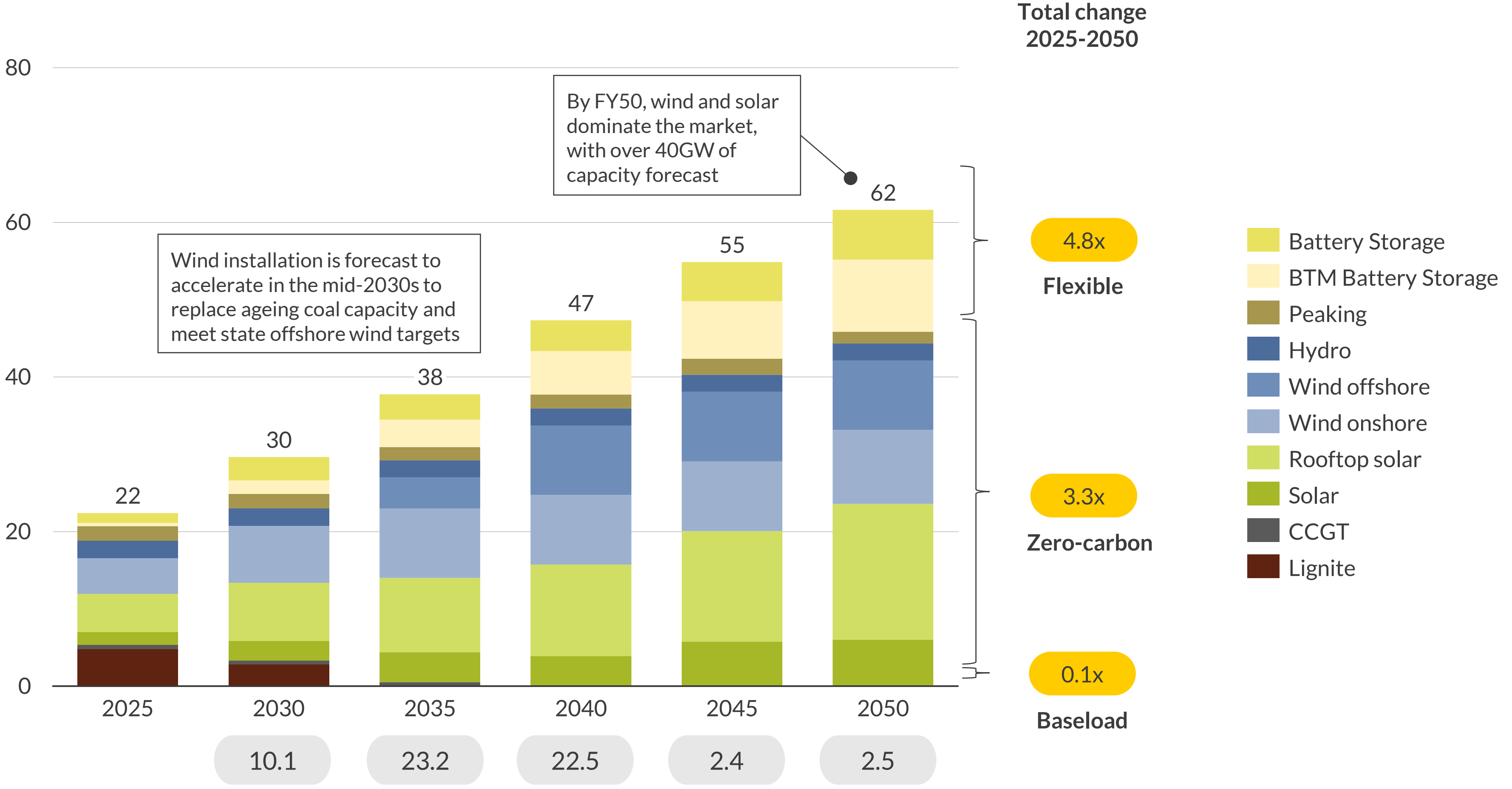
		Base Case – Targets Achieved
Policy	Offshore wind buildout targets	Assumed to meet targets on time: Victoria offshore wind generation capacity of 2GW by 2032, 4GW by 2035, 9GW by 2040.
	Renewable electricity penetration targets met	Federal and state renewable generation, storage and transmission targets are fully met, including: • 82% renewable generation in the NEM by 2030 • 95% Victorian Renewable Energy Target (VRET) by 2035 • Victoria's legislated energy storage targets are at least 2.6GW of energy storage capacity by 2030, and at least 6.3 GW by 2035.
	Gvt. subsidies / support mechanisms	Government support could include increased investment in Renewable Energy Zone (REZ) buildout, VRET2, offshore wind support packages (i.e. Contracts for Difference 'CfD'), and additional Capacity Investment Scheme (CIS) Tenders.
	Carbon pricing	Green Certificates only.
Supply	Coal plant closures	'Early exits' as per AEMO 2024 ISP Step Change Optimal Development Pathway (ODP). Closure of Yallourn in FY29, Loy Yang B in FY32 and Loy Yang A in FY34.
	Variable Renewable Energy (VRE) buildout	As per AEMO 2024 ISP Step Change ODP. 23 GW new utility-scale wind and solar by 2049-50 including 9 GW offshore wind.
	Transmission buildout	As per AEMO 2024 ISP Step Change ODP – see Appendix for additional details.
	Commodity prices (coal and gas)	As per Aurora Central, with long term gas prices at $15/GJ and coal prices at $4/GJ.
	Weather year[1]	The FY2016 reference weather year was chosen for Aurora's half-hourly renewable generation and demand traces. This year is considered representative of "average" wind and solar load factor patterns and demand. Selecting a consistent reference weather year is essential for accurate forecasting, as weather significantly affects renewable generation and demand, which in turn impacts wholesale prices. This approach ensures a consistent basis for analysis.
Demand	Expected energy demand growth	High degree of residential, commercial and industrial electrification and uptake of electric vehicles assumed. In 2050, Step change scenario sees 290TWh of residential and business demand, 48TWh of hydrogen demand and 68TWh of EV demand.
	Distributed Energy Resources (DER) / Consumer Energy Resources (CER)	Capacity of coordinated CER storage is expected to rise from today's 0.2 GW to 3.7 GW in 2029-30, and then 37 GW in 2049-50 – making up 66% of the National Electricity Market's energy storage nameplate capacity under AEMO 2024 ISP Step Change Scenario.
	Electric Vehicle (EV) uptake	97% of all vehicles expected to be battery EVs as per AEMO 2024 ISP Step Change Scenario.

1) Aurora's weather year approach uses a single reference year, providing a consistent view of weather impacts on energy generation. In contrast, AEMO's rolling weather year approach uses multiple historical weather years to capture a broader range of variability – see Appendix for details on representative weather year analysis

Source: Aurora Energy Research

Victoria's electricity market is expected to become increasingly dominated by renewable and flexible technologies

VIC Capacity[1]
Nameplate GW



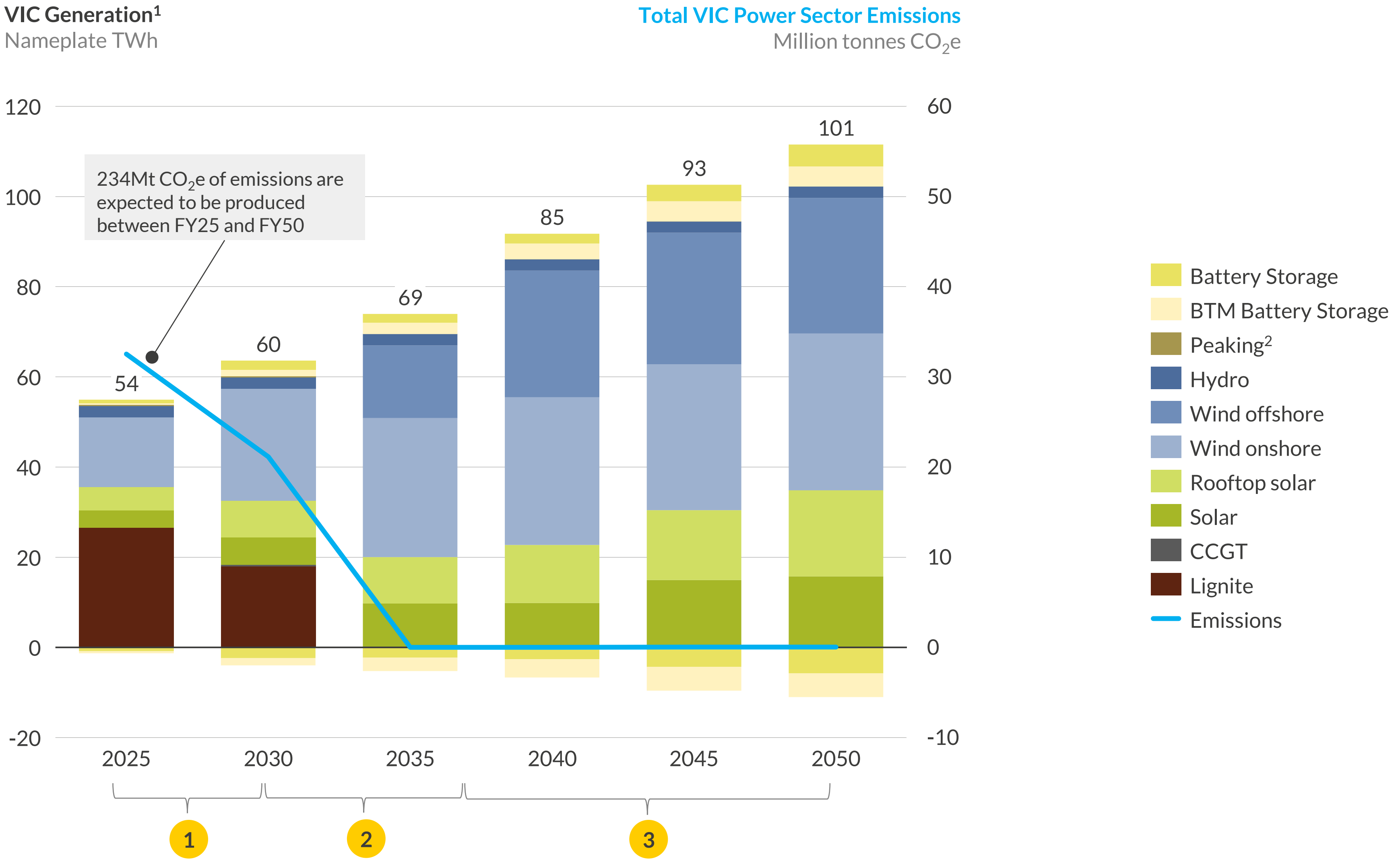
Total 5-year CapEx for new-build utility-scale solar, wind and battery, real $A2023 bn[2]

Victoria Generator Capacity

- The rapid increase of solar capacity installations in the short-term is driven largely by rooftop solar as governments continue to incentivise uptake and consumers seek to reduce their electricity bills.
- State-backed renewable projects help drive renewable buildout in Victoria, with an increase in wind capacity of 59% from FY25 to FY30.
- Following the exit of coal from the NEM, higher fuel prices increase the cost of firming from gas-peaking plants. This prompts more battery capacity buildout to supply periods of peak demand in the long term.
- Coal capacity retirements accelerate from the late 2020s as costs increase with end-of-life issues and greater required ramping.
- Significant capital expenditure is required for the energy transition, with a total of $23.2 billion in real 2023 dollars projected for new utility-scale solar, wind, and battery projects between FY31 and FY35. These investments will be crucial for replacing present thermal baseload generators and ensuring power reliability.

1) Differences in capacity build-out from AEMO ISP levels primarily stem from modelling approaches—AEMO's model seeks to minimise total system cost, while Aurora's focuses on NPV-driven plant economics; 2) Each CapEx figure is inclusive of the preceding 5-year period i.e. FY26-30 CapEx provided in FY30, calculated using 2023 AEMO IASR CapEx assumptions – see Appendix for details

Electricity sector emissions will halve by FY32 compared to current levels, if the achievement of state targets are met



1) Excludes Victoria imports and exports; 2) Aurora's use of a single reference weather year may result in more modest gas peaking generation forecasts compared to AEMO's rolling weather year approach, as it avoids the potential overestimation of generation needs that can arise from modelling extreme weather variability across multiple years – see Appendix for details

1 2025-30

- Generation from renewable resources makes up an increasing portion of the production mix in the 2020s as assets are rapidly deployed to meet state-based renewable energy targets of 65% by 2030 and 95% by 2035.
- By FY30, renewable generation is expected to increase by 54% from FY25 levels.

2 2031-35

- The 2030s see a rapid exit of coal from the system. Baseload thermal generation declines throughout the forecast, fully exiting Victoria by FY35.
- By FY35, total electricity sector emissions reach zero. This rapid reduction is driven by the early closure of coal plants in Victoria, which are strong contributors to baseload emissions in Victoria.

3 2036-50

- The loss of bulk energy provided for by coal is offset predominantly by renewable wind and solar generation.

The closure of coal plants in Victoria places upwards pressure on wholesale power prices, with prices surpassing projected 2025 levels by more than 120% in certain years

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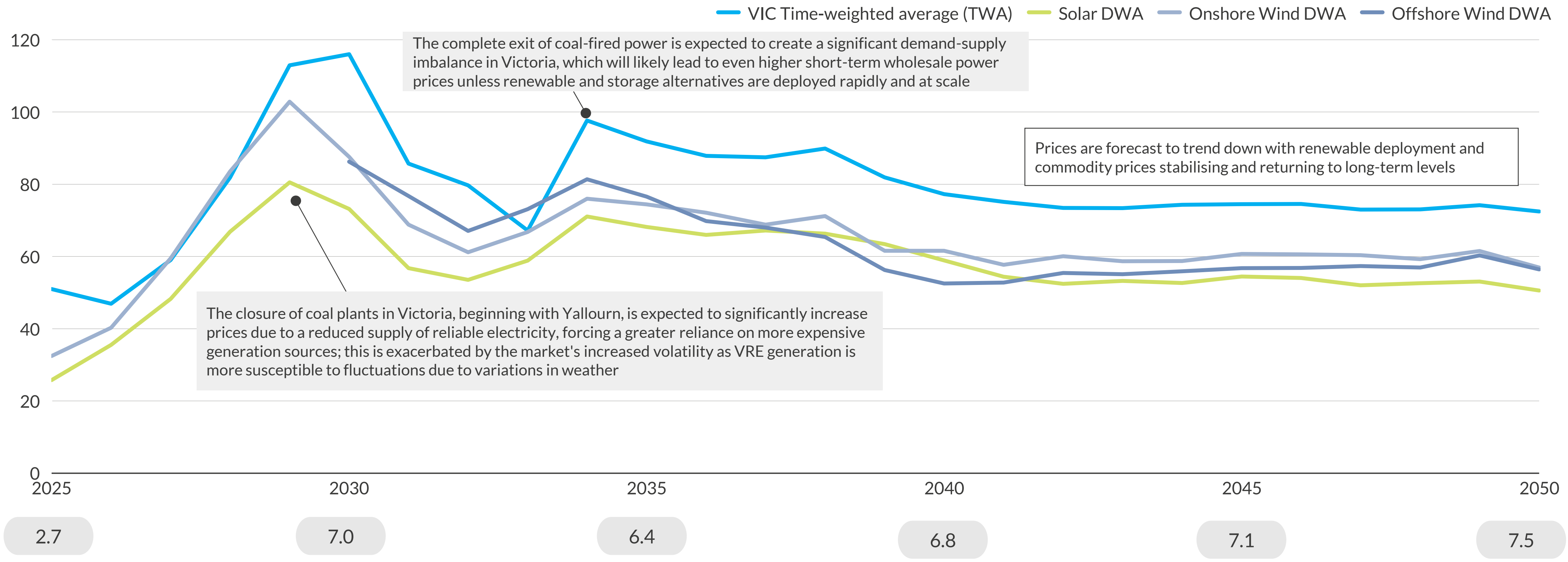
Victoria Wholesale Power Price[1]
A$/MWh



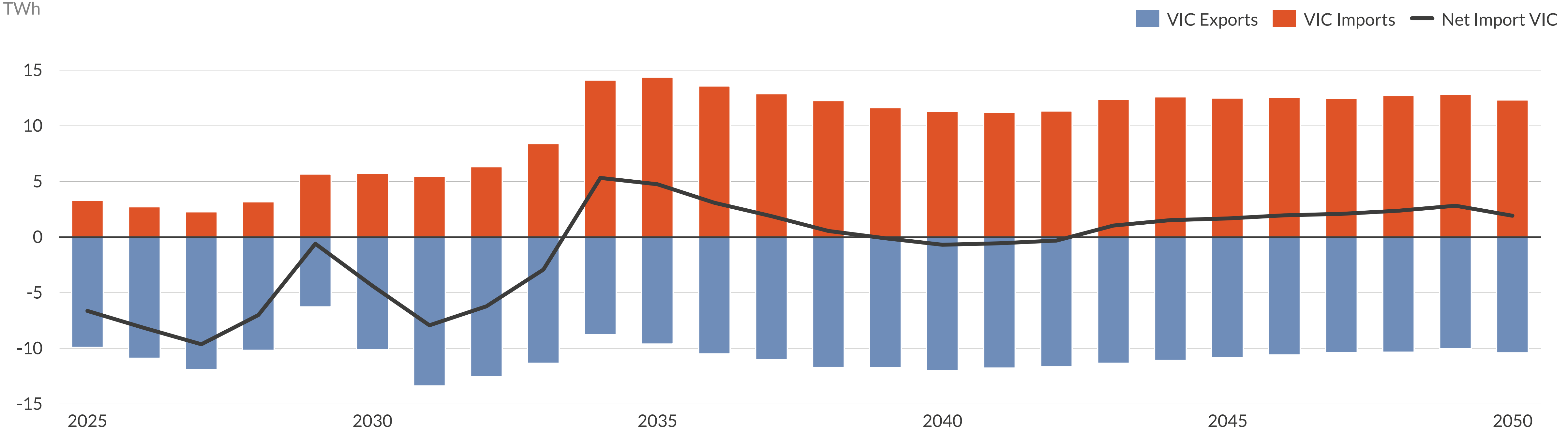
Annual wholesale power costs, real $A2023 bn[2]

1) Dispatch-weighted average (DWA) prices curtailing at $-Large-scale Generation Certificate (LGC); 2) Wholesale power cost = TWA price x Generation for each respective year

Source: Aurora Energy Research

Victoria remains a net electricity exporter until its coal plants close, after which it could become increasingly reliant on imported power

VIC Net Imports between VIC and TAS / SA / NSW
TWh



Victoria is currently a net exporter of electricity because of the presence of three large coal fired power plants – Yallourn, Loy Yang A and Loy Yang B, which collectively support the neighbouring states of South Australia, New South Wales and Tasmania. As these coal plants exit the power system, Victoria could increasingly become reliant on imported power from these states. This interconnection interaction differs by state, based on future generation and network augmentations affecting the National Electricity Market (NEM):

- **Tasmania –** Tasmania's increasing renewable generation capacity, particularly hydropower and wind, is forecast to lead to periods of surplus energy, resulting in reverse flows following Victorian coal exits. The introduction of Marinus Link will additionally enable more capacity flow in both directions between Victoria and Tasmania.
- **South Australia –** Project EnergyConnect, which is proposed to run from New South Wales to South Australia, with a connection to Red Cliffs in Victoria, is expected to increase flow to South Australia in the short-term after the Stage 1 commissioning in FY25. Following the retirement of coal, this connection will help support Victoria by importing power from the mid 2030s.
- **New South Wales –** The Victoria-New South Wales interconnector (VNI) has traditionally seen Victoria as a net exporter, leveraging Victoria's diverse generation mix to support New South Wales' demand, which is forecast to be maintained in the long term.

Source: Aurora Energy Research

Victoria is expected to continue as a net exporter to NSW, but may increasingly rely on electricity from Tasmania following the commissioning of Marinus Link

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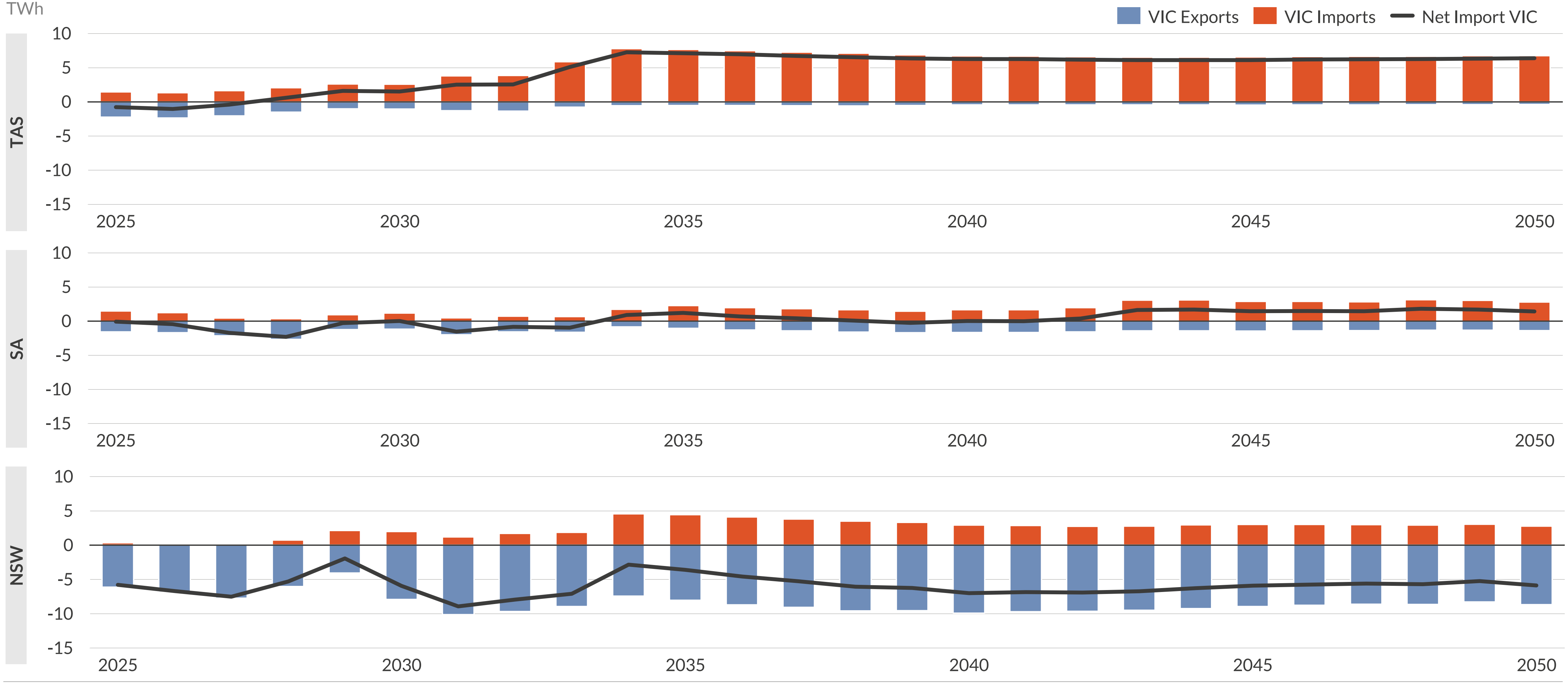
Base Case – Interconnector flows between VIC and TAS / SA / NSW



Source: Aurora Energy Research

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III. Appendix

The difference in coal closure timings and VRE buildout between the Base Case and Status Quo Scenario could significantly impact the pace of emissions reductions

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Under the Status Quo scenario, Pre-2022 VRET[1] are assumed to be met. VRET1[2] auction capacities included, along with 2GW of offshore wind by 2034. However, there is no requirement to meet updated VRET of 65% by 2030 and 95% by 2035.

		Base Case – Targets achieved	Status Quo scenario – Variations to Base Case
Policy	Offshore wind buildout targets	Assumed to meet targets on time: Victoria offshore wind generation capacity of 2GW by 2032, 4GW by 2035, 9GW by 2040	2GW of offshore wind by 2034 in VIC.
	Renewable electricity penetration targets met	Forced to meet renewable energy, storage and offshore wind targets set by the Victorian government.	Not assumed – progress toward targets is determined by the model.
	Gvt. subsidies / support mechanisms	Government support could include increased investment in REZ buildout, VRET2, offshore wind support packages (i.e. CfD), and additional Capacity Investment Scheme (CIS) Tenders.	Status quo, as per current legislation and announcements.
	Carbon pricing	Green Certificates only.	
Supply	Coal plant closures	'Early exits' as per AEMO 2024 ISP Step Change Optimal Development Pathway (ODP). Closure of Yallourn in FY29, Loy Yang B in FY32 and Loy Yang A in FY34.	Coal closures in Victoria as per asset owner announcements (Loy Yang A in FY36, Loy Yang B in FY48).
	Variable Renewable Energy (VRE) buildout	As per AEMO 2024 ISP Step Change ODP.	2GW of offshore wind by 2034 in VIC; economic solution for generation technology capacity build (excluding offshore wind).
	Transmission buildout	As per AEMO 2024 ISP Step Change ODP.	
	Commodity prices (coal and gas)	As per Aurora Central, with long term gas prices at $15/GJ and coal prices at $4/GJ.	
	Weather year[3]	FY2016 - median weather year.	
Demand	Expected energy demand growth	High degree of residential and industrial electrification and uptake of electric vehicles assumed. In 2050, Step change scenario sees 290TWh of residential and business demand, 48TWh of hydrogen demand and 68TWh of EV demand.	
	Distributed Energy Resources (DER) / Consumer Energy Resources (CER)	As per AEMO 2024 ISP Step Change ODP.	
	Electric Vehicle (EV) uptake	97% of all vehicles expected to be battery EVs as per AEMO 2024 ISP Step Change Scenario.	

1) VRET includes updated 95% target by 2035; 2) Non-committed VRET2 projects are assumed to be built later than proposed timing ; 3) Aurora's weather year approach uses a single reference year, providing a consistent view of weather impacts on energy generation. In contrast, AEMO's rolling weather year approach uses multiple historical weather years to capture a broader range of variability – see Appendix for details on representative weather year analysis

Source: Aurora Energy Research

This scenario highlights how later coal plant closures, compared to the Base Case, could slow the transition to renewables and prolong Victoria's reliance on thermal generation

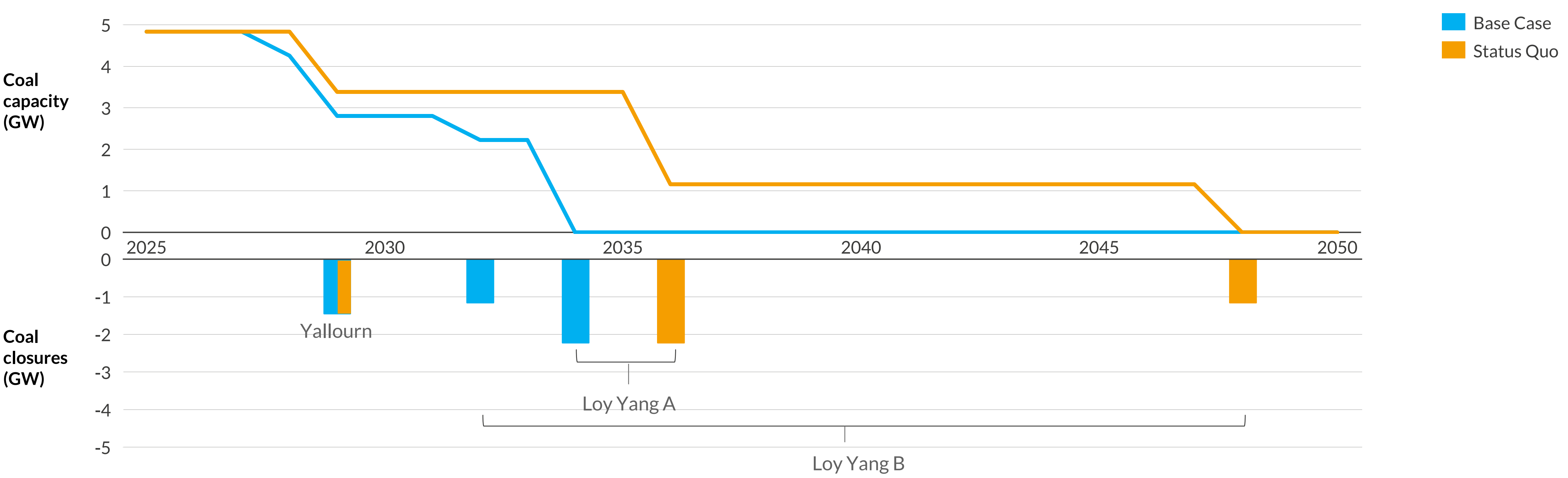
Coal plant closures in Victoria are scheduled for dates later than the Base Case, aligned with current asset owner announcement dates. As a result, state renewable energy targets are not achieved under this scenario.

The below closure dates have been modelled under the Status Quo scenario:

- Yallourn – FY29 (no change from Base Case)
- Loy Yang A – FY36 (2-year delay from Base Case)
- Loy Yang B – FY48 (16-year delay from Base Case)

To contrast, the Australian Energy Market Operator (AEMO) 2024 Integrated System Plan (ISP) sees accelerated coal closures and renewables buildout, incorporated in the Base Case.

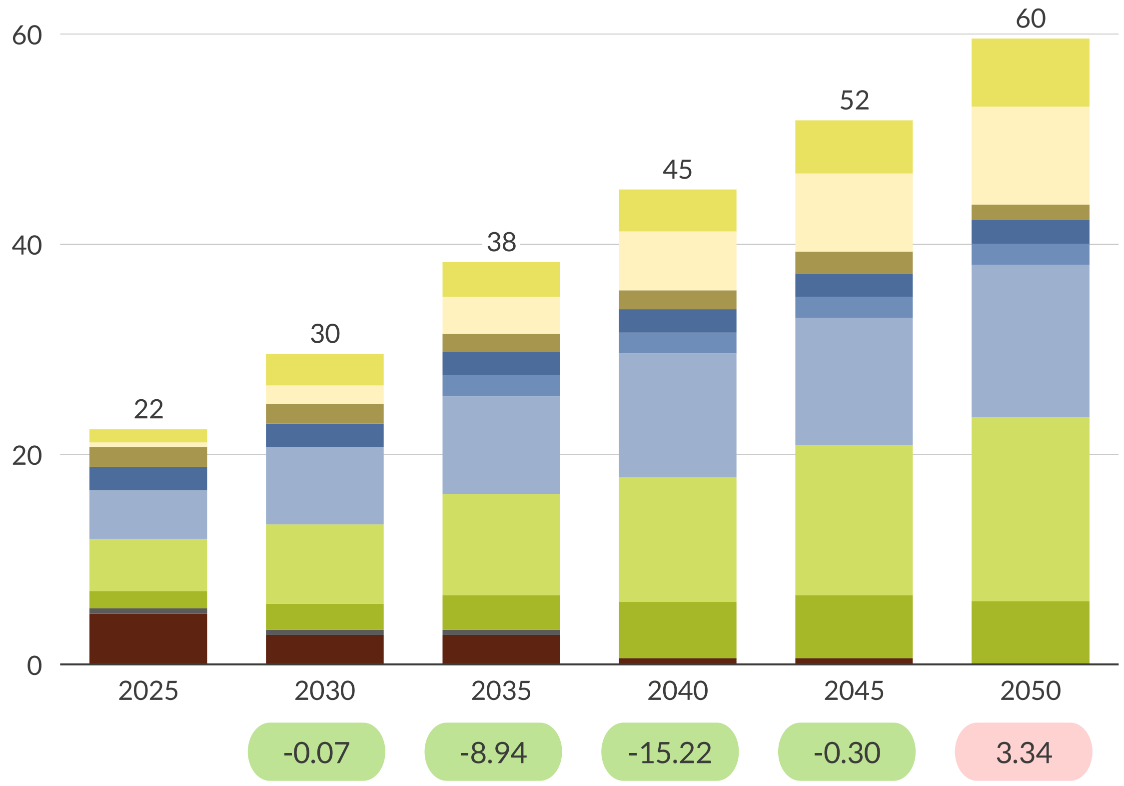
VIC Coal Capacity and Coal Plant Closure Timings



Coal plant closures following current asset owner announcements extend thermal capacity dominance into the late 2040s, reducing the need for renewables expansion

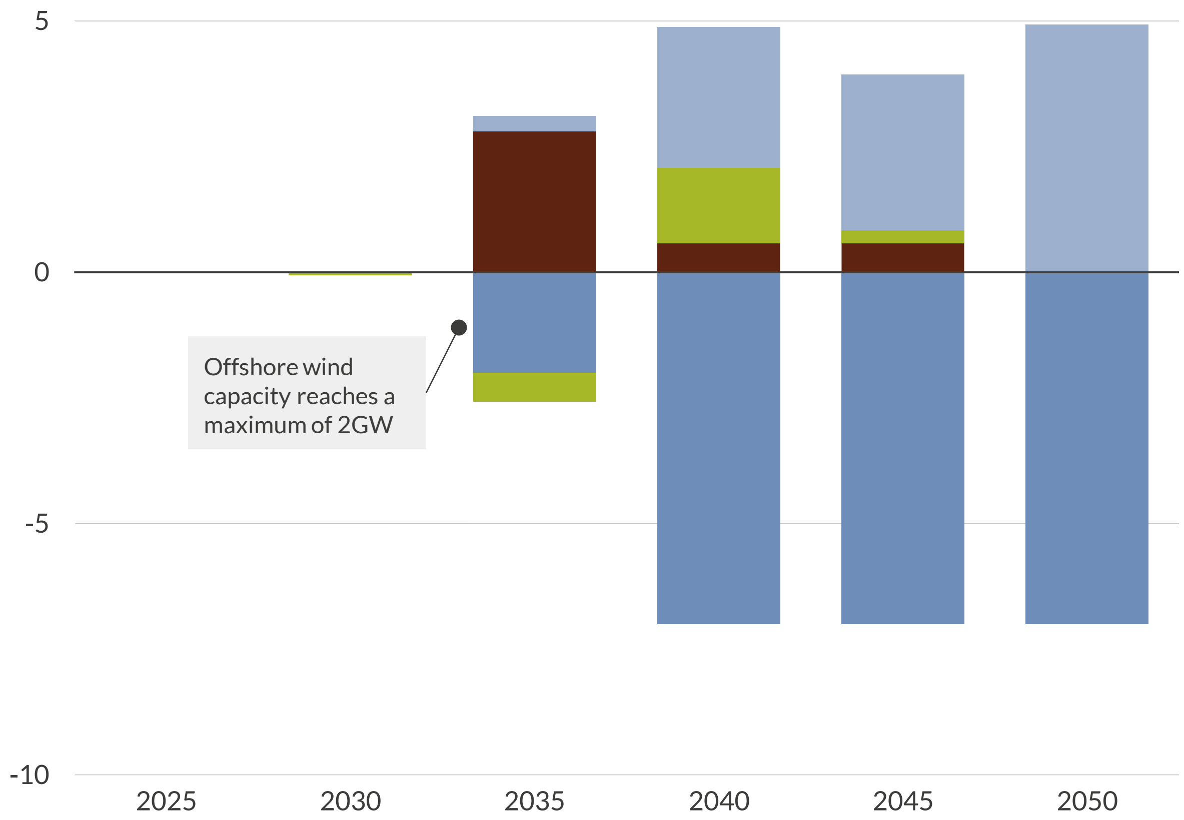
AURORA

VIC Capacity[1]
Nameplate GW



Delta from Base Case: Total 5-year CapEx for new-build utility-scale solar, wind and battery , real $A2023 bn[2]

VIC Capacity Delta , comparison to Base Case
Nameplate GW

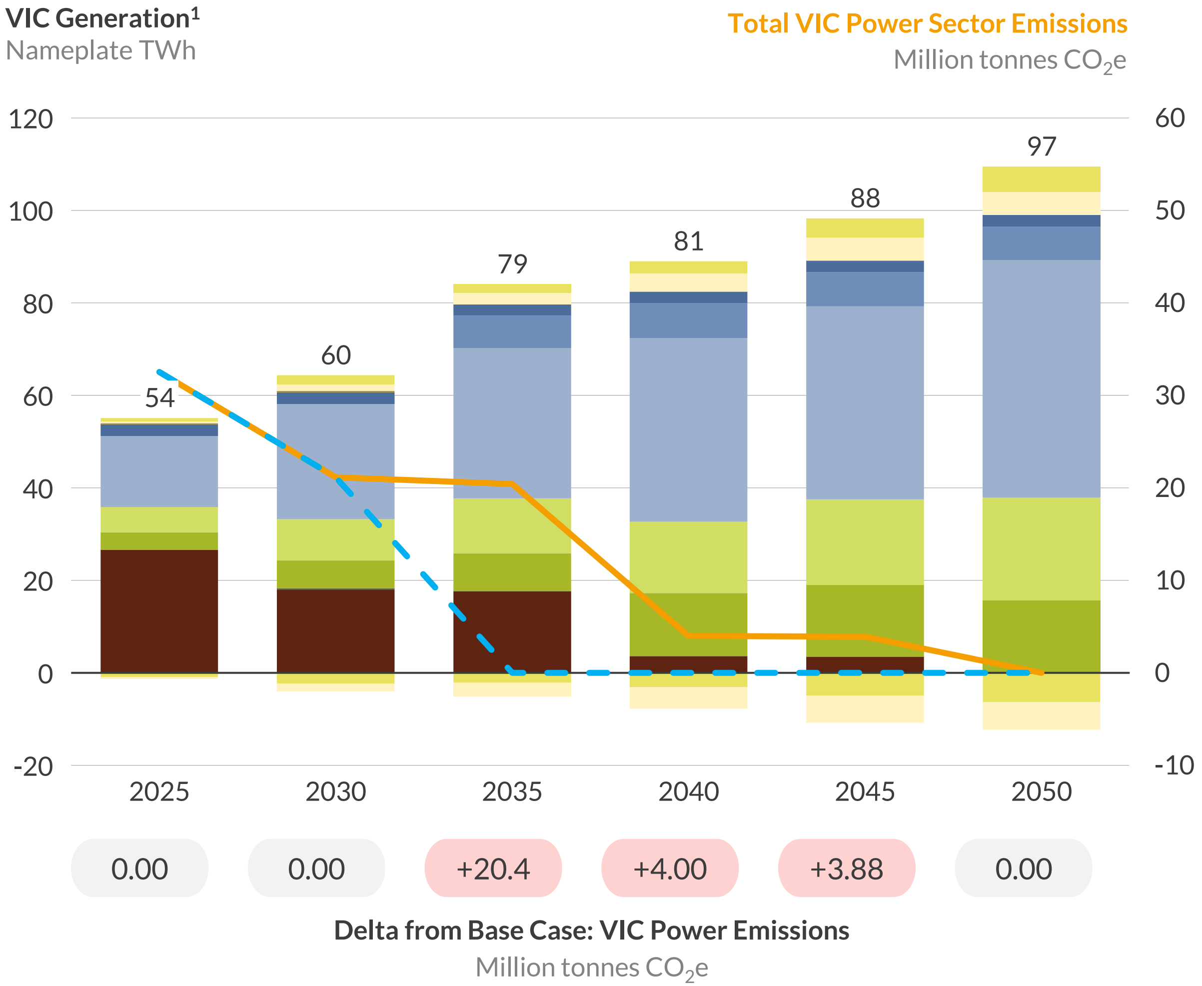


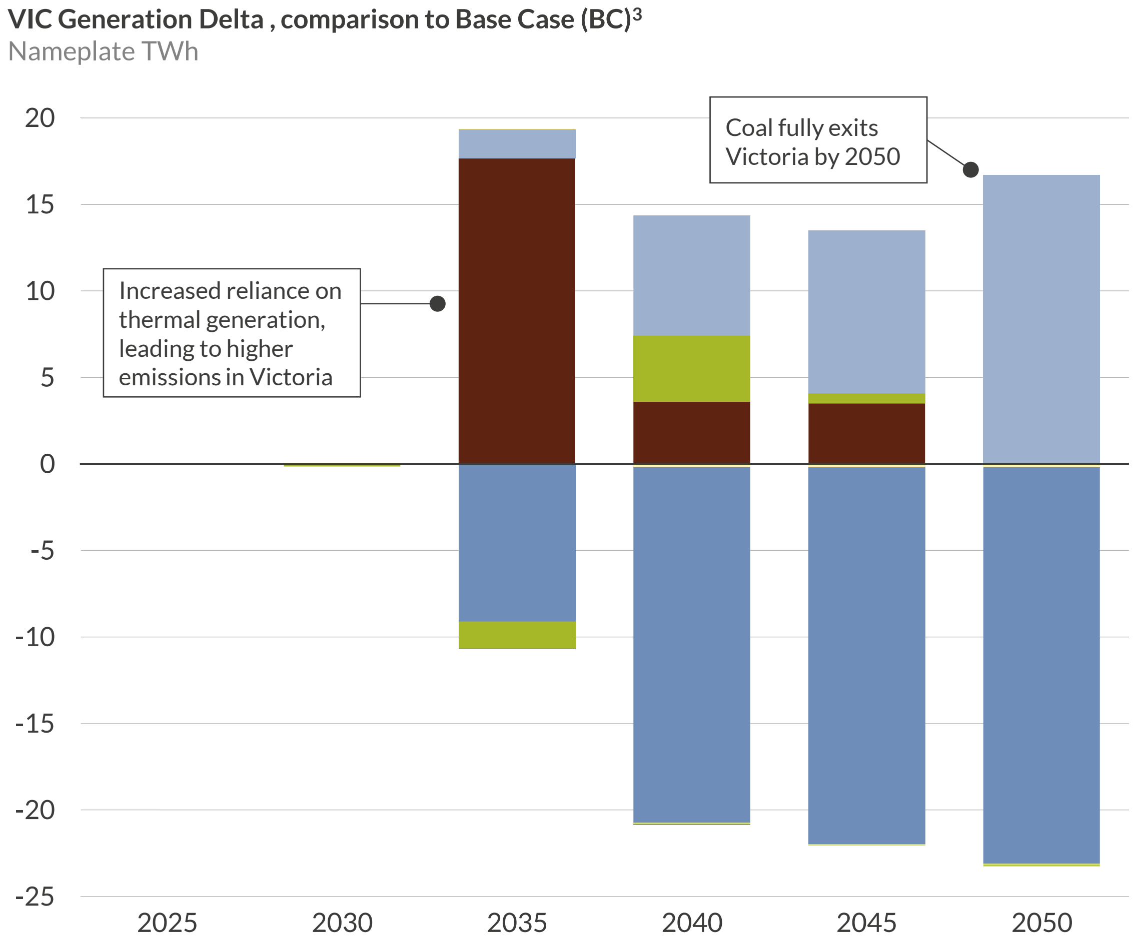
Battery Storage | BTM Battery Storage | Peaking | Hydro | Wind offshore | Wind onshore | Rooftop solar | Solar | CCGT | Lignite

1) Differences in capacity build-out from AEMO ISP levels primarily stem from modelling approaches—AEMO's model seeks to minimise total system cost, while Aurora's focuses on NPV-driven plant economics; 2) Each CapEx figure is inclusive of the preceding 5-year period i.e. FY26-30 CapEx provided in FY30, calculated using 2023 AEMO IASR CapEx assumptions – see Appendix for details

Source: Aurora Energy Research

If coal exits Victoria according to current announced asset owner dates, power sector emissions are projected to exceed the Base Case scenario by over 20 $MtCO_2e$ in FY35





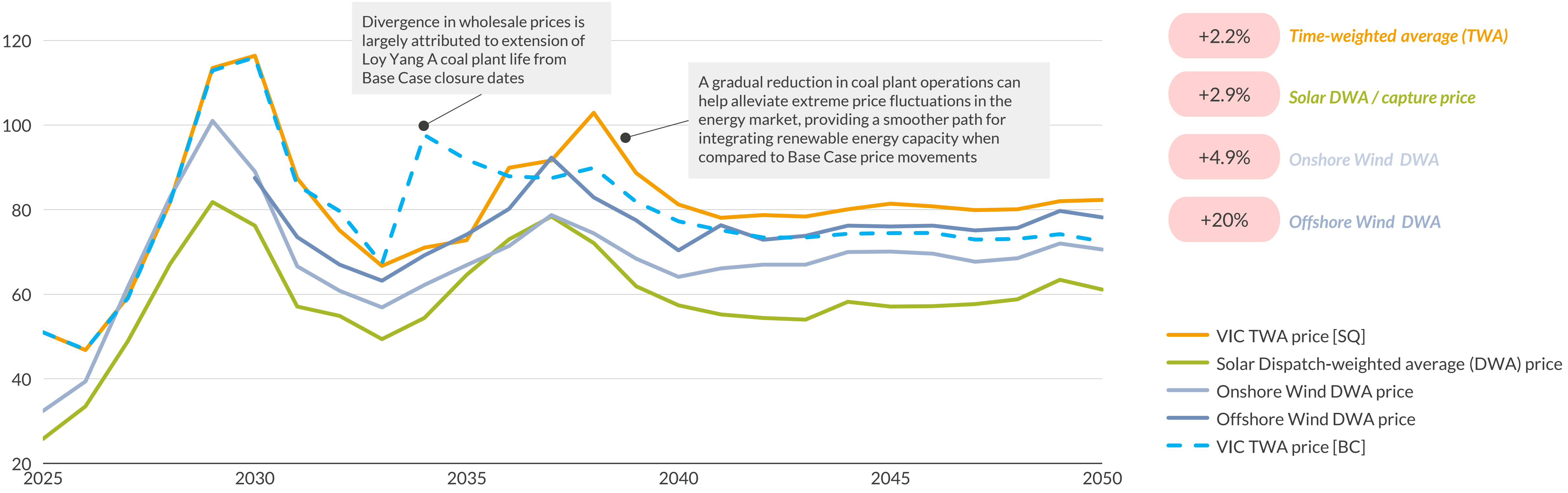
Battery Storage	Peaking[2]	Wind offshore	Rooftop solar	CCGT	Emissions [SQ]
BTM Battery Storage	Hydro	Wind onshore	Solar	Lignite	Emissions [BC]

1) Excludes Victoria imports and exports; 2) Aurora's use of a single reference weather year may result in more modest gas peaking generation forecasts compared to AEMO's rolling weather year approach, as it avoids the potential overestimation of generation needs that can arise from modelling extreme weather variability across multiple years – see Appendix for details; 3) SQ = Status Quo; BC = Base Case

Source: Aurora Energy Research

Wholesale electricity prices decrease by over $20/MWh below Base Case levels in certain years, largely attributed to a shift in coal plant closure timings

Victoria Wholesale Power Price[1]
A$/MWh



2025	2030	2035	2040	2045	2050
0.0	+0.01	-0.71	-0.18	-0.03	+0.47

Delta from Base Case: Annual wholesale power costs, real $A2023 bn[2]

Average percentage price change from Base Case,
FY25 to FY50

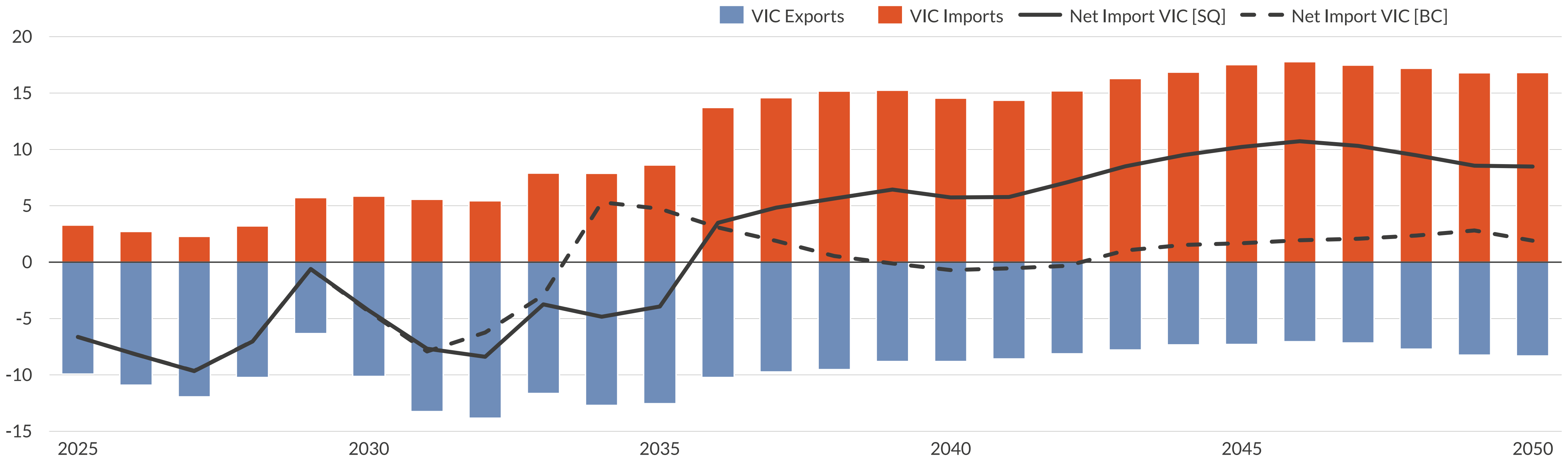
+2.2%	*Time-weighted average (TWA)*
+2.9%	*Solar DWA / capture price*
+4.9%	*Onshore Wind DWA*
+20%	*Offshore Wind DWA*

1) DWA prices curtailing at $-Large-scale Generation Certificate (LGC); 2) Wholesale power cost = TWA x Generation for each respective year

Source: Aurora Energy Research

Victoria is projected to increasingly rely on electricity imports as coal-fired power stations retire and offshore wind development is capped, limiting domestic generation

VIC Net Imports between VIC and TAS / SA / NSW
TWh



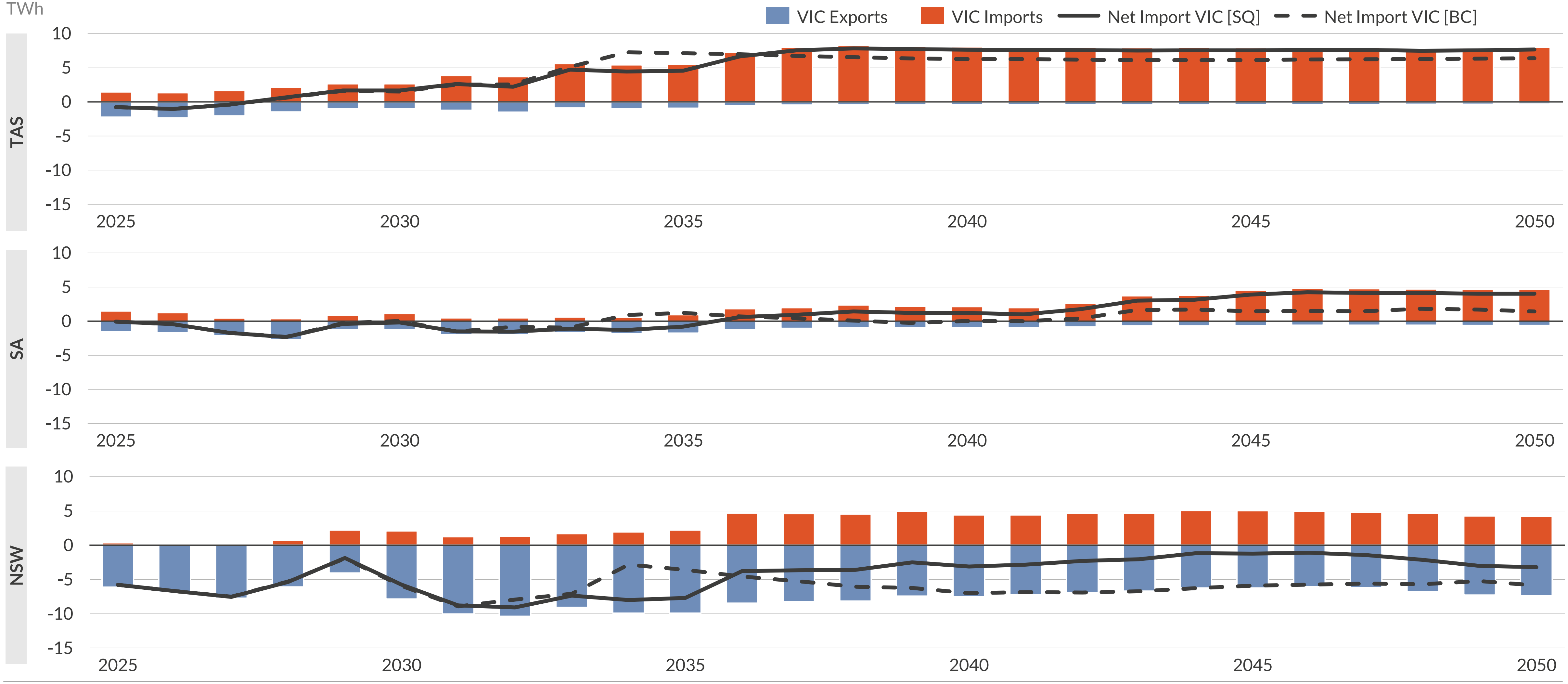
- In both scenarios, Victoria is expected to transition from being a net exporter to a net importer of electricity over the long term, driven by the rising demand for electricity and the retirement of large-scale coal-fired power stations.
- Delaying the closure of these coal plants beyond the Base Case could reduce the need for electricity imports, thereby decreasing Victoria's reliance on interstate energy.
- While the planned commissioning of the Marinus Link interconnector and the deployment of 2GW of offshore wind in this scenario may offer some relief, the reduction in offshore wind capacity compared to the Base Case leads to a significant increase in electricity imports from the late 2030s, underscoring the greater reliance on interstate energy.

Source: Aurora Energy Research

A divergence of imported generated power from Base Case is observed from the 2030s, largely caused by the delay in coal plant closures and electricity supply shortfall

AURORA

Comparison to Base Case – Interconnector flows between VIC and TAS / SA / NSW



Source: Aurora Energy Research

Agenda

I. Market overview

II. Market modelling scenarios

1. Base Case – Targets Achieved scenario
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3. Demand Increase scenario
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5. Low Weather Year scenario
6. Delayed Victoria Transmission Buildout scenario
7. Removal of Offshore Wind in Victoria scenario
8. Victoria's Accelerated Offshore Wind Buildout scenario (hypothetical)

III. Appendix

Under the Demand Increase scenario, households and businesses are forecasted to use 15% more electricity in comparison to the Base Case

AURORA

Increased electricity consumption beyond the Base Case drives up wholesale prices and requires more renewable capacity. With demand rising due to factors like industrial expansion, faster Electric Vehicle adoption, or underperformance in energy efficiency initiatives, the system faces greater challenges in replacing capacity and ensuring reliable supply.

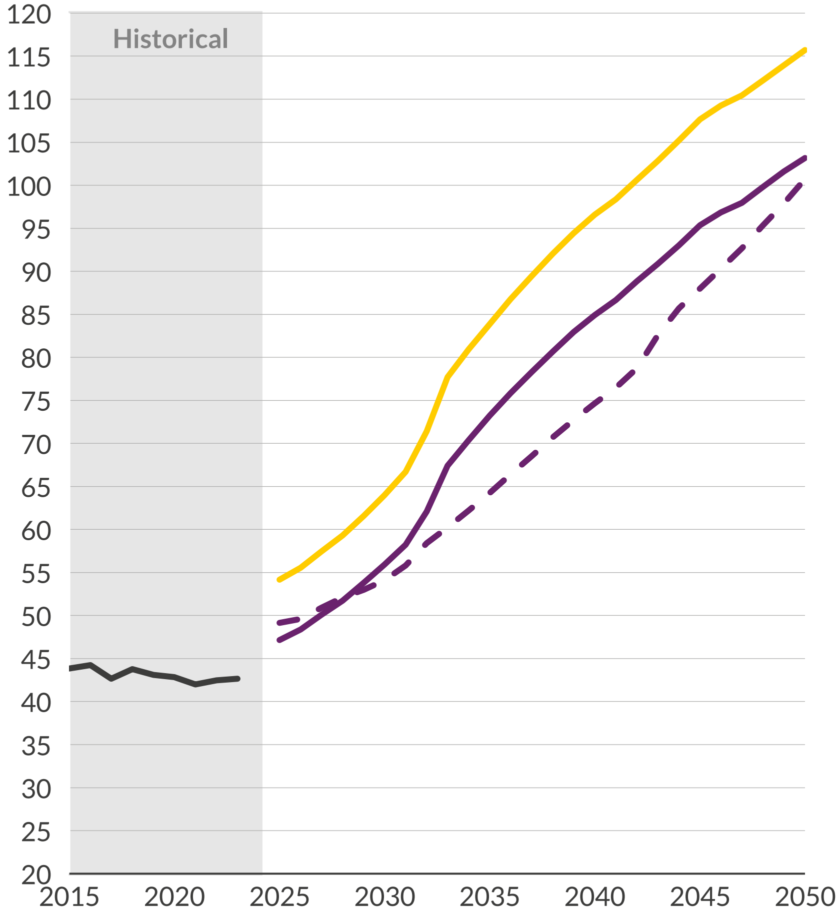
		Base Case – Targets achieved	Demand Increase scenario – Variations to Base Case
Policy	**Offshore wind buildout targets**	Assumed to meet targets on time: Victoria offshore wind generation capacity of 2GW by 2032, 4GW by 2035, 9GW by 2040	
	Renewable electricity penetration targets met	Forced to meet renewable energy, storage and offshore wind targets set by the Victorian government.	Not assumed – progress toward targets is determined by the model.
	Gvt. subsidies / support mechanisms	Government support could include increased investment in REZ buildout, VRET2, offshore wind support packages (i.e. CfD), and additional Capacity Investment Scheme (CIS) Tenders.	
	Carbon pricing	Green Certificates only.	
Supply	**Coal plant closures**	'Early exits' as per AEMO 2024 ISP Step Change Optimal Development Pathway (ODP). Closure of Yallourn in FY29, Loy Yang B in FY32 and Loy Yang A in FY34.	
	Variable Renewable Energy (VRE) buildout	As per AEMO 2024 ISP Step Change ODP.	Offshore wind buildout according to current VIC target timings; economic solution for generation technology capacity build (excluding offshore wind).
	Transmission buildout	As per AEMO 2024 ISP Step Change ODP.	
	Commodity prices (coal and gas)	As per Aurora Central, with long term gas prices at $15/GJ and coal prices at $4/GJ.	
	Weather year[1]	FY2016 - median weather year.	
Demand	**Expected energy demand growth**	High degree of residential and industrial electrification and uptake of electric vehicles assumed. In 2050, Step change scenario sees 290TWh of residential and business demand, 48TWh of hydrogen demand and 68TWh of EV demand.	15% Increase to levels of residential, commercial and industrial demand from AEMO ISP Step Change ODP.
	Distributed Energy Resources (DER) / Consumer Energy Resources (CER)	As per AEMO 2024 ISP Step Change ODP.	
	Electric Vehicle (EV) uptake	97% of all vehicles expected to be battery EVs as per AEMO 2024 ISP Step Change Scenario.	

1) Aurora's weather year approach uses a single reference year, providing a consistent view of weather impacts on energy generation. In contrast, AEMO's rolling weather year approach uses multiple historical weather years to capture a broader range of variability – see Appendix for details on representative weather year analysis

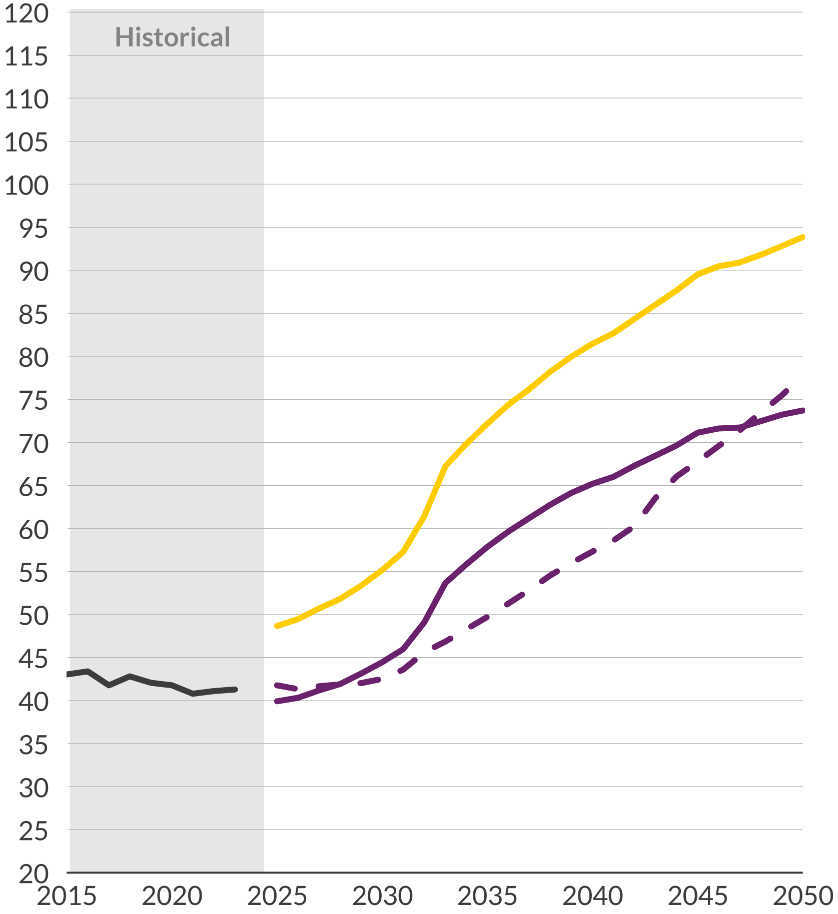
Source: Aurora Energy Research

Victoria faces a balancing act: accelerating electrification for decarbonisation while ensuring the state can meet its renewable energy goals

VIC Underlying demand[1]
TWh



VIC Operational demand[2]
TWh



Demand Increase [S3] 2024 ISP Step Change 2022 ISP Step Change History

1) Underlying demand includes commercial and residential demand and EV demand; 2) Operational demand is underlying demand net of rooftop solar and behind-the-meter (BTM) battery generation

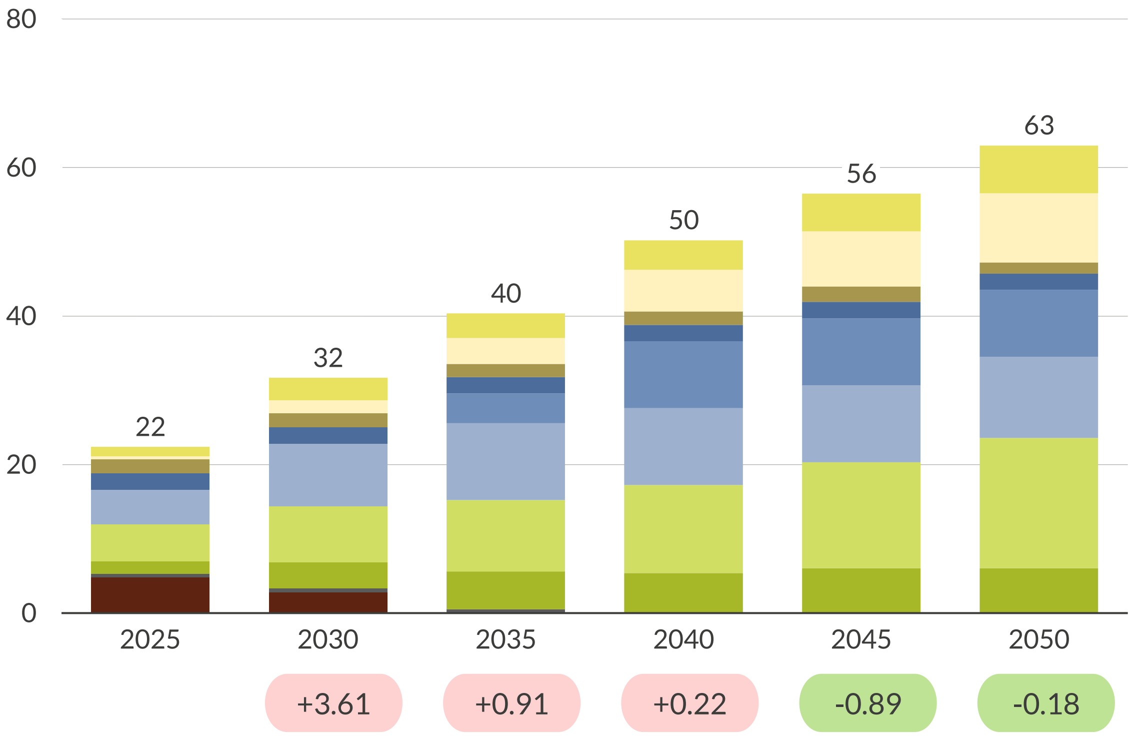
Source: DCCEEW, NEATS Public Portal, Australian Energy Council, Victoria State Government

Demand forecasts

- Meeting Victoria's ambitious renewable energy target of 65% by 2030 and 95% by 2035 is already challenging under current AEMO demand projections as observed in Base Case.
- A significant rise in demand from the Base Case—potentially driven by the growth of energy-intensive industries, increased adoption of new technologies like electric vehicles, or shortfalls in achieving energy efficiency goals—could put further pressure on the grid and delay Victoria's progress toward its renewable energy targets, especially if demand has been underestimated.
- To evaluate the potential impacts of heightened demand on Victoria's electricity market and renewable energy trajectory, this scenario explores a 15% increase in AEMO's demand forecasts.
- By examining this scenario, we can gain insights into the adaptations and investments required to balance supply and demand while maintaining Victoria's commitment to a clean energy future.

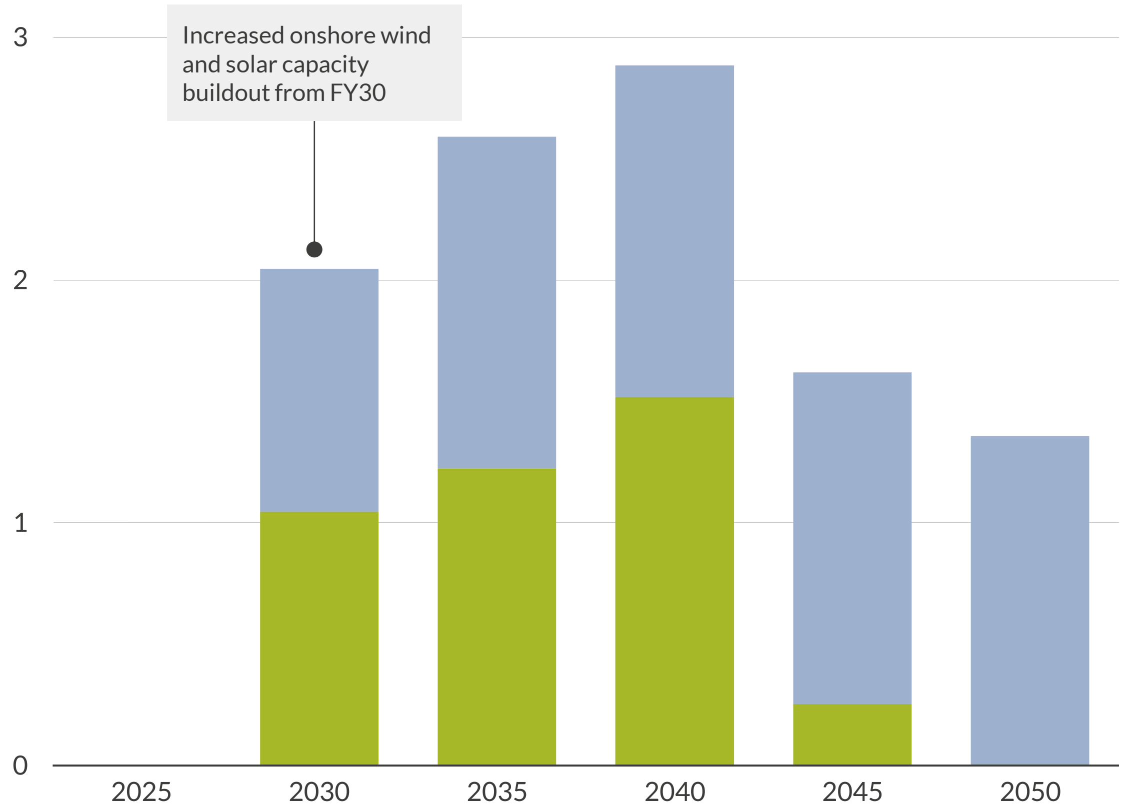
An estimated additional 10.5GW buildout of onshore wind and solar capacity is required to meet increased demand

VIC Capacity[1]
Nameplate GW



Delta from Base Case: Total 5-year CapEx for new-build utility-scale solar, wind and battery , real $A2023 bn[2]

VIC Capacity Delta , comparison to Base Case
Nameplate GW



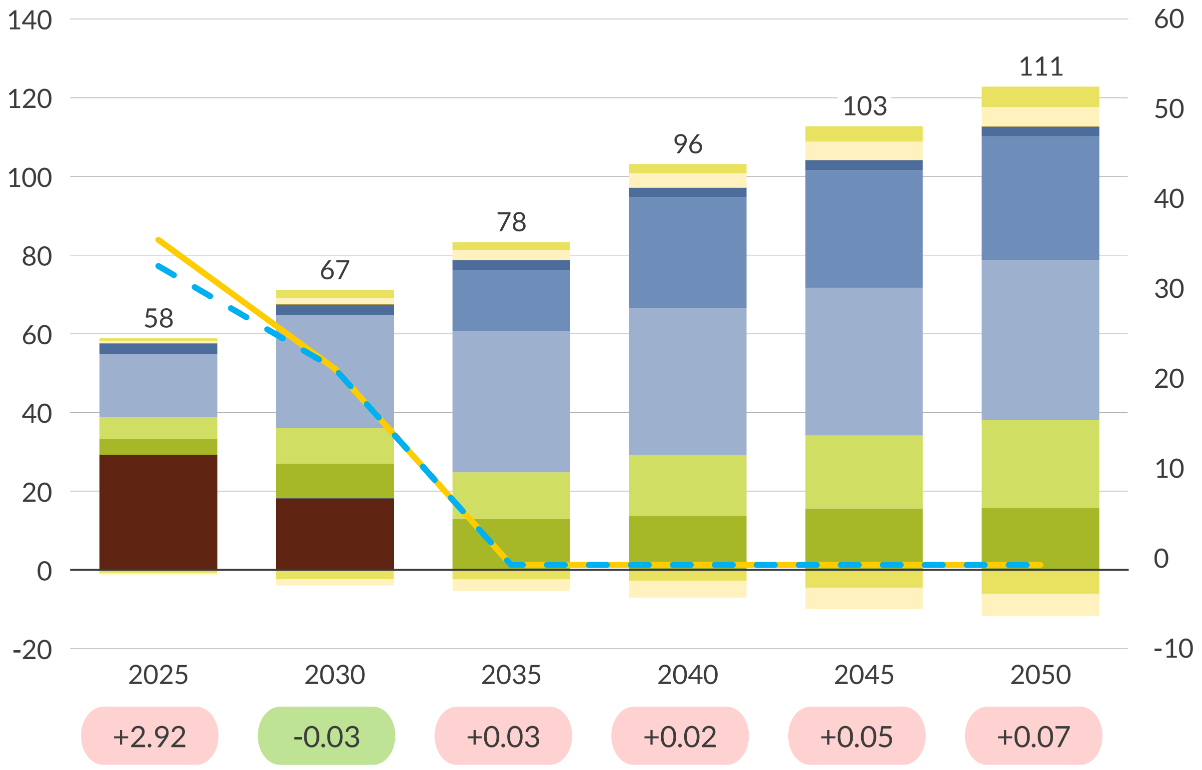
Battery Storage | BTM Battery Storage | Peaking | Hydro | Wind offshore | Wind onshore | Rooftop solar | Solar | CCGT | Lignite

1) Differences in capacity build-out from AEMO ISP levels primarily stem from modelling approaches—AEMO's model seeks to minimise total system cost, while Aurora's focuses on NPV-driven plant economics; 2) Each CapEx figure is inclusive of the preceding 5-year period i.e. FY26-30 CapEx provided in FY30, calculated using 2023 AEMO IASR CapEx assumptions – see Appendix for details
Source: Aurora Energy Research

The rise in power demand will necessitate a rapid increase in renewables generation - thermal might be needed in the interim as renewables take time to deploy

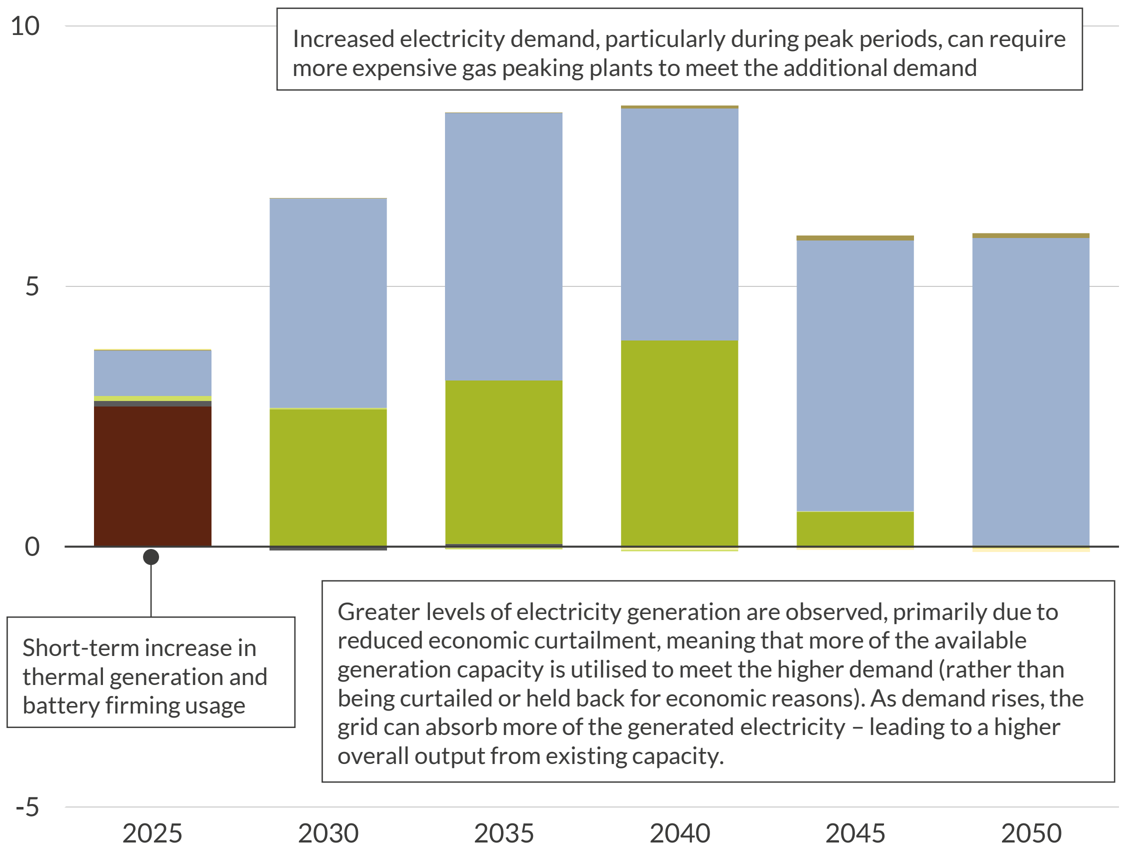
VIC Generation[1]
Nameplate TWh

Total VIC Power Sector Emissions
Million tonnes CO_2e



Delta from Base Case: VIC Power Emissions
Million tonnes CO_2e

VIC Generation Delta , comparison to Base Case (BC)
Nameplate TWh



Battery Storage | Peaking[2] | Wind offshore | Rooftop solar | CCGT | Emissions [S3]
BTM Battery Storage | Hydro | Wind onshore | Solar | Lignite | Emissions [BC]

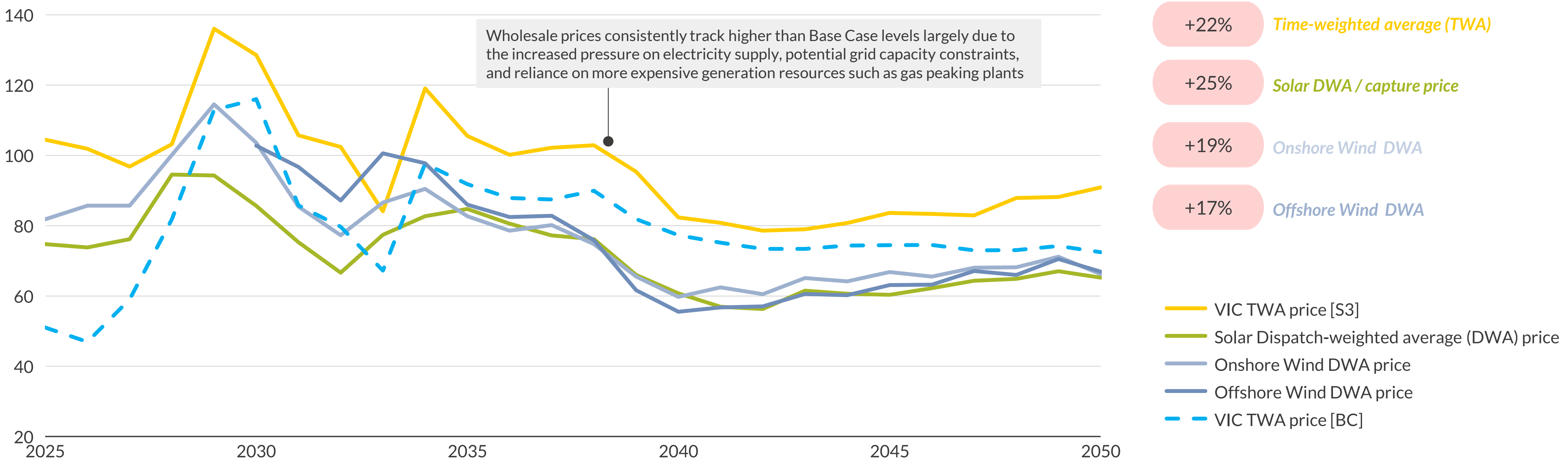
1) Excludes Victoria imports and exports; 2) Aurora's use of a single reference weather year may result in more modest gas peaking generation forecasts compared to AEMO's rolling weather year approach, as it avoids the potential overestimation of generation needs that can arise from modelling extreme weather variability across multiple years – see Appendix for details

Source: Aurora Energy Research

Time-weighted average power prices are expected to increase by over 22% from Base Case levels in response to higher electricity demand

AURORA

Victoria Wholesale Power Price[1]
A$/MWh



2025	2030	2035	2040	2045	2050
+3.3	+1.6	+1.8	+1.1	+1.4	+2.6

Delta from Base Case: Annual wholesale power costs, real $A2023 bn[2]

Average percentage price change from Base Case,
FY25 to FY50

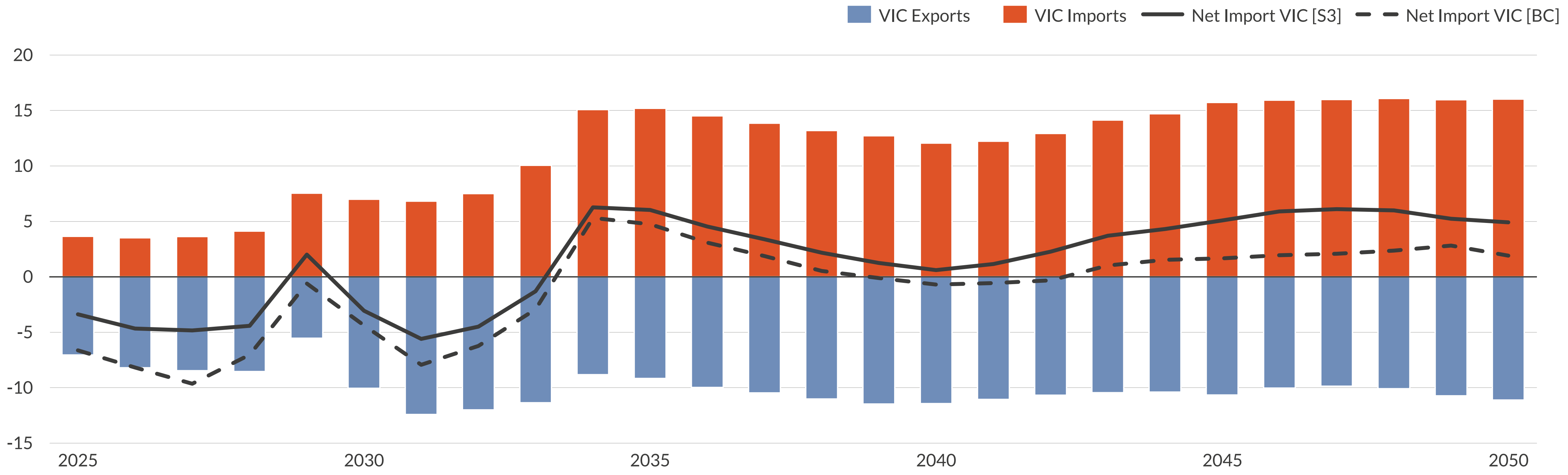
+22%	*Time-weighted average (TWA)*
+25%	*Solar DWA / capture price*
+19%	*Onshore Wind DWA*
+17%	*Offshore Wind DWA*

1) DWA prices curtailing at $-Large-scale Generation Certificate (LGC); 2) Wholesale power cost = TWA x Generation for each respective year

Source: Aurora Energy Research

Victoria's reliance on interstate electricity will intensify as its coal-fired power stations reach the end of their operational lifespan

VIC Net Imports between VIC and TAS / SA / NSW
TWh



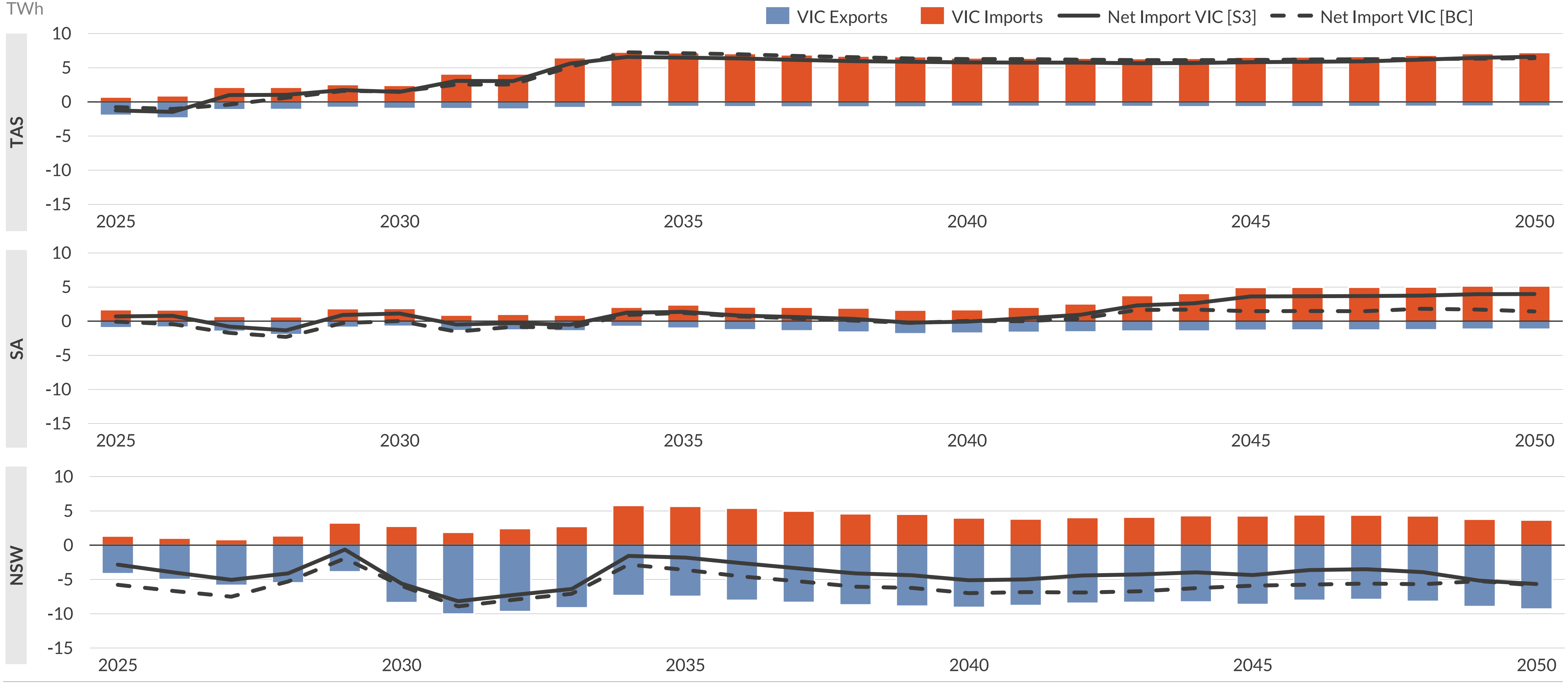
- This shift from being a net exporter to a net importer of electricity is driven by the closure of large-scale coal plants and rising electricity demand.
- In the short term, Victoria will reduce exports to interconnected states as local generation struggles to meet growing demand. In the medium term and onwards, the state is expected to import more electricity than in the Base Case scenario to compensate for the loss of coal generation and satisfy increased demand.
- Additionally, under an increased demand scenario, the strain on interconnectors is likely to grow, amplifying net imports as Victoria relies more heavily on interstate resources to bridge the gap between local generation and higher electricity consumption. This increased strain could also limit Victoria's ability to export surplus power during periods of high local generation.

Source: Aurora Energy Research

The convergence of rising electricity consumption and imminent exit of coal will necessitate an expansion of interstate energy imports from TAS, SA and NSW

Comparison to Base Case – Interconnector flows between VIC and TAS / SA / NSW

TWh



Source: Aurora Energy Research

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8. Victoria's Accelerated Offshore Wind Buildout scenario (hypothetical)

III. Appendix

Despite record capacity deployment in recent years, consumer energy resources could face headwinds from declining subsidies and increasing export costs

AURORA

CER/DER uptake in this scenario follows the *Progressive Change* pathway from AEMO's 2024 Final ISP, with lower EV ownership, behind-the-meter batteries and rooftop solar compared to the Base Case. Potential challenges could arise in a low CER/DER uptake case, such as increased grid constraints and wider network impacts not captured in Victoria's wholesale power price movements. To compensate, greater reliance on grid-scale resources would be necessary, possibly sourced from neighbouring states.

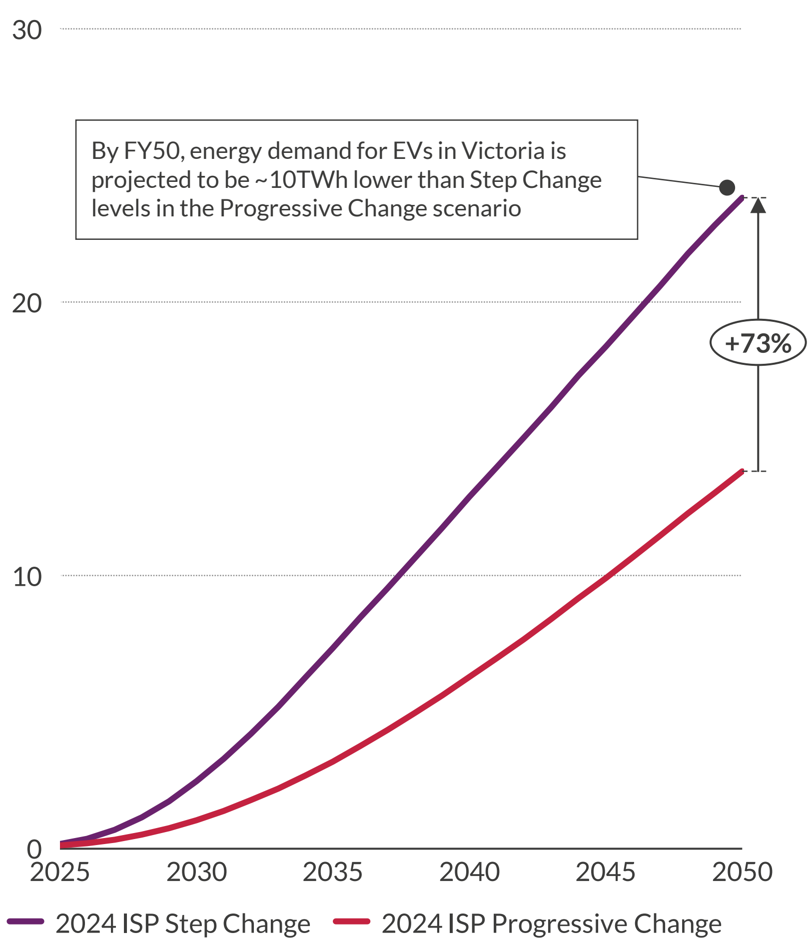
		Base Case – Targets achieved	Slow CER/DER uptake – Variations to Base Case
Policy	**Offshore wind buildout targets**	Assumed to meet targets on time: Victoria offshore wind generation capacity of 2GW by 2032, 4GW by 2035, 9GW by 2040	
	Renewable electricity penetration targets met	Forced to meet renewable energy, storage and offshore wind targets set by the Victorian government.	Not assumed – progress toward targets is determined by the model.
	Gvt. subsidies / support mechanisms	Government support could include increased investment in REZ buildout, VRET2, offshore wind support packages (i.e. CfD), and additional Capacity Investment Scheme (CIS) Tenders.	Slower investment in utility-scale assets and CER as per AEMO 2024 ISP Progressive Change.
	Carbon pricing	Green Certificates only.	
Supply	**Coal plant closures**	'Early exits' as per AEMO 2024 ISP Step Change Optimal Development Pathway (ODP). Closure of Yallourn in FY29, Loy Yang B in FY32 and Loy Yang A in FY34.	
	Variable Renewable Energy (VRE) buildout	As per AEMO 2024 ISP Step Change ODP.	Offshore wind buildout according to current VIC target timings; economic solution for generation technology capacity build (excluding offshore wind).
	Transmission buildout	As per AEMO 2024 ISP Step Change ODP.	
	Commodity prices (coal and gas)	As per Aurora Central, with long term gas prices at $15/GJ and coal prices at $4/GJ.	
	Weather year	FY2016 - median weather year.	
Demand	**Expected energy demand growth**	High degree of residential and industrial electrification and uptake of electric vehicles assumed. In 2050, Step change scenario sees 290TWh of residential and business demand, 48TWh of hydrogen demand and 68TWh of EV demand.	
	Distributed Energy Resources (DER) / Consumer Energy Resources (CER)	As per AEMO 2024 ISP Step Change ODP.	As per AEMO 2024 ISP Progressive Change Scenario: • 10.6 GW of Rooftop PV (CER solar) capacity by FY50; and • 1.8 GW of CER batteries capacity by FY50.
	Electric Vehicle (EV) uptake	97% of all vehicles expected to be battery EVs as per AEMO 2024 ISP Step Change Scenario.	63% of all vehicles expected to be battery EVs as per AEMO 2024 ISP Progressive Change Scenario.

Source: Aurora Energy Research

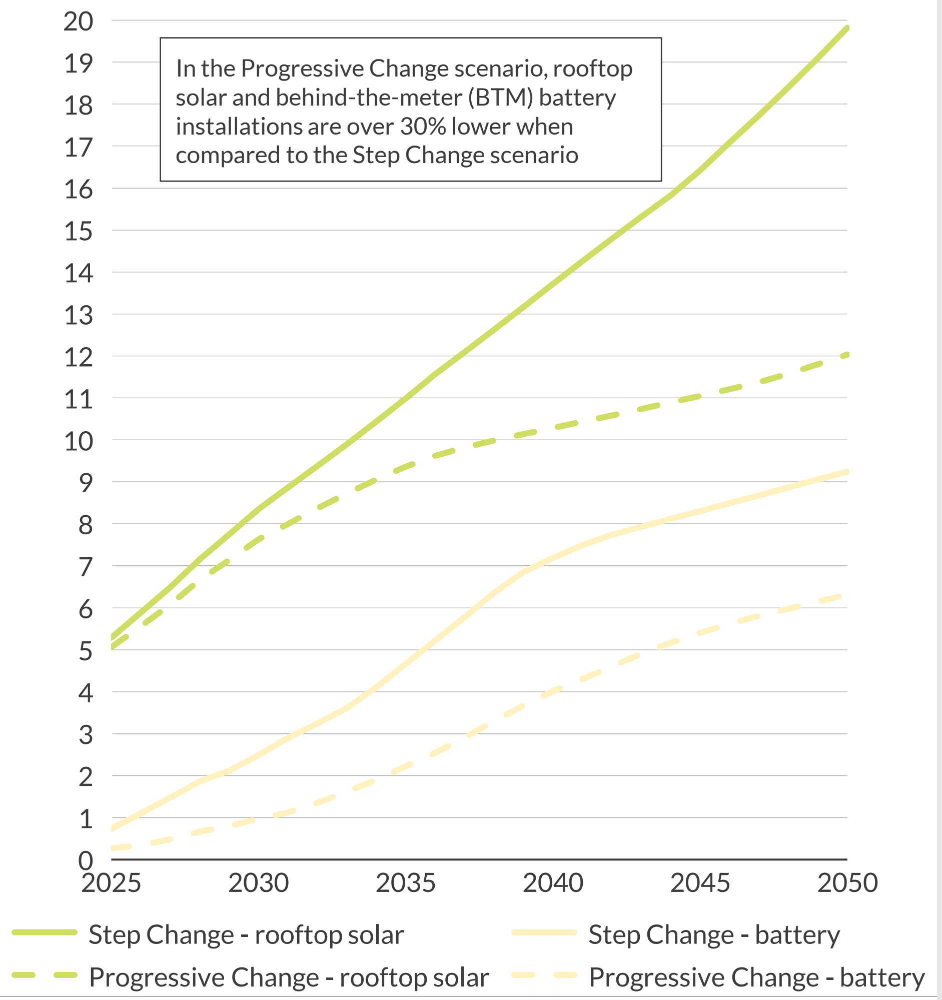
A shift to AEMO's Progressive Change scenario sees slower EV uptake and CER adoption, delaying the energy transition and prolonging reliance on fossil fuels

AURORA

VIC Energy Demand from Electric vehicles
TWh, 2024 ISP Step Change vs Progressive Change



VIC Rooftop solar and BTM battery capacity
GW, 2025 to 2050 under 2024 AEMO ISP



1) Data provided in calendar years

Source: AEMO

Electric Vehicle (EV) Demand

- AEMO's Progressive Change scenario takes a more conservative view on EV adoption rates in Victoria.
- Despite a favorable policy environment, several barriers may deter consumers from switching to EVs. These include high upfront costs, limited charging infrastructure (especially in apartments and remote areas), and concerns about range anxiety.

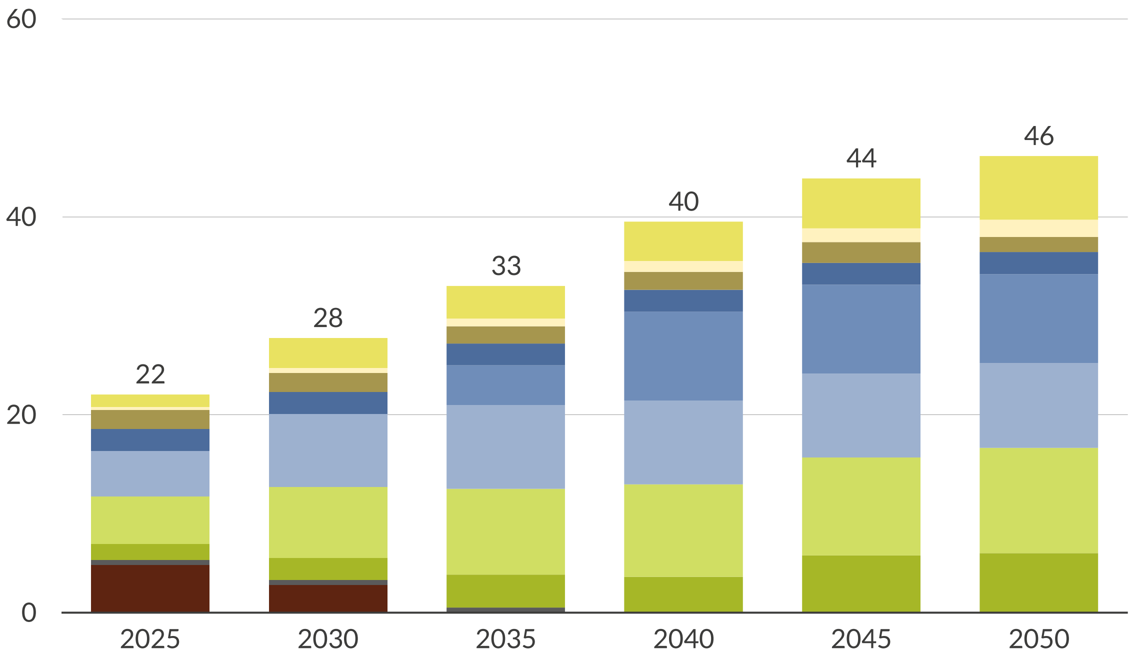
Solar and behind-the-meter batteries

- Reduced uptake under the Progressive Change scenario has significant implications for Victoria's energy landscape. Rooftop solar in Victoria plays a pivotal role in decentralising energy production, allowing households and businesses to generate their own electricity.
- BTM batteries further enhance this by enabling the storage of excess solar energy, which can then be used during peak demand periods, reducing reliance on fossil fuels. Slower growth in BTM resources means that Victoria will see a more gradual shift in its energy mix.

With low CER uptake in Victoria, the state faces a shortfall in rooftop solar and behind-the-meter storage capacity, which could hinder energy transition progress

AURORA

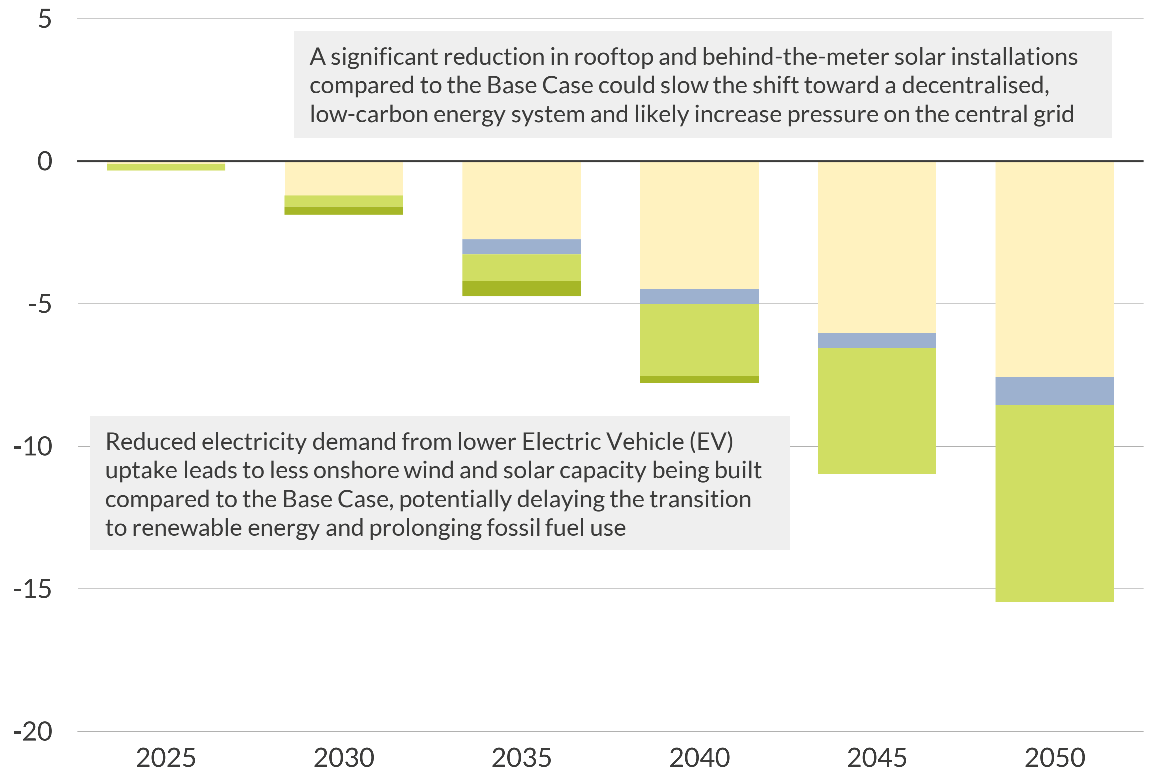
VIC Capacity
Nameplate GW



	2030	2035	2040	2045	2050
	-0.33	-1.33	+0.21	+0.20	-0.87

Delta from Base Case: Total 5-year CapEx for new-build utility-scale solar, wind and battery , real $A2023 bn[1]

VIC Capacity Delta , comparison to Base Case
Nameplate GW



Battery Storage | BTM Battery Storage | Peaking | Hydro | Wind offshore | Wind onshore | Rooftop solar | Solar | CCGT | Lignite

1) Each CapEx figure is inclusive of the preceding 5-year period i.e. FY26-30 CapEx provided in FY30, calculated using 2023 AEMO IASR CapEx assumptions – see Appendix for details

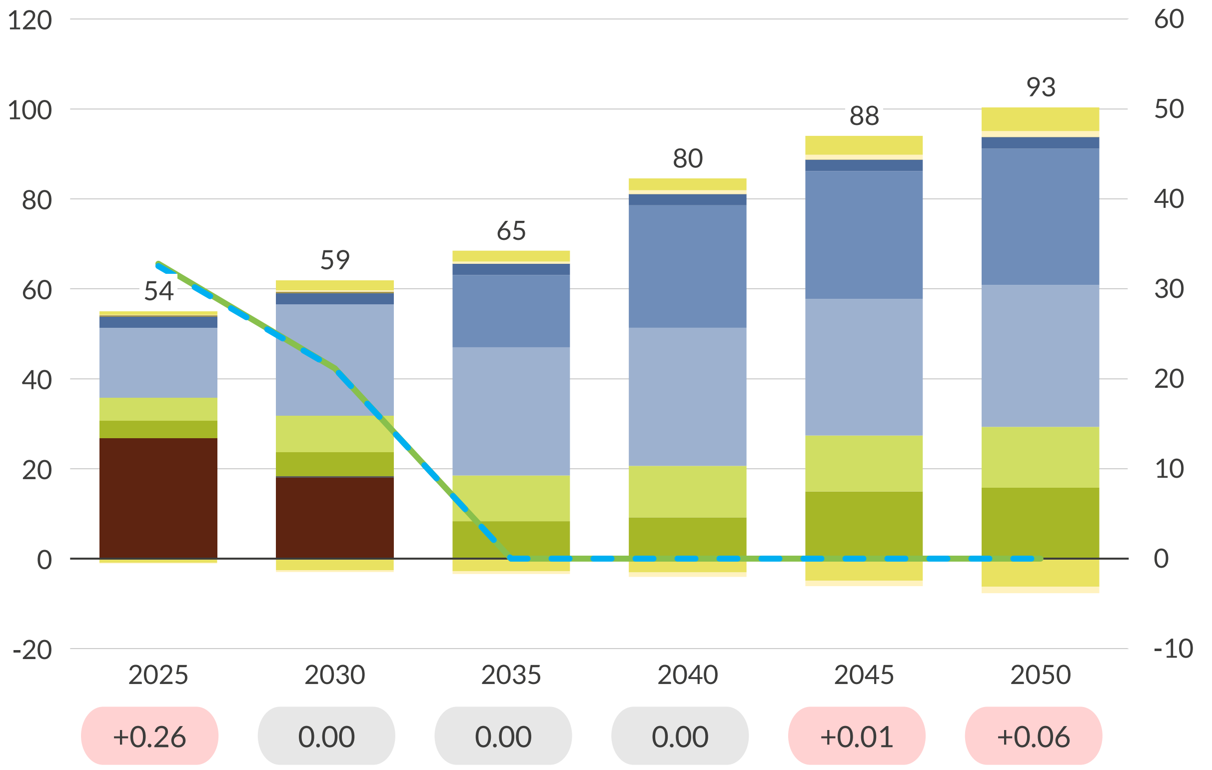
Source: Aurora Energy Research

Similarly, state-wide electricity generation is suppressed as a direct consequence of slower growth in EV adoption, which leads to lower overall electricity demand

AURORA

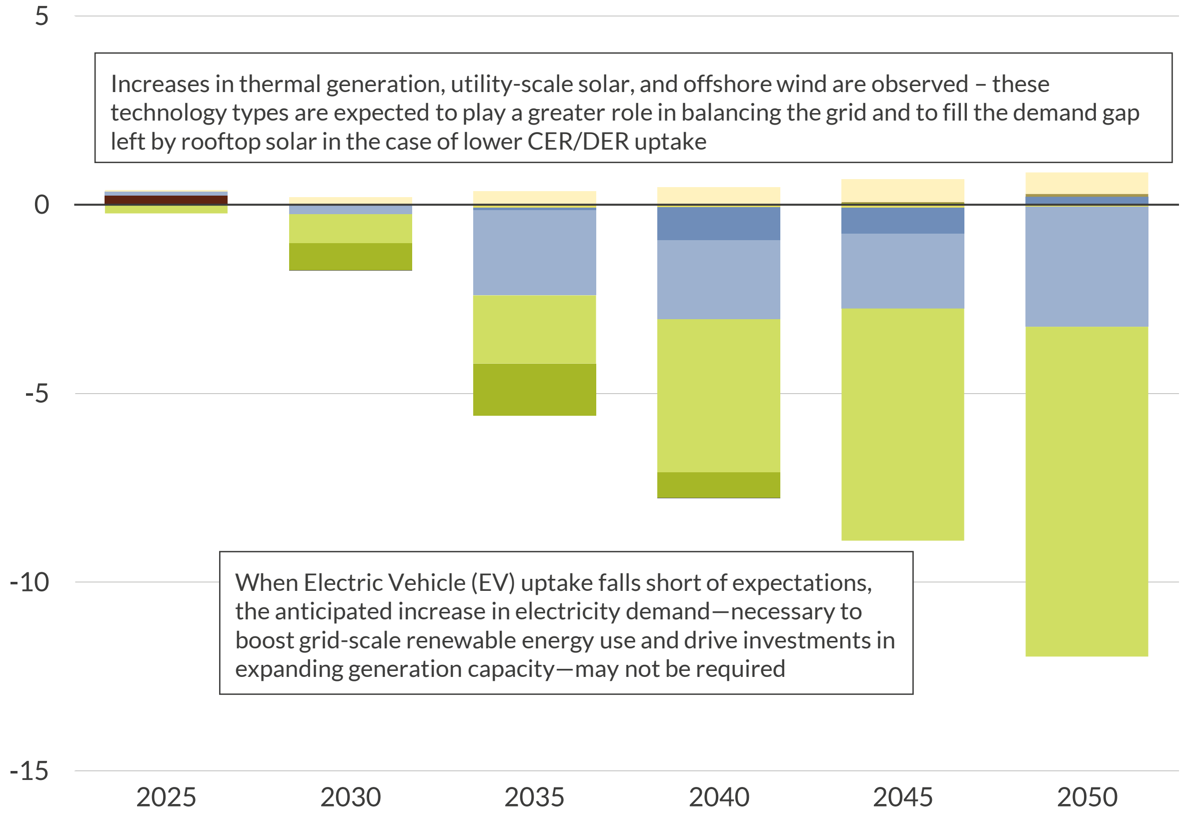
VIC Generation[1]
Nameplate TWh

Total VIC Power Sector Emissions
Million tonnes CO_2e



Delta from Base Case: VIC Power Emissions
Million tonnes CO_2e

VIC Generation Delta , comparison to Base Case (BC)
Nameplate TWh



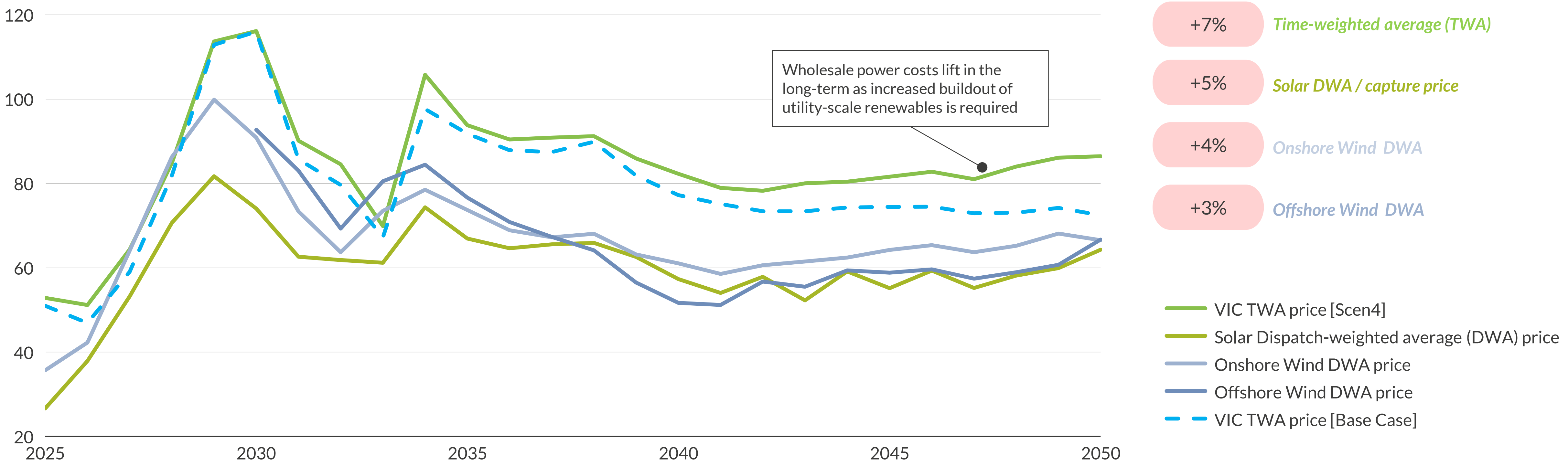
Battery Storage | Peaking[2] | Wind offshore | Rooftop solar | CCGT | Emissions [S4]
BTM Battery Storage | Hydro | Wind onshore | Solar | Lignite | Emissions [BC]

1) Excludes Victoria imports and exports; 2) Aurora's use of a single reference weather year may result in more modest gas peaking generation forecasts compared to AEMO's rolling weather year approach, as it avoids the potential overestimation of generation needs that can arise from modelling extreme weather variability across multiple years – see Appendix for details

Source: Aurora Energy Research

Less buildout of behind-the-meter solar and battery is expected to increase time-weighted average electricity prices relative to Base Case in the medium to long-term

Victoria Wholesale Power Price[1]
A$/MWh



2025	2030	2035	2040	2045	2050
+0.1	-0.2	-0.3	-0.2	+0.02	+0.5

Delta from Base Case: Annual wholesale power costs, real $A2023 bn[2]

Average percentage price change from Base Case,
FY25 to FY50

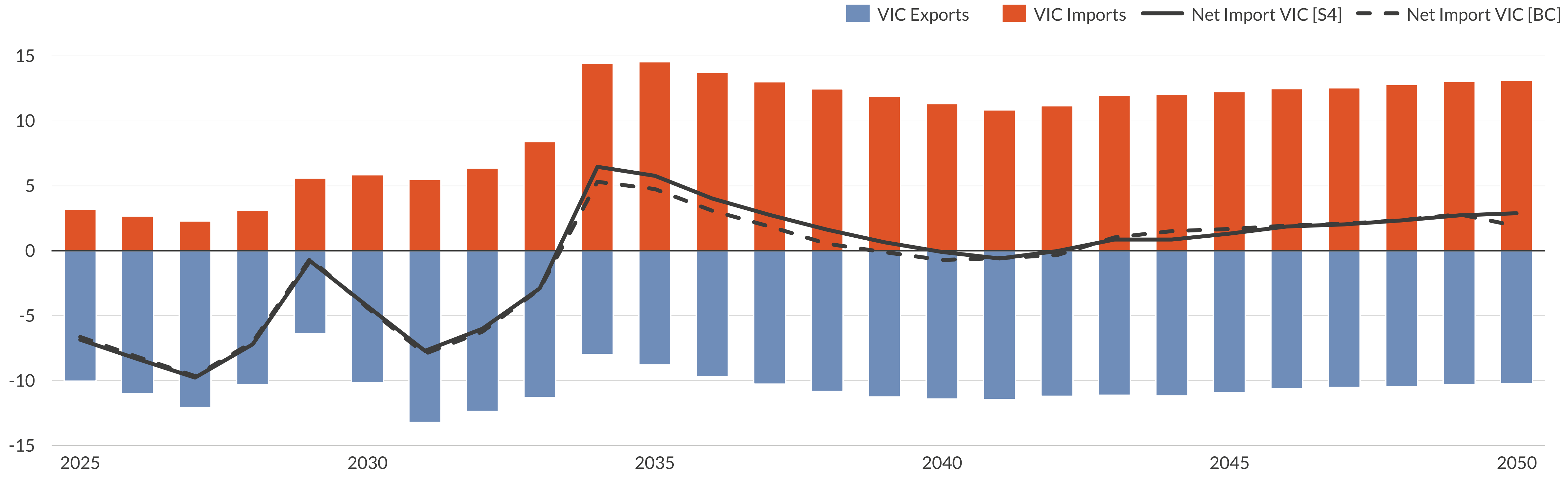
+7%	*Time-weighted average (TWA)*
+5%	*Solar DWA / capture price*
+4%	*Onshore Wind DWA*
+3%	*Offshore Wind DWA*

1) DWA prices curtailing at $-Large-scale Generation Certificate (LGC); 2) Wholesale power cost = TWA x Generation for each respective year

Source: Aurora Energy Research

Lower levels of CER/DER uptake is expected to strain interconnector capacity in the medium term as Victoria's reliance on interstate imports grows

VIC Net Imports between VIC and TAS / SA / NSW
TWh

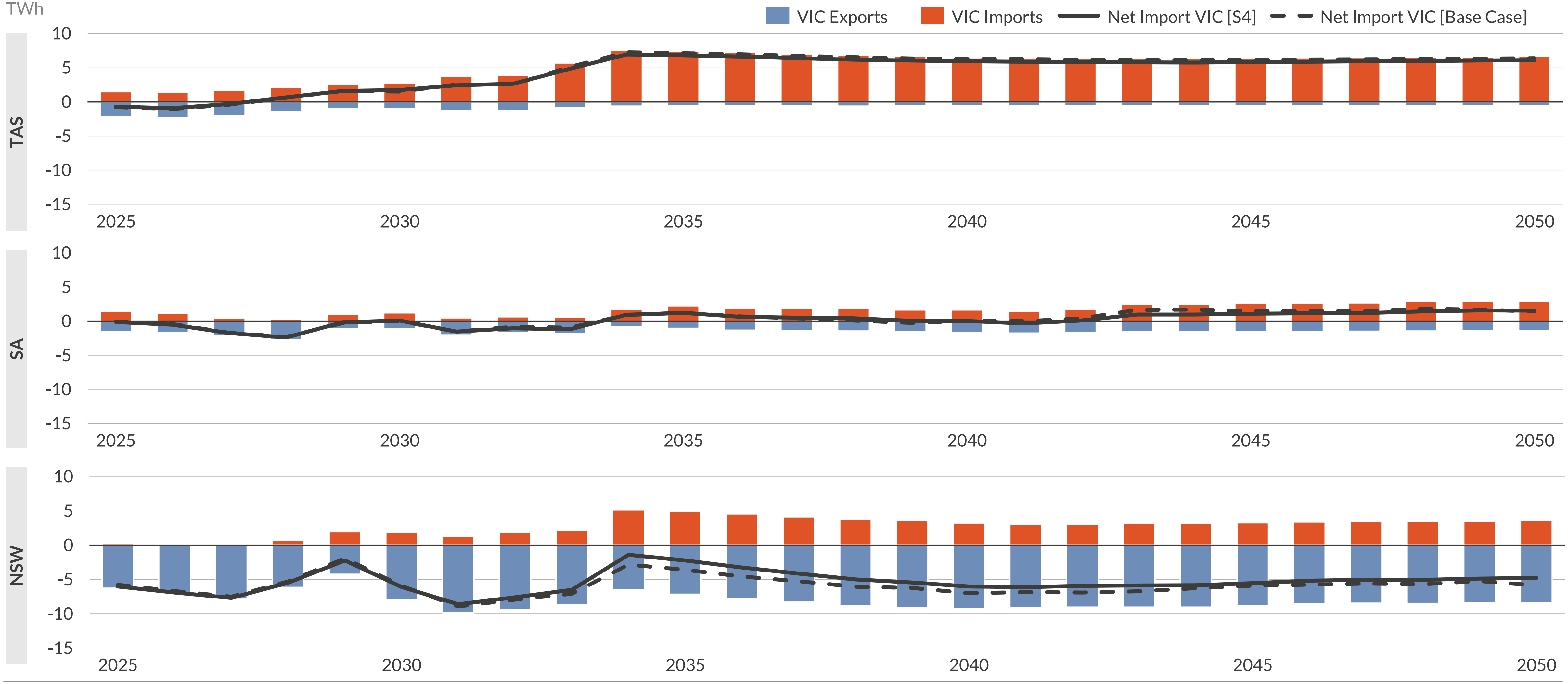


- Suppressed local generation from behind-the-meter (BTM) resources leads to increased reliance on electricity imports in times of high electricity demand in Victoria. This is expected to impact Victoria in the medium-term as coal plants retire, leading Victoria to depend on other states when it would have previously relied on BTM resources.
- The introduction of Marinus Link further enables capacity flow in both directions between Victoria and Tasmania, thereby increasing the reliability and resilience of the electricity grid in both states, particularly critical as lower levels of BTM resources may increase Victoria's vulnerability.

Source: Aurora Energy Research

Reduced adoption of CER/DER will diminish Victoria's domestic electricity generation, potentially leading to a slight reduction in net exports to New South Wales

Comparison to Base Case – Interconnector flows between VIC and TAS / SA / NSW
TWh



Source: Aurora Energy Research

Agenda

AURORA

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1. Base Case – Targets Achieved scenario
2. Status Quo scenario
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8. Victoria's Accelerated Offshore Wind Buildout scenario (hypothetical)

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As variable renewable energy (VRE) capacity increases, the risk of energy supply shortages during renewable energy droughts becomes more pronounced

AURORA

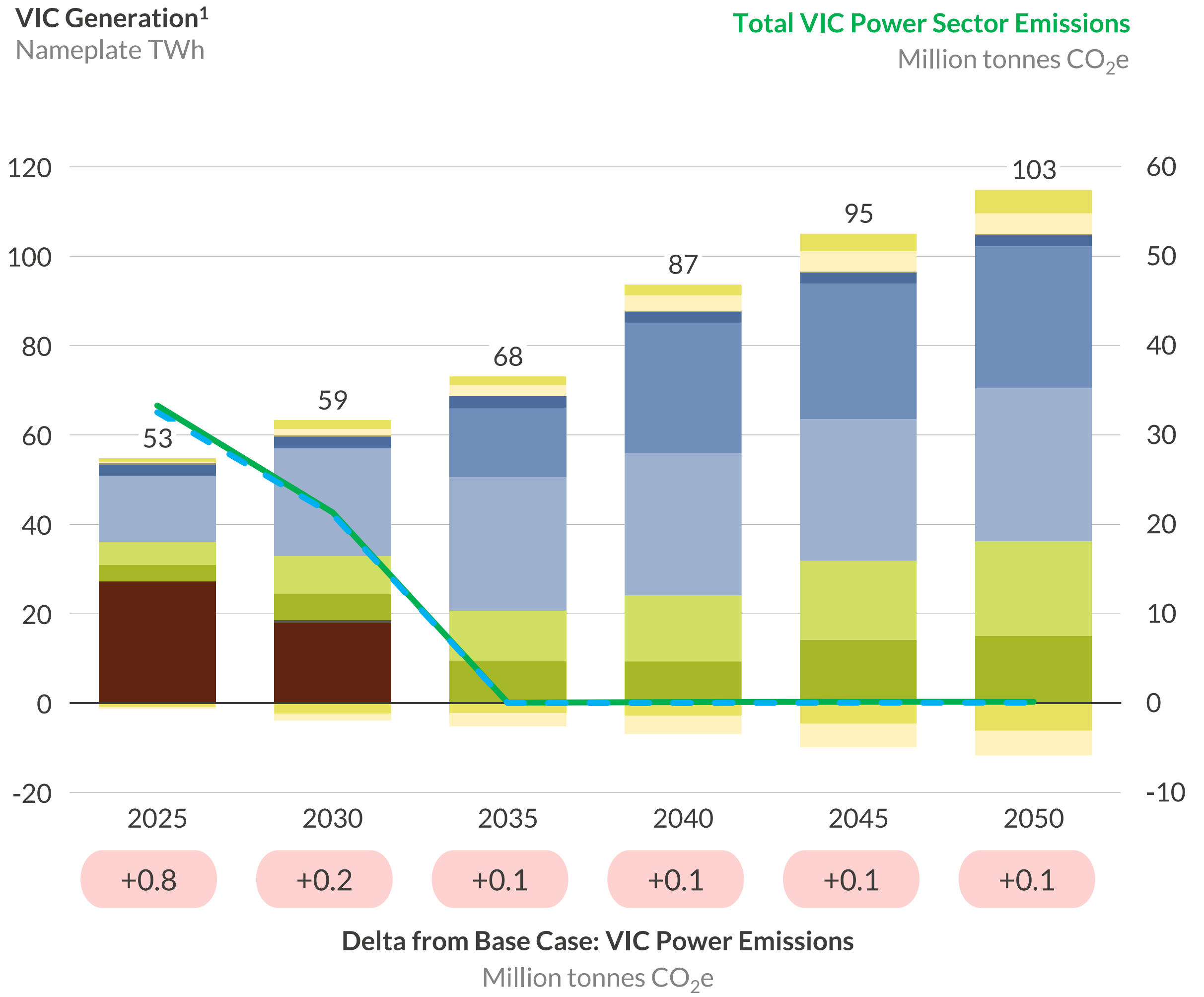
This scenario maintains the original capacity buildout and energy mix from Base Case, but experiences lower renewable energy generation due to a less favorable weather pattern – this is characterised by reduced wind speeds and solar irradiance, commonly referred to as a 'renewable energy drought'

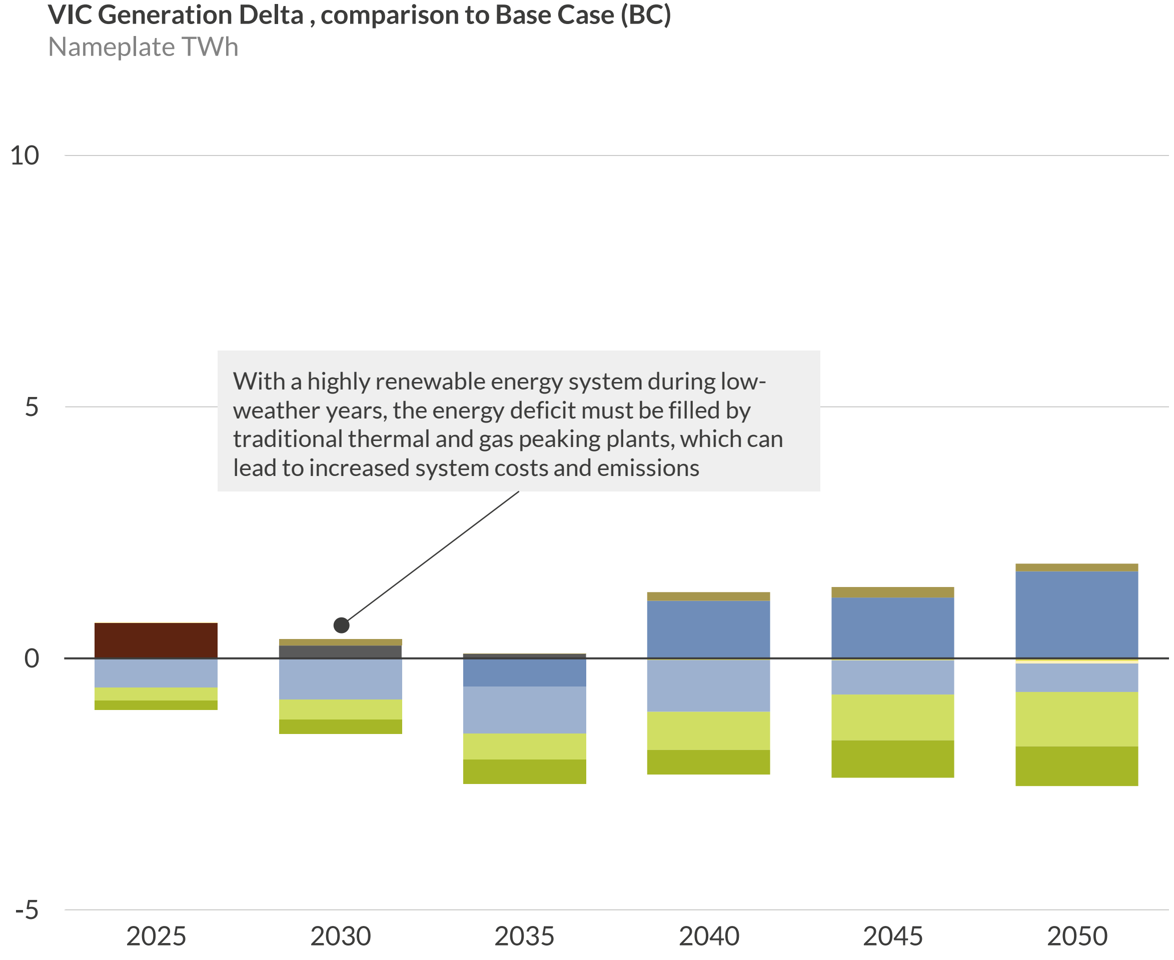
		Base Case – Targets achieved	Low Weather Year – Variations to Base Case
Policy	Offshore wind buildout targets	Assumed to meet targets on time: Victoria offshore wind generation capacity of 2GW by 2032, 4GW by 2035, 9GW by 2040	
	Renewable electricity penetration targets met	Forced to meet renewable energy, storage and offshore wind targets set by the Victorian government.	Not assumed – progress toward targets is determined by the model.
	Gvt. subsidies / support mechanisms	Government support could include increased investment in REZ buildout, VRET2, offshore wind support packages (i.e. CfD), and additional Capacity Investment Scheme (CIS) Tenders.	
	Carbon pricing	Green Certificates only.	
Supply	Coal plant closures	'Early exits' as per AEMO 2024 ISP Step Change Optimal Development Pathway (ODP). Closure of Yallourn in FY29, Loy Yang B in FY32 and Loy Yang A in FY34.	
	Variable Renewable Energy (VRE) buildout	As per AEMO 2024 ISP Step Change ODP.	Offshore wind buildout according to current VIC target timings; economic solution for generation technology capacity build (excluding offshore wind).
	Transmission buildout	As per AEMO 2024 ISP Step Change ODP.	
	Commodity prices (coal and gas)	As per Aurora Central, with long term gas prices at $15/GJ and coal prices at $4/GJ.	
	Weather year[1]	FY2016 - median weather year.	5% reduction to reference weather year load factors / Variable Renewable Energy (VRE) generation levels.
Demand	Expected energy demand growth	High degree of residential and industrial electrification and uptake of electric vehicles assumed. In 2050, Step change scenario sees 290TWh of residential and business demand, 48TWh of hydrogen demand and 68TWh of EV demand.	
	Distributed Energy Resources (DER) / Consumer Energy Resources (CER)	As per AEMO 2024 ISP Step Change ODP.	
	Electric Vehicle (EV) uptake	97% of all vehicles expected to be battery EVs as per AEMO 2024 ISP Step Change Scenario.	

1) Aurora's weather year approach uses a single reference year, providing a consistent view of weather impacts on energy generation. In contrast, AEMO's rolling weather year approach uses multiple historical weather years to capture a broader range of variability – see Appendix for details on representative weather year analysis

Source: Aurora Energy Research

Low weather years present a downside for renewable generators with demand being met by thermal and gas peaking plants





Battery Storage | BTM Battery Storage | Peaking[2] | Hydro | Wind offshore | Wind onshore | Rooftop solar | Solar | CCGT | Lignite | Emissions [S5] | Emissions [BC]

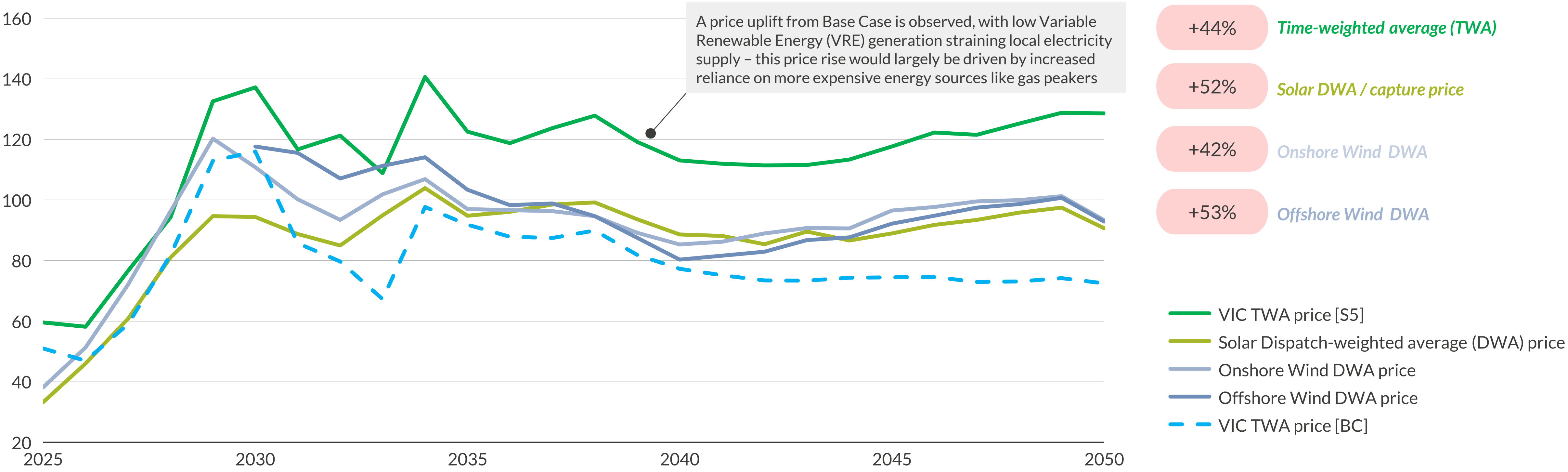
1) Excludes Victoria imports and exports; 2) Aurora's use of a single reference weather year may result in more modest gas peaking generation forecasts compared to AEMO's rolling weather year approach, as it avoids the potential overestimation of generation needs that can arise from modelling extreme weather variability across multiple years – see Appendix for details

Source: Aurora Energy Research

Power prices are expected to increase by ~44% from Base Case due to lower renewable generation and reliance on more expensive generators

AURORA

Victoria Wholesale Power Price[1]
A$/MWh



2025	2030	2035	2040	2045	2050
+0.4	+1.1	+1.9	+3.0	+4.0	+5.7

Delta from Base Case: Annual wholesale power costs, real $A2023 bn[2]

Average percentage price change from Base Case,
FY25 to FY50

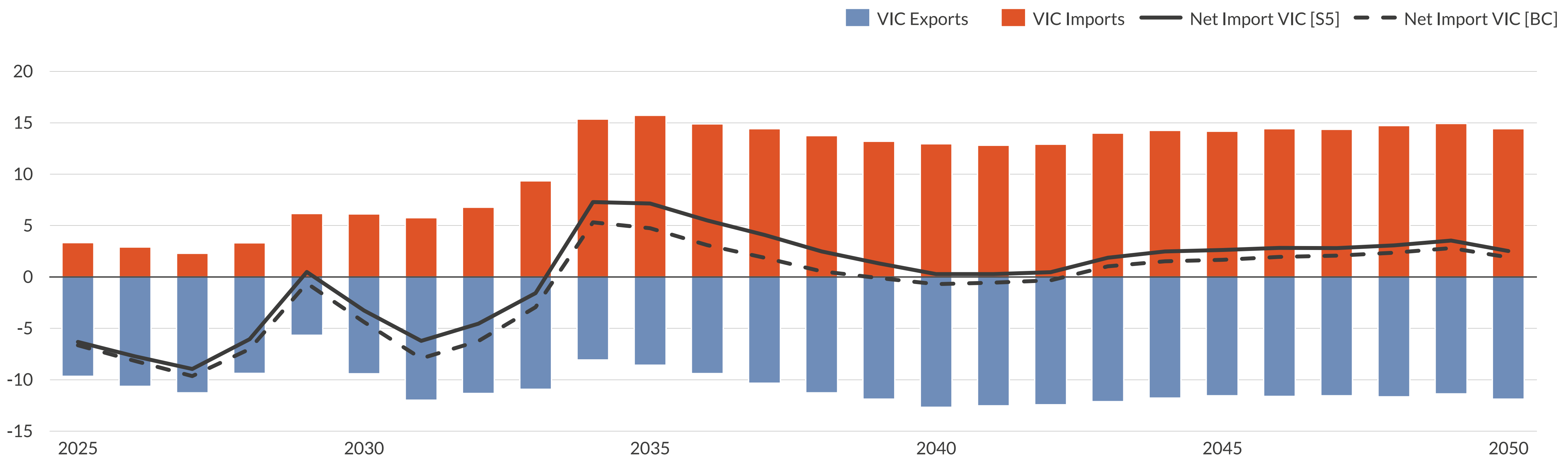
+44%	*Time-weighted average (TWA)*
+52%	*Solar DWA / capture price*
+42%	*Onshore Wind DWA*
+53%	*Offshore Wind DWA*

1) DWA prices curtailing at $-Large-scale Generation Certificate (LGC); 2) Wholesale power cost = TWA x Generation for each respective year

Source: Aurora Energy Research

Victoria's reliance on imports increases during periods of lower Variable Renewable Energy (VRE) generation to meet state demand, a trend consistent across the forecast

VIC Net Imports between VIC and TAS / SA / NSW
TWh



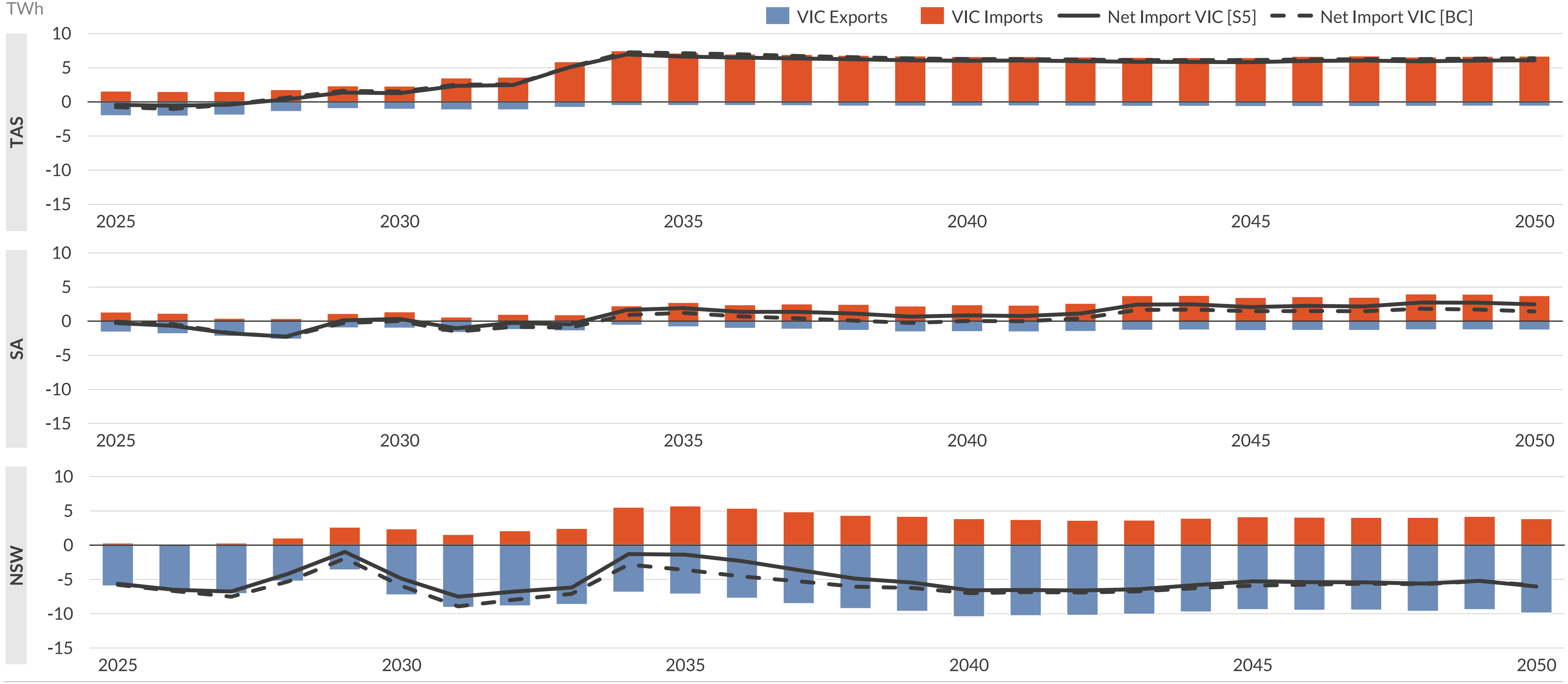
- During renewable energy droughts—extended periods when wind and solar output are significantly reduced—Victoria's reliance on imports grows due to lower Variable Renewable Energy (VRE) generation. These droughts make it more challenging for the state to meet demand, increasing dependence on electricity imports from neighbouring states to maintain grid stability and ensure a reliable power supply for consumers.
- Interconnectors play a crucial role in transferring energy from regions with surplus generation to Victoria during these periods. This scenario demonstrates a consistent rise in net imports compared to Base Case levels, as the state's reliance on external energy sources grows more pronounced during low VRE generation periods. The prolonged nature of renewable energy droughts adds to this dependence, highlighting the challenges of balancing the grid in a system with high VRE penetration.

Source: Aurora Energy Research

Reduced renewable energy generation in Victoria has the potential to strain domestic electricity supplies, consequently limiting exports to New South Wales

AURORA

Comparison to Base Case – Interconnector flows between VIC and TAS / SA / NSW



Source: Aurora Energy Research

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8. Victoria's Accelerated Offshore Wind Buildout scenario (hypothetical)

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Postponement of REZ expansion and Marinus Link could create a bottleneck for VRE development in Victoria, limiting the state's renewable energy potential

AURORA

Delays in Victoria's transmission build could lead to higher energy costs, reduced investment in renewables, increased market volatility, and potential reliability issues, ultimately impeding the state's progress toward sustainable energy goals

		Base Case – Targets achieved	Delayed Victoria Transmission Buildout – Variations to Base Case
Policy	Offshore wind buildout targets	Assumed to meet targets on time: Victoria offshore wind generation capacity of 2GW by 2032, 4GW by 2035, 9GW by 2040	
	Renewable electricity penetration targets met	Forced to meet renewable energy, storage and offshore wind targets set by the Victorian government.	Not assumed – progress toward targets is determined by the model.
	Gvt. subsidies / support mechanisms	Government support could include increased investment in REZ buildout, VRET2, offshore wind support packages (i.e. CfD), and additional Capacity Investment Scheme (CIS) Tenders.	Lower levels of government intervention assumed in comparison to Base Case with respect to network augmentation and interconnector upgrades.
	Carbon pricing	Green Certificates only.	
Supply	Coal plant closures	'Early exits' as per AEMO 2024 ISP Step Change Optimal Development Pathway (ODP). Closure of Yallourn in FY29, Loy Yang B in FY32 and Loy Yang A in FY34.	
	Variable Renewable Energy (VRE) buildout	As per AEMO 2024 ISP Step Change ODP.	Offshore wind buildout according to current VIC target timings; economic solution for generation technology capacity build (excluding offshore wind).
	Transmission buildout	As per AEMO 2024 ISP Step Change ODP.	2-year delay to VIC Renewable Energy Zone (REZ) expansions and a 3-year delay of Marinus Link, from AEMO 2024 ISP Step Change timings.
	Commodity prices (coal and gas)	As per Aurora Central, with long term gas prices at $15/GJ and coal prices at $4/GJ.	
	Weather year[1]	FY2016 - median weather year.	
Demand	Expected energy demand growth	High degree of residential and industrial electrification and uptake of electric vehicles assumed. In 2050, Step change scenario sees 290TWh of residential and business demand, 48TWh of hydrogen demand and 68TWh of EV demand.	
	Distributed Energy Resources (DER) / Consumer Energy Resources (CER)	As per AEMO 2024 ISP Step Change ODP.	
	Electric Vehicle (EV) uptake	97% of all vehicles expected to be battery EVs as per AEMO 2024 ISP Step Change Scenario.	

1) Aurora's weather year approach uses a single reference year, providing a consistent view of weather impacts on energy generation. In contrast, AEMO's rolling weather year approach uses multiple historical weather years to capture a broader range of variability – see Appendix for details on representative weather year analysis

Source: Aurora Energy Research

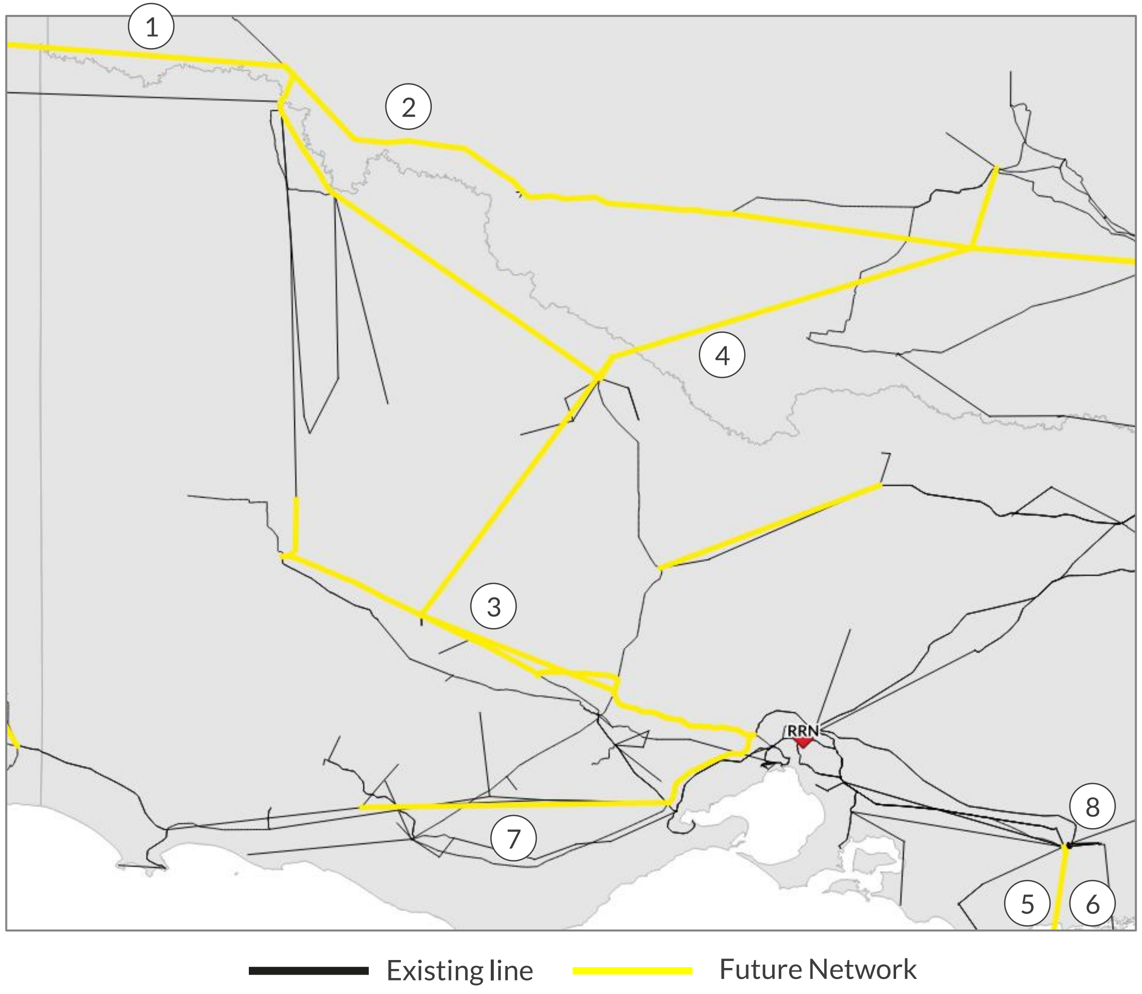
This scenario incorporates a 2-year delay to Renewable Energy Zone (REZ) expansion timelines under AEMO 2024 ISP Step Change and a 3-year delay of Marinus Link

AURORA

Victoria Network Augmentation – Scenario Inputs
AEMO 2024 ISP vs Scenario 6 Delayed Timelines

	Targeted Region	Project Name	Assumed commissioning date	
			AEMO 2024 ISP	S6 – Delayed buildout
1	SA, VIC	Project EnergyConnect SA – VIC Stage 1	2025	2025
2	VIC, NSW	Project EnergyConnect VIC – NSW Stage 2	2028	2030
3	VIC	Western Renewables Link (WRL)	2028	2030
4	NSW, VIC	VNI West (Victoria to New South Wales Interconnector West)	2030	2032
5	TAS, VIC	Project Marinus (Stage 1)	2031	2034
6	TAS, VIC	Project Marinus (Stage 2)	2033	2036
7	VIC	Western Victoria Grid Reinforcement	2034	2036
8	VIC	Eastern Victoria Grid Reinforcement	2036	2038

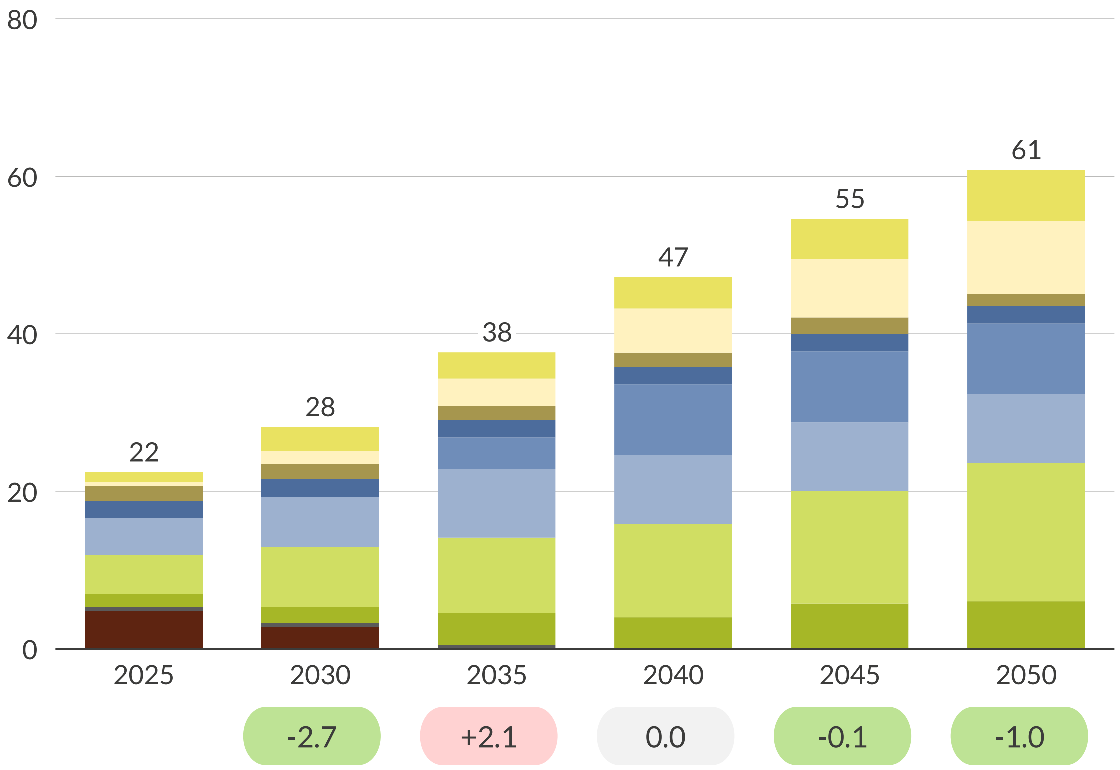
VIC AEMO 2024 ISP network augmentations



Source: Aurora Energy Research

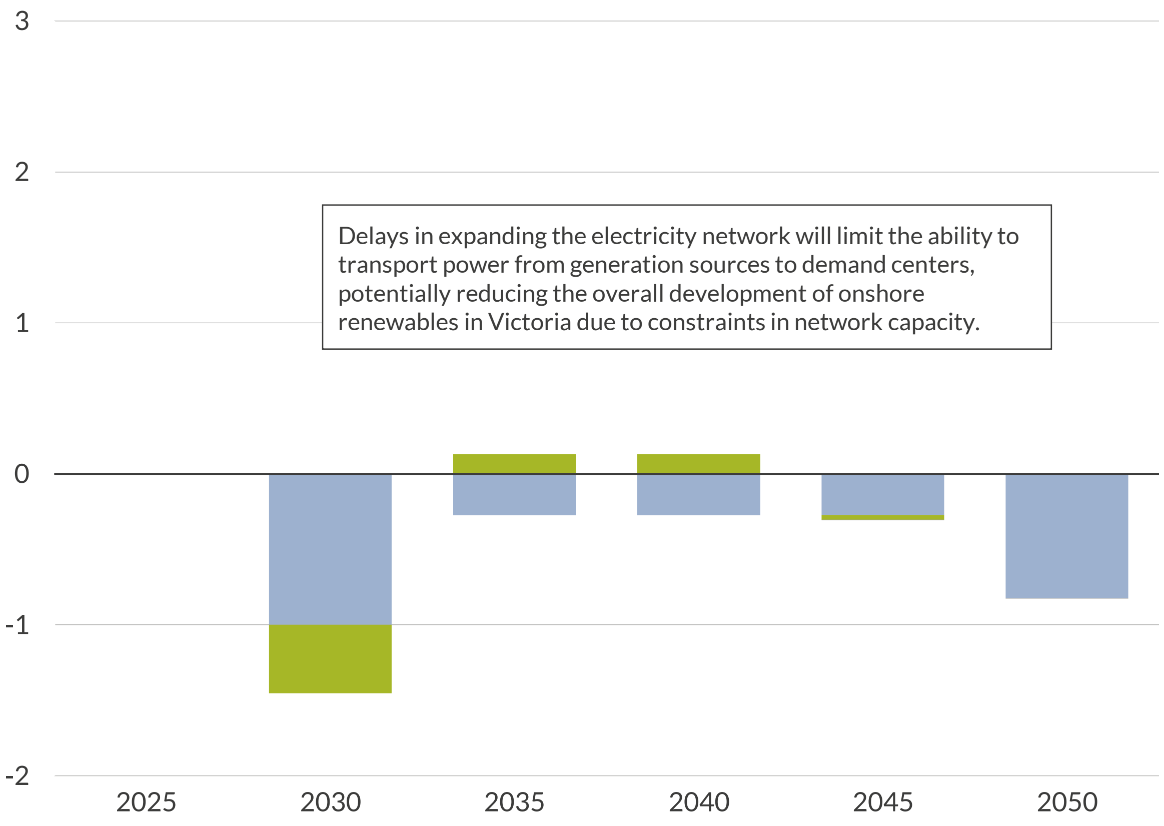
Transmission augmentation delays could limit network hosting capacity and consequently reduce renewable capacity buildout

VIC Capacity[1]
Nameplate GW



Delta from Base Case: Total 5-year CapEx for new-build utility-scale solar, wind and battery , real $A2023 bn[2]

VIC Capacity Delta , comparison to Base Case
Nameplate GW



Battery Storage | BTM Battery Storage | Peaking | Hydro | Wind offshore | Wind onshore | Rooftop solar | Solar | CCGT | Lignite

1) Differences in capacity build-out from AEMO ISP levels primarily stem from modelling approaches—AEMO's model seeks to minimise total system cost, while Aurora's focuses on NPV-driven plant economics; 2) Each CapEx figure is inclusive of the preceding 5-year period i.e. FY26-30 CapEx provided in FY30, calculated using 2023 AEMO IASR CapEx assumptions – see Appendix for details

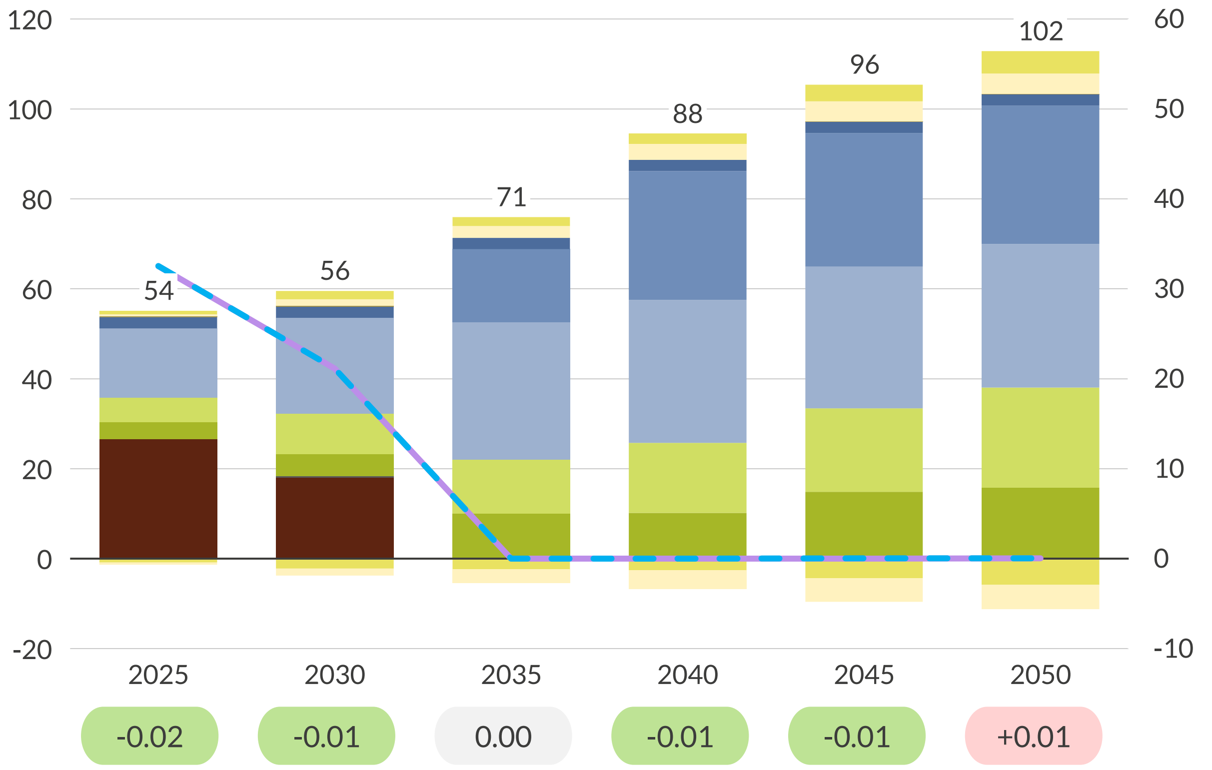
Source: Aurora Energy Research

Network constraints have adverse impacts on generation as a greater proportion of electricity is curtailed

AURORA

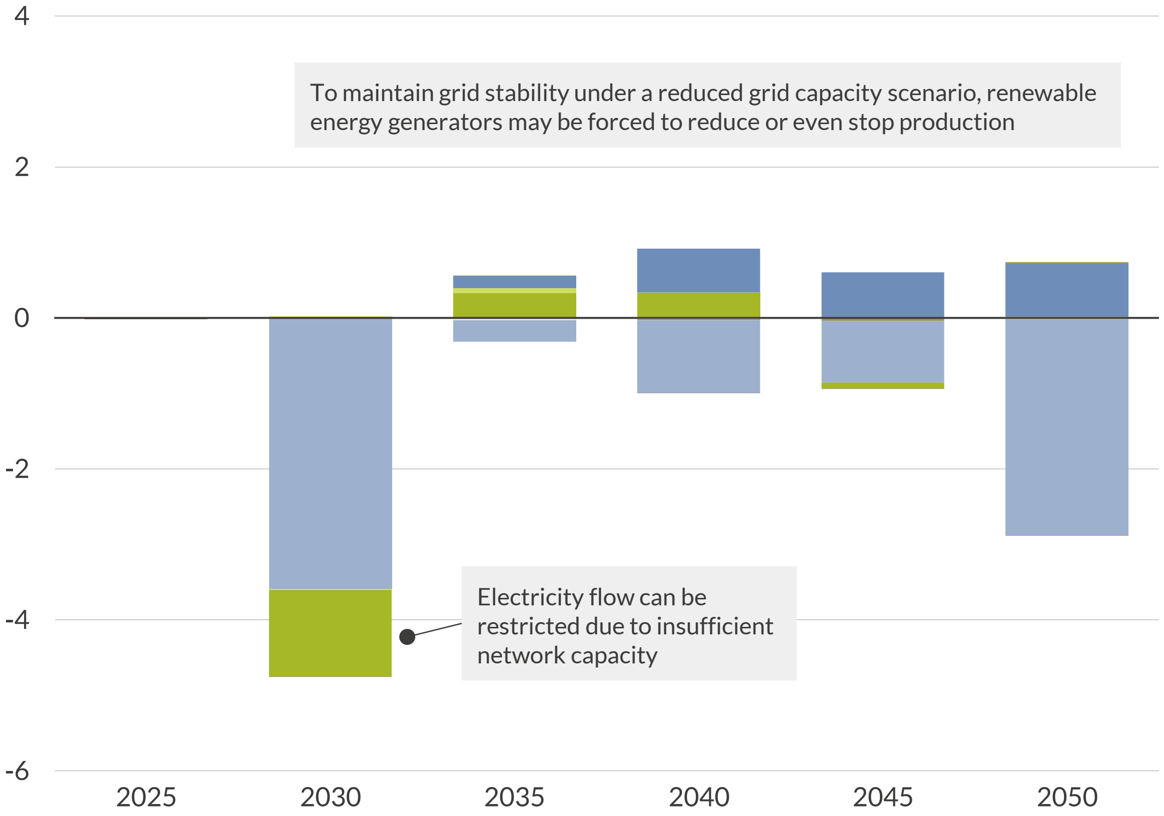
VIC Generation[1]
Nameplate TWh

Total VIC Power Sector Emissions
Million tonnes CO_2e



Delta from Base Case: VIC Power Emissions
Million tonnes CO_2e

VIC Generation Delta , comparison to Base Case (BC)
Nameplate TWh



Battery Storage | BTM Battery Storage | Peaking[2] | Hydro | Wind offshore | Wind onshore | Rooftop solar | Solar | CCGT | Lignite | Emissions [S6] | Emissions [BC]

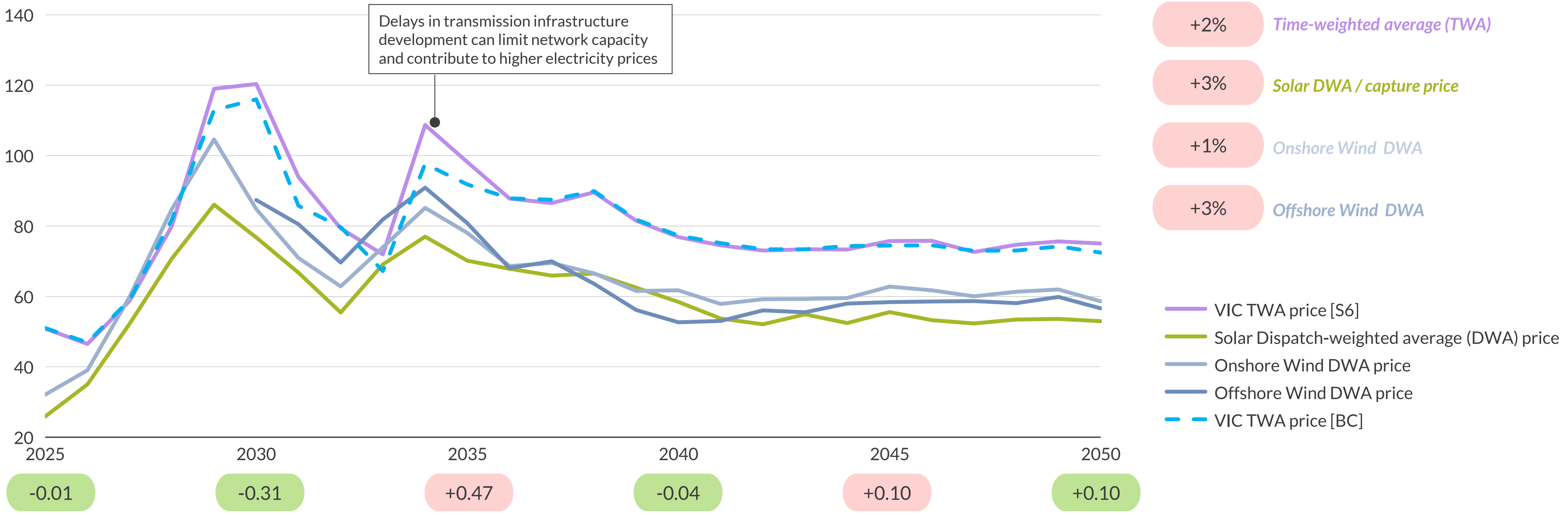
1) Excludes Victoria imports and exports; 2) Aurora's use of a single reference weather year may result in more modest gas peaking generation forecasts compared to AEMO's rolling weather year approach, as it avoids the potential overestimation of generation needs that can arise from modelling extreme weather variability across multiple years – see Appendix for details

Source: Aurora Energy Research

Insufficient transmission infrastructure can result in network congestion, leading to increased electricity transmission costs and subsequently higher power prices

AURORA

Victoria Wholesale Power Price[1]
A$/MWh



Delta from Base Case: Annual wholesale power costs, real $A2023 bn[2]

Average percentage price change from Base Case,
FY25 to FY50

+2%	*Time-weighted average (TWA)*
+3%	*Solar DWA / capture price*
+1%	*Onshore Wind DWA*
+3%	*Offshore Wind DWA*

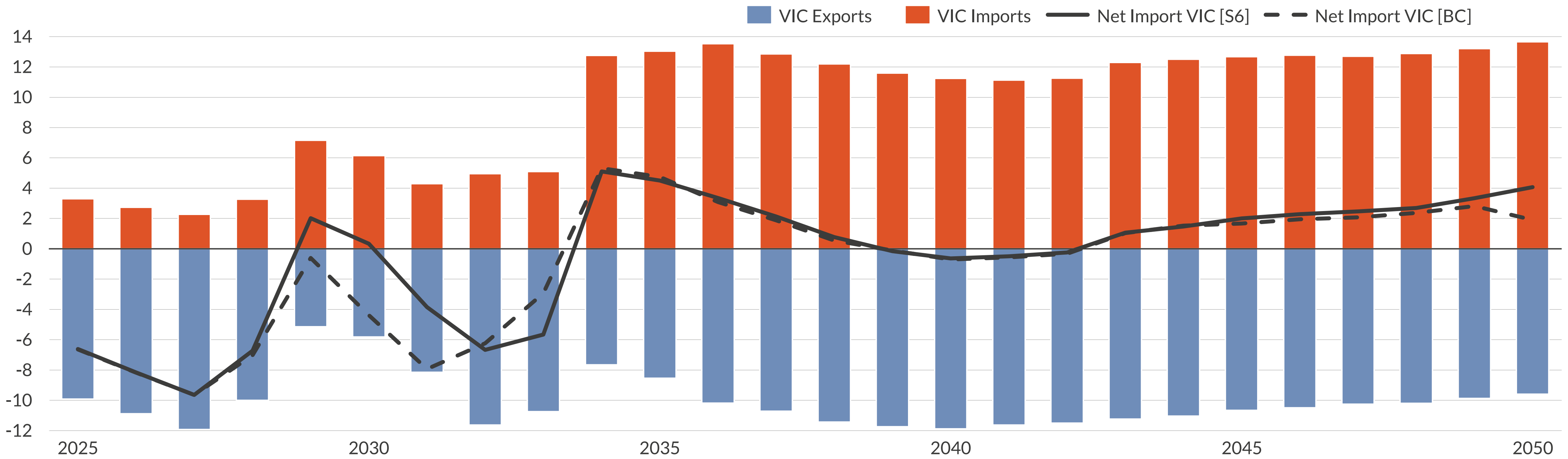
1) DWA prices curtailing at $-Large-scale Generation Certificate (LGC); 2) Wholesale power cost = TWA x Generation for each respective year

Source: Aurora Energy Research

Delays in transmission augmentation and interconnector commissioning dates see reduced capacity transfers between connected NEM regions

AURORA

VIC Net Imports between VIC and TAS / SA / NSW
TWh



- Victoria's ability to import electricity from lower-cost regions is constrained when transmission infrastructure is inadequate, and the same applies to its capacity to export. This limitation not only drives up wholesale prices but also alters import/export dynamics, reducing overall capacity transfer in the years leading up to coal's exit from the system in the mid-2030s.
- Delays in transmission augmentation and interconnector commissioning during the 2030s could compound these issues, leading to reduced capacity transfers between connected NEM regions.
- Although transmission upgrades eventually restore network transfer capacity to Base Case levels, net imports remain higher in the long term under a delayed transmission scenario compared to the Base Case. This is likely due to the delayed network expansions constraining the build-out of generation capacity during that critical period.

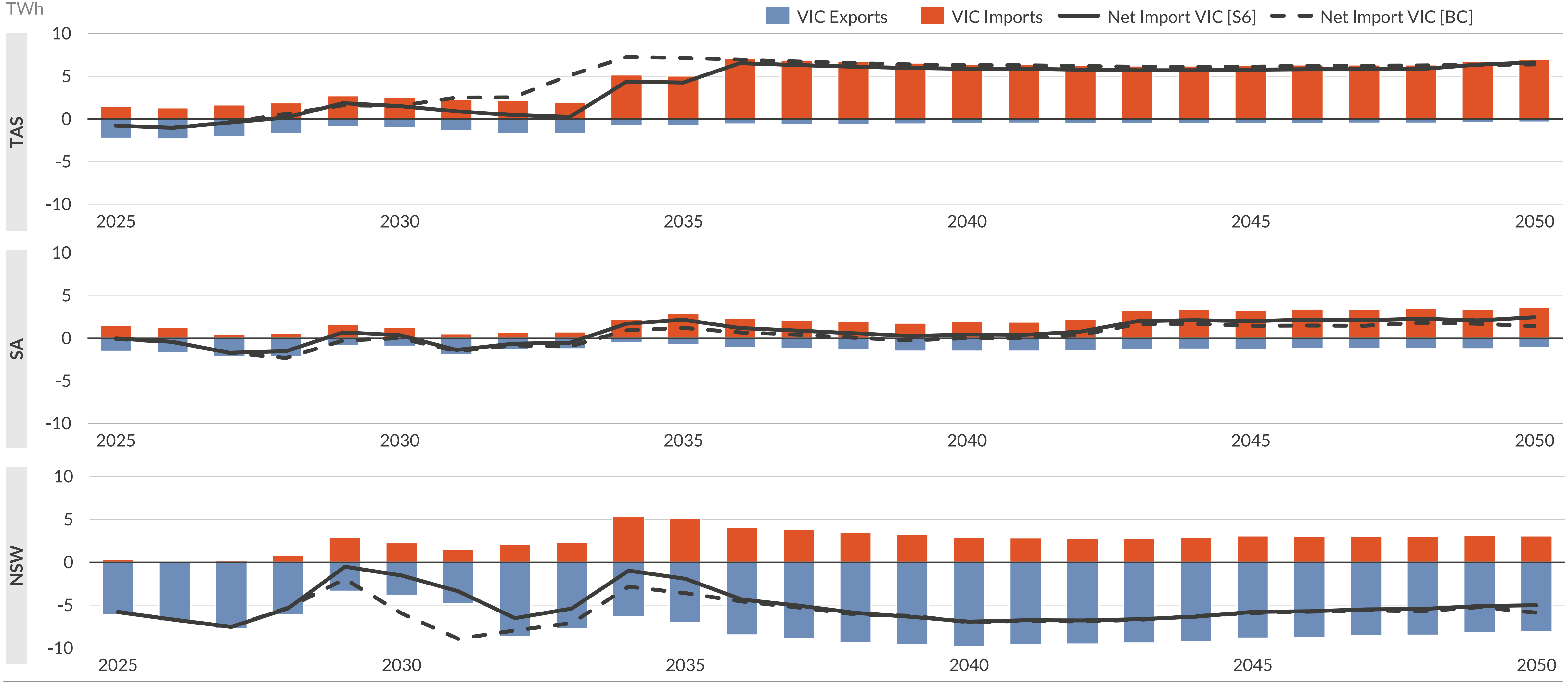
Source: Aurora Energy Research

Victoria's net importer profile could be significantly impacted by the delay of Marinus Link as TAS imports are restricted during the 2030s

AURORA

Comparison to Base Case – Interconnector flows between VIC and TAS / SA / NSW

TWh



Source: Aurora Energy Research

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III. Appendix

In the possible event of licensing delays or change in policy, Victoria risks not meeting state offshore wind targets

AURORA

Having no offshore wind development could result in prolonged reliance on fossil fuels, hindering the state's efforts to reduce carbon emissions and meet climate commitments. Additionally, this may lead to higher energy costs for consumers.

		Base Case – Targets achieved	Removal of Offshore Wind in Victoria – Variations to Base Case
Policy	**Offshore wind buildout targets**	Assumed to meet targets on time: Victoria offshore wind generation capacity of 2GW by 2032, 4GW by 2035, 9GW by 2040	No offshore wind buildout in Victoria.
	Renewable electricity penetration targets met	Forced to meet renewable energy, storage and offshore wind targets set by the Victorian government.	Not assumed – progress toward targets is determined by the model.
	Gvt. subsidies / support mechanisms	Government support could include increased investment in REZ buildout, VRET2, offshore wind support packages (i.e. CfD), and additional Capacity Investment Scheme (CIS) Tenders.	Lower levels of government intervention assumed in comparison to Base Case with respect to offshore wind deployment.
	Carbon pricing	Green Certificates only.	
Supply	**Coal plant closures**	'Early exits' as per AEMO 2024 ISP Step Change Optimal Development Pathway (ODP). Closure of Yallourn in FY29, Loy Yang B in FY32 and Loy Yang A in FY34.	
	Variable Renewable Energy (VRE) buildout	As per AEMO 2024 ISP Step Change ODP.	No offshore wind buildout in Victoria; economic solution for generation technology capacity build (excluding offshore wind).
	Transmission buildout	As per AEMO 2024 ISP Step Change ODP.	
	Commodity prices (coal and gas)	As per Aurora Central, with long term gas prices at $15/GJ and coal prices at $4/GJ.	
	Weather year[1]	FY2016 - median weather year.	
Demand	**Expected energy demand growth**	High degree of residential and industrial electrification and uptake of electric vehicles assumed. In 2050, Step change scenario sees 290TWh of residential and business demand, 48TWh of hydrogen demand and 68TWh of EV demand.	
	Distributed Energy Resources (DER) / Consumer Energy Resources (CER)	As per AEMO 2024 ISP Step Change ODP.	
	Electric Vehicle (EV) uptake	97% of all vehicles expected to be battery EVs as per AEMO 2024 ISP Step Change Scenario.	

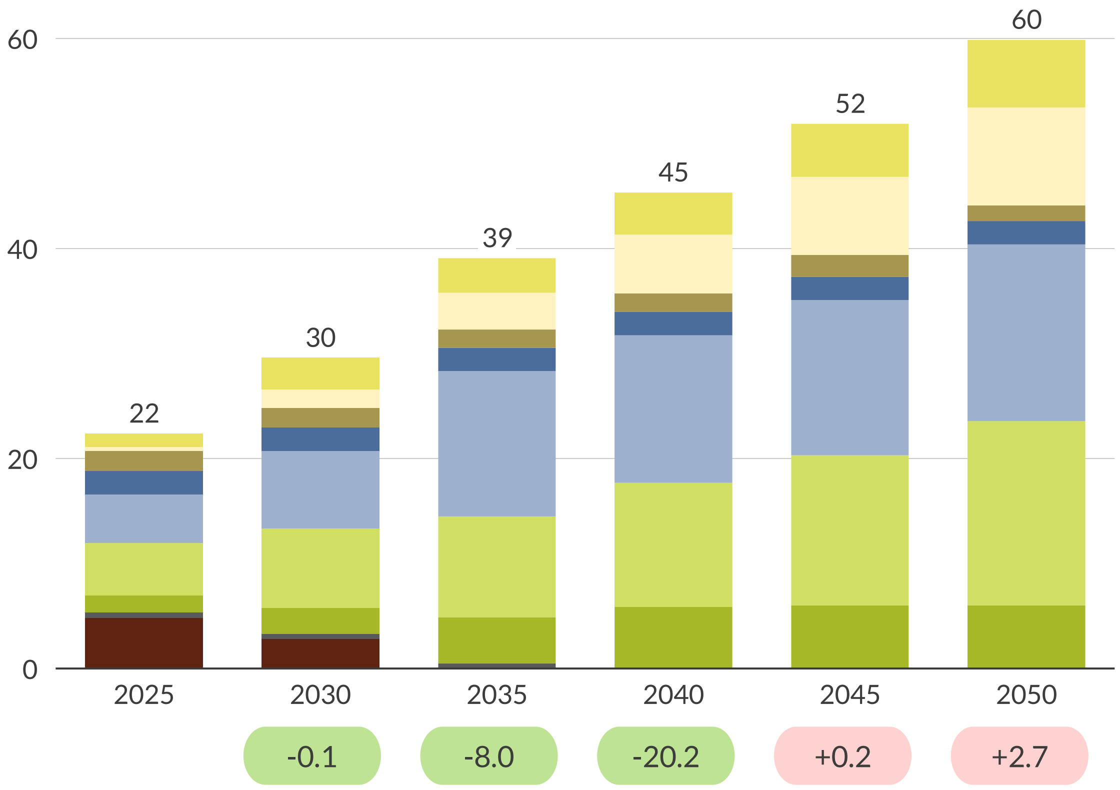
1) Aurora's weather year approach uses a single reference year, providing a consistent view of weather impacts on energy generation. In contrast, AEMO's rolling weather year approach uses multiple historical weather years to capture a broader range of variability – see Appendix for details on representative weather year analysis

Source: Aurora Energy Research

The absence of offshore wind capacity sees increased buildout of lower cost onshore wind and solar technology, though long-term capacity does not reach Base Case levels

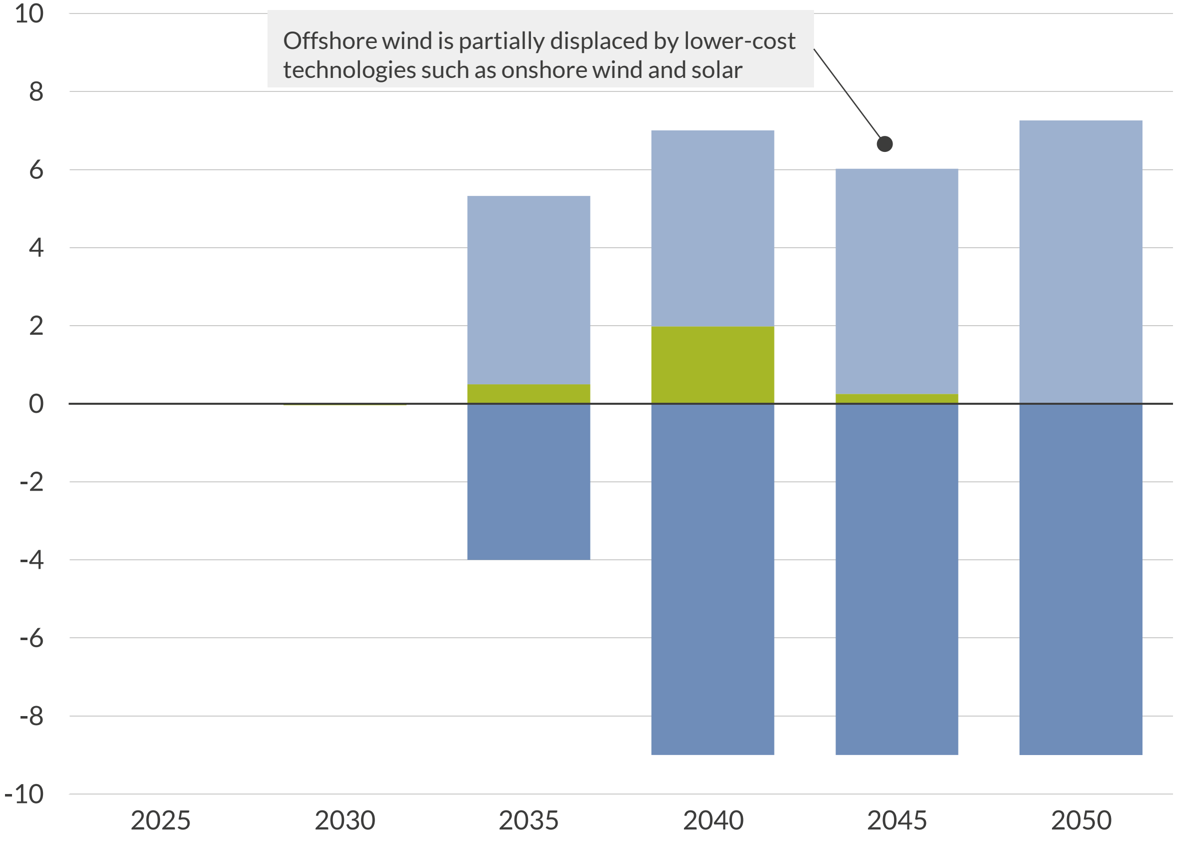
AURORA

VIC Capacity[1]
Nameplate GW



Delta from Base Case: Total 5-year CapEx for new-build utility-scale solar, wind and battery , real $A2023 bn[2]

VIC Capacity Delta , comparison to Base Case
Nameplate GW



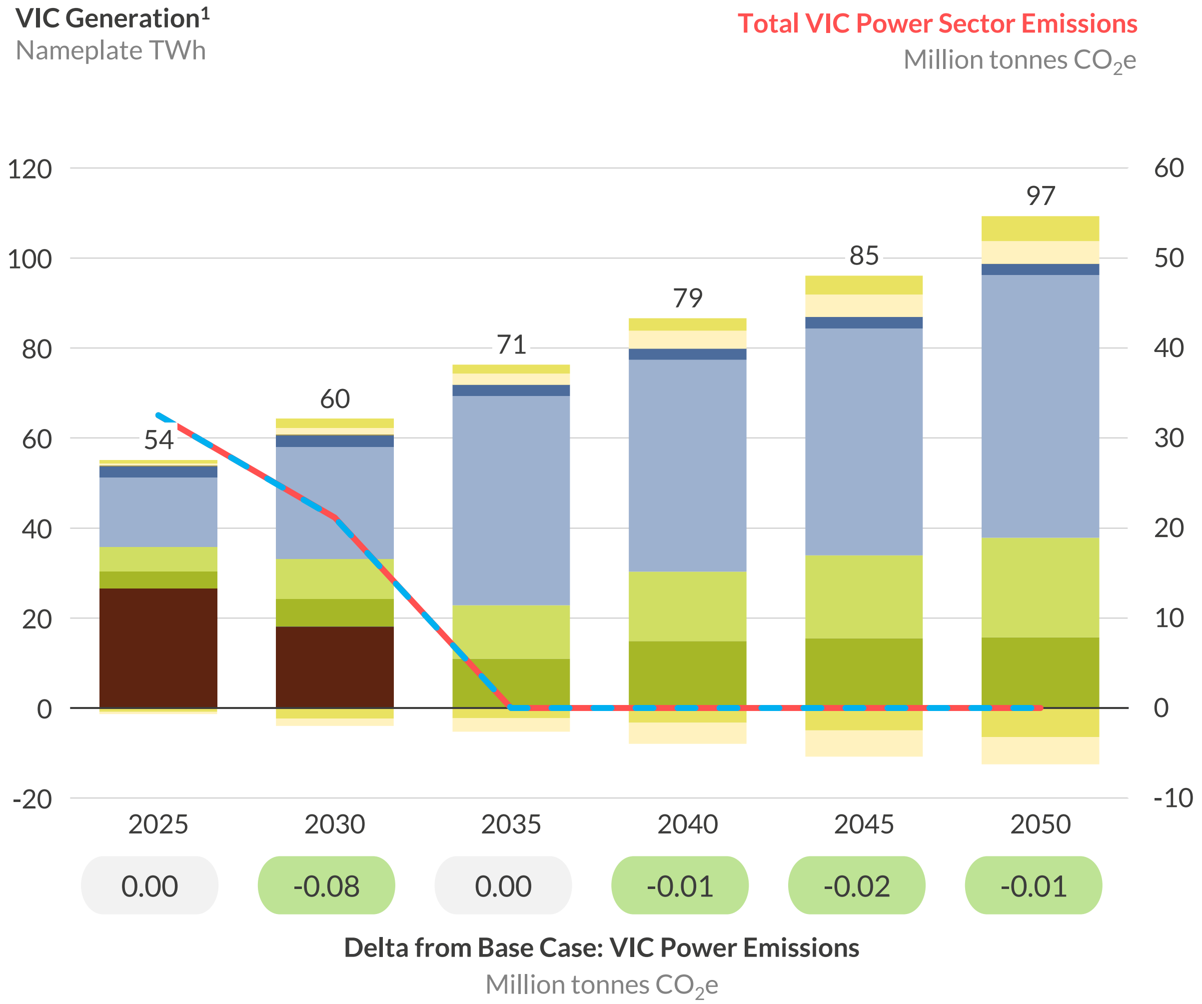
Battery Storage | BTM Battery Storage | Peaking | Hydro | Wind offshore | Wind onshore | Rooftop solar | Solar | CCGT | Lignite

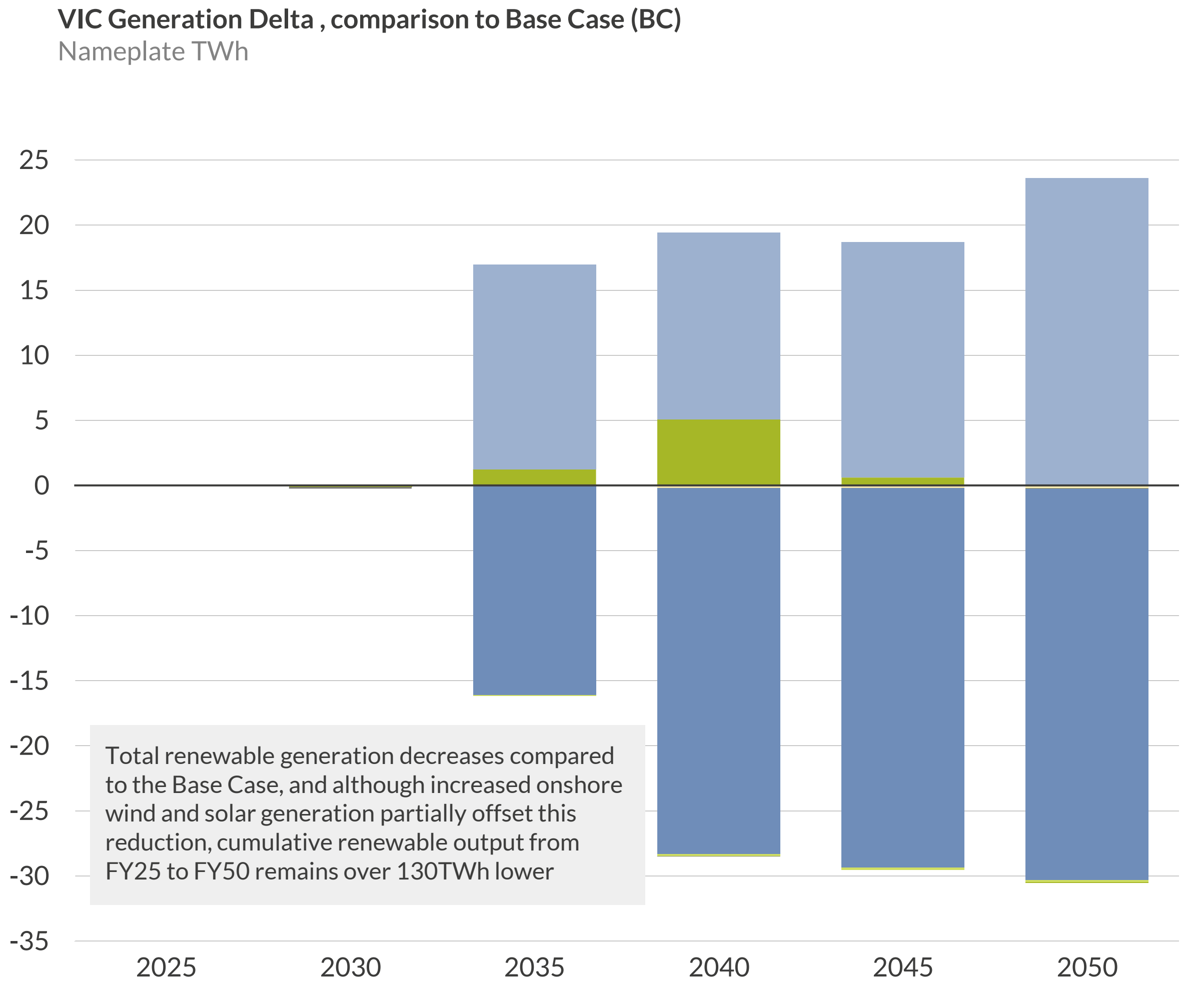
1) Differences in capacity build-out from AEMO ISP levels primarily stem from modelling approaches—AEMO's model seeks to minimise total system cost, while Aurora's focuses on NPV-driven plant economics; 2) Each CapEx figure is inclusive of the preceding 5-year period i.e. FY26-30 CapEx provided in FY30, calculated using 2023 AEMO IASR CapEx assumptions – see Appendix for details

Source: Aurora Energy Research

Without offshore wind, Victoria will become a major net importer following coal plant closures as the state becomes reliant on local onshore wind and solar electricity

AURORA





Battery Storage | BTM Battery Storage | Peaking[2] | Hydro | Wind offshore | Wind onshore | Rooftop solar | Solar | CCGT | Lignite | Emissions [S7] | Emissions [BC]

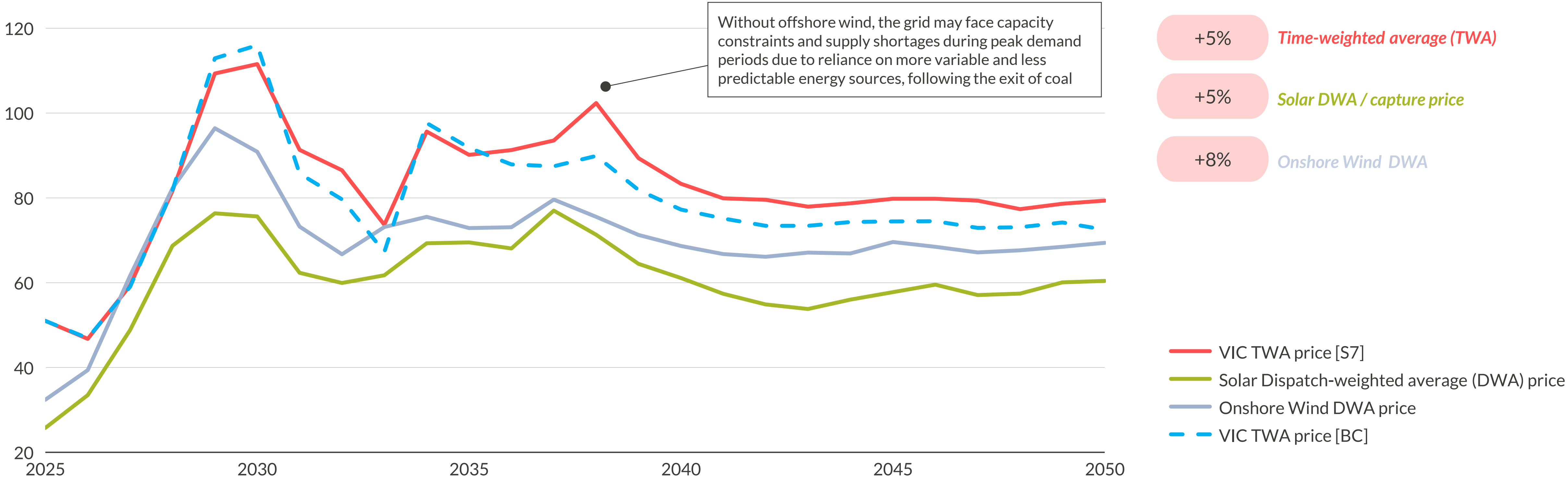
1) Excludes Victoria imports and exports; 2) Aurora's use of a single reference weather year may result in more modest gas peaking generation forecasts compared to AEMO's rolling weather year approach, as it avoids the potential overestimation of generation needs that can arise from modelling extreme weather variability across multiple years – see Appendix for details

Source: Aurora Energy Research

The consistent generation profile of offshore wind plays a crucial role in maintaining grid stability, and without it, the grid faces increased price volatility and higher costs

AURORA

Victoria Wholesale Power Price[1]
A$/MWh



2025	2030	2035	2040	2045	2050
0.0	-0.3	0.0	-0.2	-0.4	+0.2

Delta from Base Case: Annual wholesale power costs, real $A2023 bn[2]

Average percentage price change from Base Case,
FY25 to FY50

+5%	*Time-weighted average (TWA)*
+5%	*Solar DWA / capture price*
+8%	*Onshore Wind DWA*

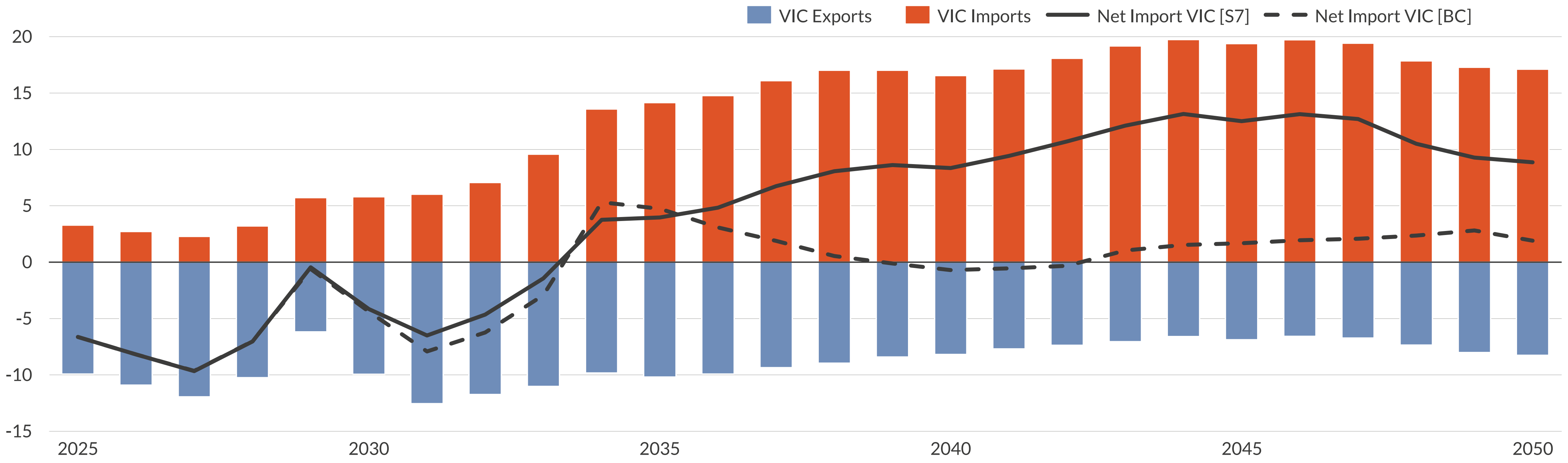
1) DWA prices curtailing at $-Large-scale Generation Certificate (LGC); 2) Wholesale power cost = TWA x Generation for each respective year

Source: Aurora Energy Research

A shortage of local electricity generation due to the absence of offshore wind power in the late 2030s is expected to lead to a significant increase in net imports into Victoria

AURORA

VIC Net Imports between VIC and TAS / SA / NSW
TWh



- Without the additional generation capacity from offshore wind, Victoria will likely become more dependent on electricity imports from neighbouring states, especially during peak demand periods and when onshore renewable generation is low.
- This lack of surplus generation will also result in reduced net exports to NSW, as Victoria's local power generation will be needed to meet its own demand.
- The increased strain on interconnectors may limit Victoria's ability to support neighbouring states during times of high demand or low generation in those regions, further altering the dynamics of electricity flow between states.

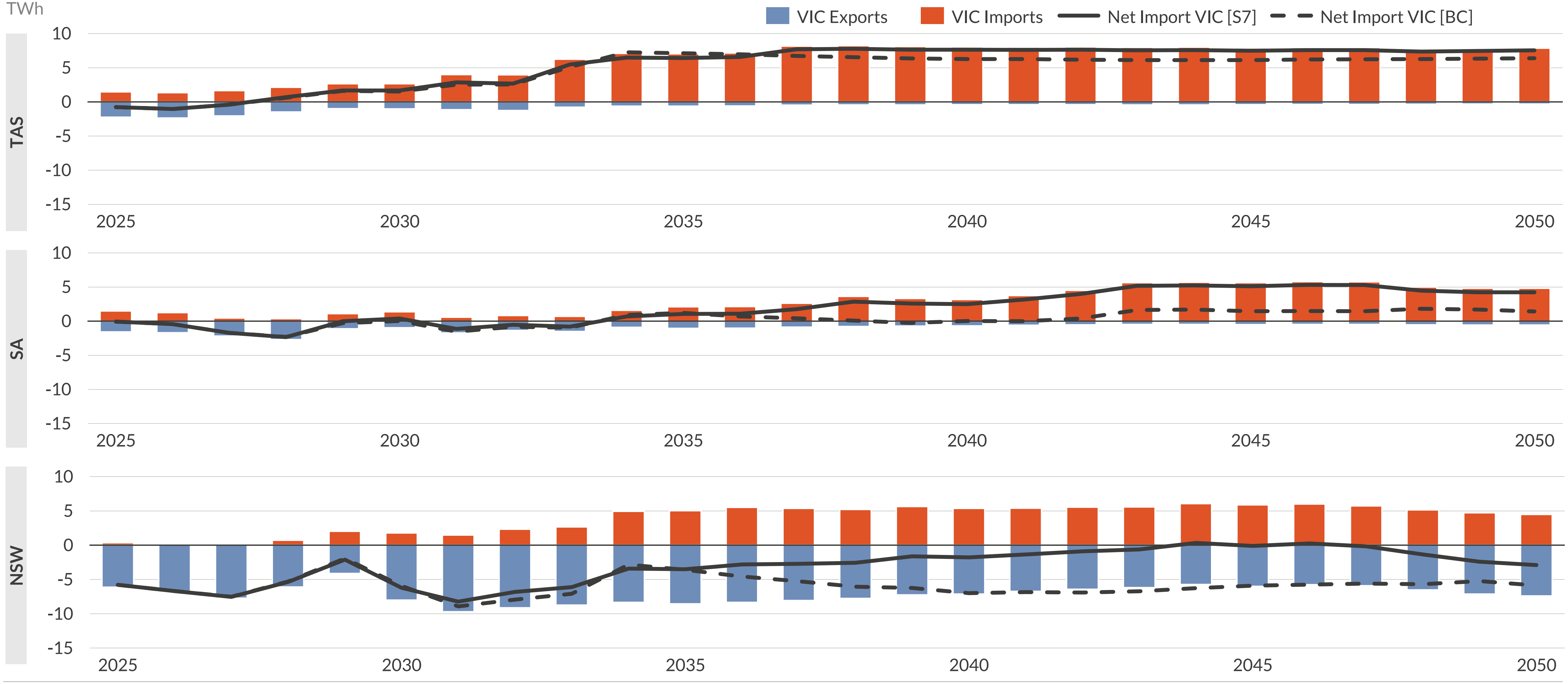
Source: Aurora Energy Research

Offshore wind is crucial for Victoria's energy self-sufficiency; its absence is expected to lead to reduced exports to NSW and increased imports from TAS and SA

AURORA

Comparison to Base Case – Interconnector flows between VIC and TAS / SA / NSW

TWh



Source: Aurora Energy Research

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III. Appendix

In a hypothetical scenario, offshore wind buildout could be brought forward five years earlier than current state targets under accelerated development

AURORA

We have explored this hypothetical scenario to demonstrate the potential impact of offshore wind on Victoria's energy transition. While accelerating offshore wind development could stabilise power prices and expedite progress toward climate goals, it would also require significant investments in grid infrastructure to support the increased capacity.

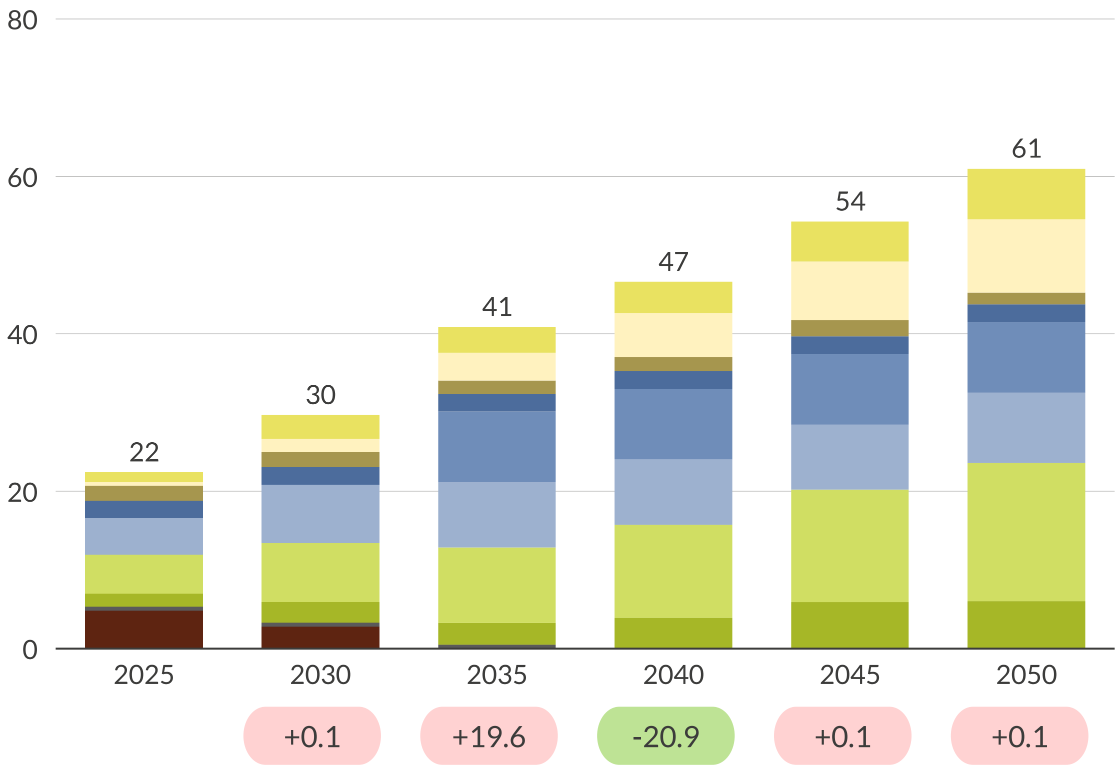
		Base Case – Targets achieved	Accelerated Offshore Wind in Victoria (hypothetical) – Variations to Base Case
Policy	Offshore wind buildout targets	Assumed to meet targets on time: Victoria offshore wind generation capacity of 2GW by 2032, 4GW by 2035, 9GW by 2040	Hypothetical scenario where 9GW of offshore wind development in Victoria is deployed by 2035 (5 years earlier than current announced dates).
	Renewable electricity penetration targets met	Forced to meet renewable energy, storage and offshore wind targets set by the Victorian government.	Not assumed – progress toward targets is determined by the model.
	Gvt. subsidies / support mechanisms	Government support could include increased investment in REZ buildout, VRET2, offshore wind support packages (i.e. CfD), and additional Capacity Investment Scheme (CIS) Tenders.	
	Carbon pricing	Green Certificates only.	
Supply	Coal plant closures	'Early exits' as per AEMO 2024 ISP Step Change Optimal Development Pathway (ODP). Closure of Yallourn in FY29, Loy Yang B in FY32 and Loy Yang A in FY34.	
	Variable Renewable Energy (VRE) buildout	As per AEMO 2024 ISP Step Change ODP.	Offshore wind buildout hypothetically occurs 5 years earlier than currently targeted; economic solution for generation technology capacity build (excluding offshore wind).
	Transmission buildout	As per AEMO 2024 ISP Step Change ODP.	
	Commodity prices (coal and gas)	As per Aurora Central, with long term gas prices at $15/GJ and coal prices at $4/GJ.	
	Weather year[1]	FY2016 - median weather year.	
Demand	Expected energy demand growth	High degree of residential and industrial electrification and uptake of electric vehicles assumed. In 2050, Step change scenario sees 290TWh of residential and business demand, 48TWh of hydrogen demand and 68TWh of EV demand.	
	Distributed Energy Resources (DER) / Consumer Energy Resources (CER)	As per AEMO 2024 ISP Step Change ODP.	
	Electric Vehicle (EV) uptake	97% of all vehicles expected to be battery EVs as per AEMO 2024 ISP Step Change Scenario.	

1) Aurora's weather year approach uses a single reference year, providing a consistent view of weather impacts on energy generation. In contrast, AEMO's rolling weather year approach uses multiple historical weather years to capture a broader range of variability – see Appendix for details on representative weather year analysis

Source: Aurora Energy Research

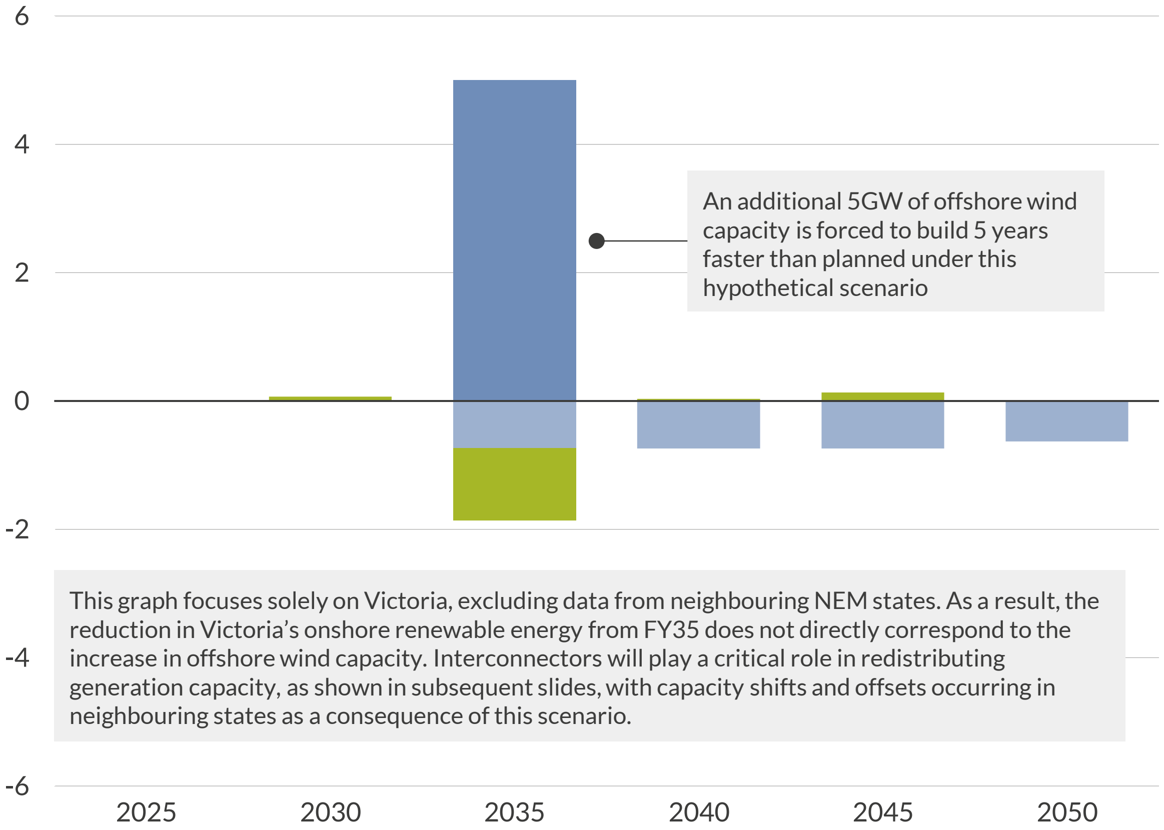
Accelerating offshore wind development could reduce the need for rapid onshore renewable energy expansion, easing land use pressures while still meeting state targets

VIC Capacity[1]
Nameplate GW



Delta from Base Case: Total 5-year CapEx for new-build utility-scale solar, wind and battery , real $A2023 bn[2]

VIC Capacity Delta , comparison to Base Case
Nameplate GW



This graph focuses solely on Victoria, excluding data from neighbouring NEM states. As a result, the reduction in Victoria's onshore renewable energy from FY35 does not directly correspond to the increase in offshore wind capacity. Interconnectors will play a critical role in redistributing generation capacity, as shown in subsequent slides, with capacity shifts and offsets occurring in neighbouring states as a consequence of this scenario.

Battery Storage | BTM Battery Storage | Peaking | Hydro | Wind offshore | Wind onshore | Rooftop solar | Solar | CCGT | Lignite

1) Differences in capacity build-out from AEMO ISP levels primarily stem from modelling approaches—AEMO's model seeks to minimise total system cost, while Aurora's focuses on NPV-driven plant economics; 2) Each CapEx figure is inclusive of the preceding 5-year period i.e. FY26-30 CapEx provided in FY30, calculated using 2023 AEMO IASR CapEx assumptions – see Appendix for details

Source: Aurora Energy Research

If Victoria rapidly expands offshore wind deployment, grid stability may be improved with access to more reliable wind resources, potentially reducing fluctuations in supply

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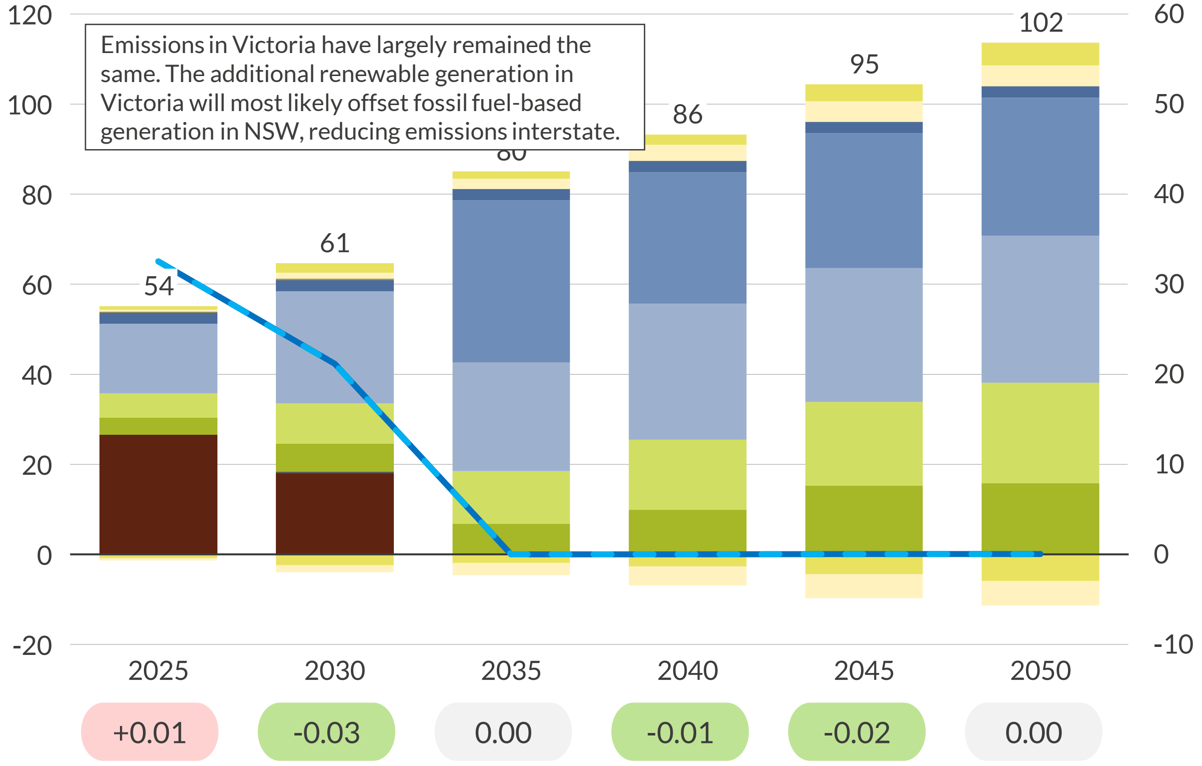
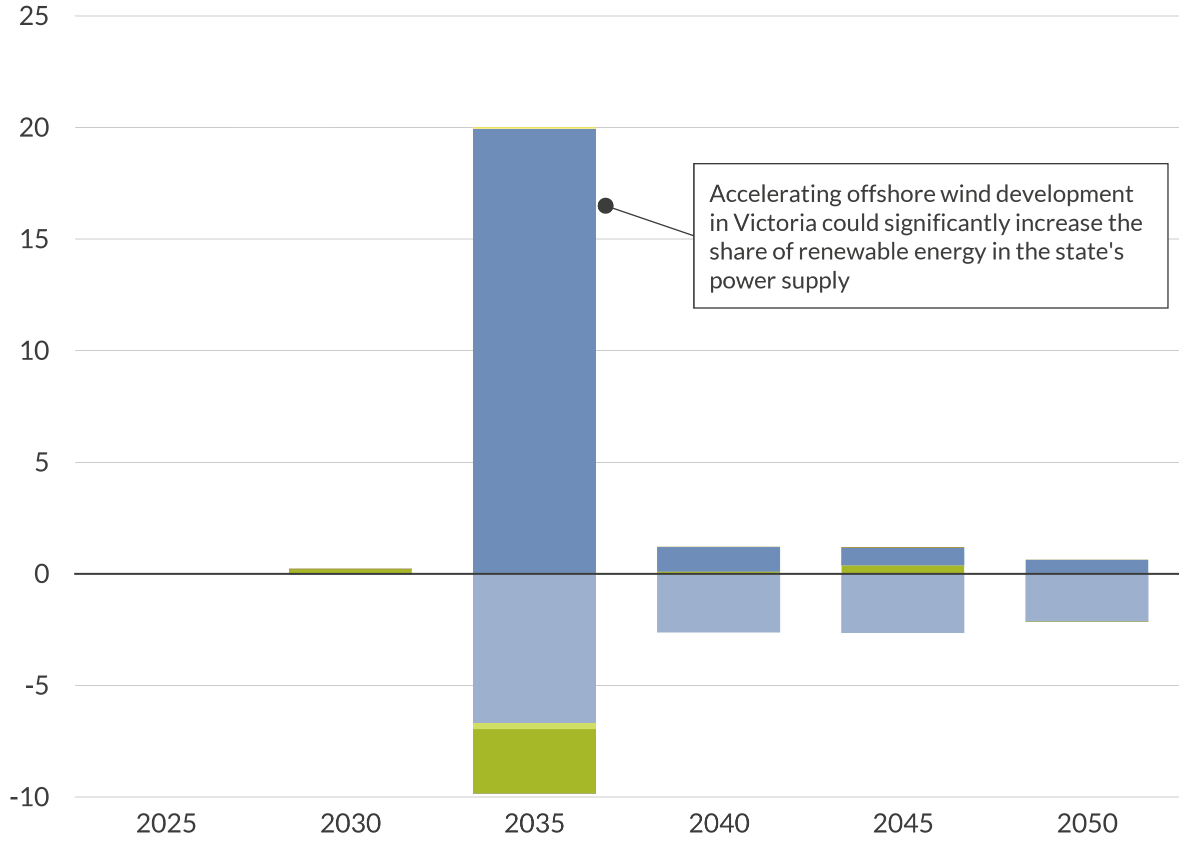
VIC Generation[1]
Nameplate TWh

Total VIC Power Sector Emissions
Million tonnes CO_2e



Delta from Base Case: VIC Power Emissions
Million tonnes CO_2e

VIC Generation Delta , comparison to Base Case (BC)
Nameplate TWh

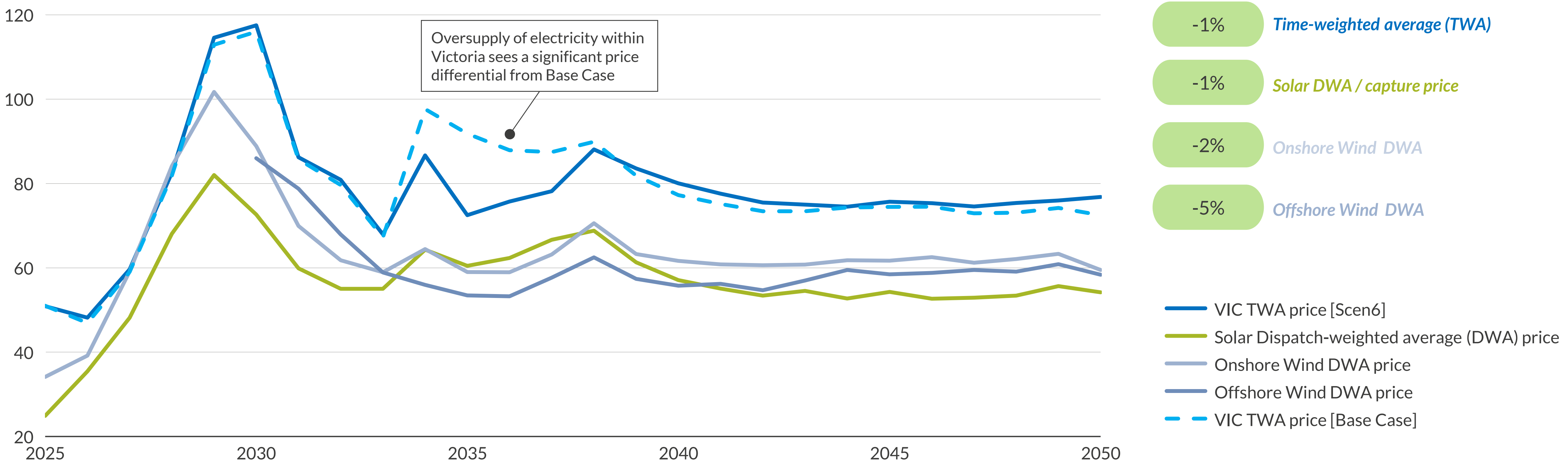


Battery Storage | Peaking[2] | Wind offshore | Rooftop solar | CCGT | Emissions [S8]
BTM Battery Storage | Hydro | Wind onshore | Solar | Lignite | Emissions [BC]

1) Excludes Victoria imports and exports; 2) Aurora's use of a single reference weather year may result in more modest gas peaking generation forecasts compared to AEMO's rolling weather year approach, as it avoids the potential overestimation of generation needs that can arise from modelling extreme weather variability across multiple years – see Appendix for details
Source: Aurora Energy Research

Forcing offshore wind to be deployed earlier in Victoria could place downward pressure on both wholesale and renewable generator capture prices in the 2030s

Victoria Wholesale Power Price[1]
A$/MWh



Average percentage price change from Base Case,
FY25 to FY50

-1%	*Time-weighted average (TWA)*
-1%	*Solar DWA / capture price*
-2%	*Onshore Wind DWA*
-5%	*Offshore Wind DWA*

2025	2030	2035	2040	2045	2050
0.0	+0.1	-0.6	+0.1	+0.01	+0.3

Delta from Base Case: Annual wholesale power costs, real $A2023 bn[2]

1) DWA prices curtailing at $-Large-scale Generation Certificate (LGC); 2) Wholesale power cost = TWA x Generation for each respective year

Source: Aurora Energy Research

If Victoria accelerates its offshore wind deployment, it could become a net exporter of electricity as early as the 2030s, powered by a surplus of clean energy

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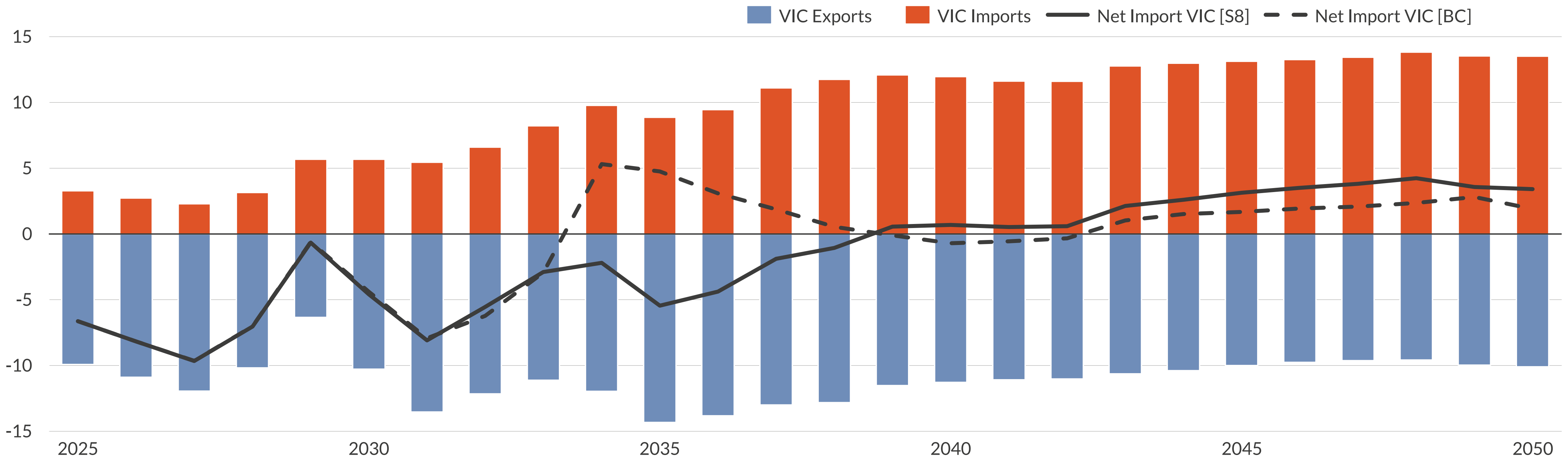
VIC Net Imports between VIC and TAS / SA / NSW
TWh



- Under this hypothetical scenario, by expediting the development and deployment of offshore wind, Victoria can significantly increase its renewable energy generation capacity. The early adoption of offshore wind will lead to a surplus of electricity, transforming Victoria from a net importer to a net exporter.
- However, rapid deployment of offshore wind will necessitate substantial investments in grid infrastructure to accommodate the increased renewable energy generation and ensure grid stability. Becoming a net exporter will require careful management of electricity markets to optimise revenue and avoid grid congestion issues.

Faster offshore wind buildout could significantly reduce Victoria's reliance on Tasmania's electricity imports, potentially creating a more robust energy supply

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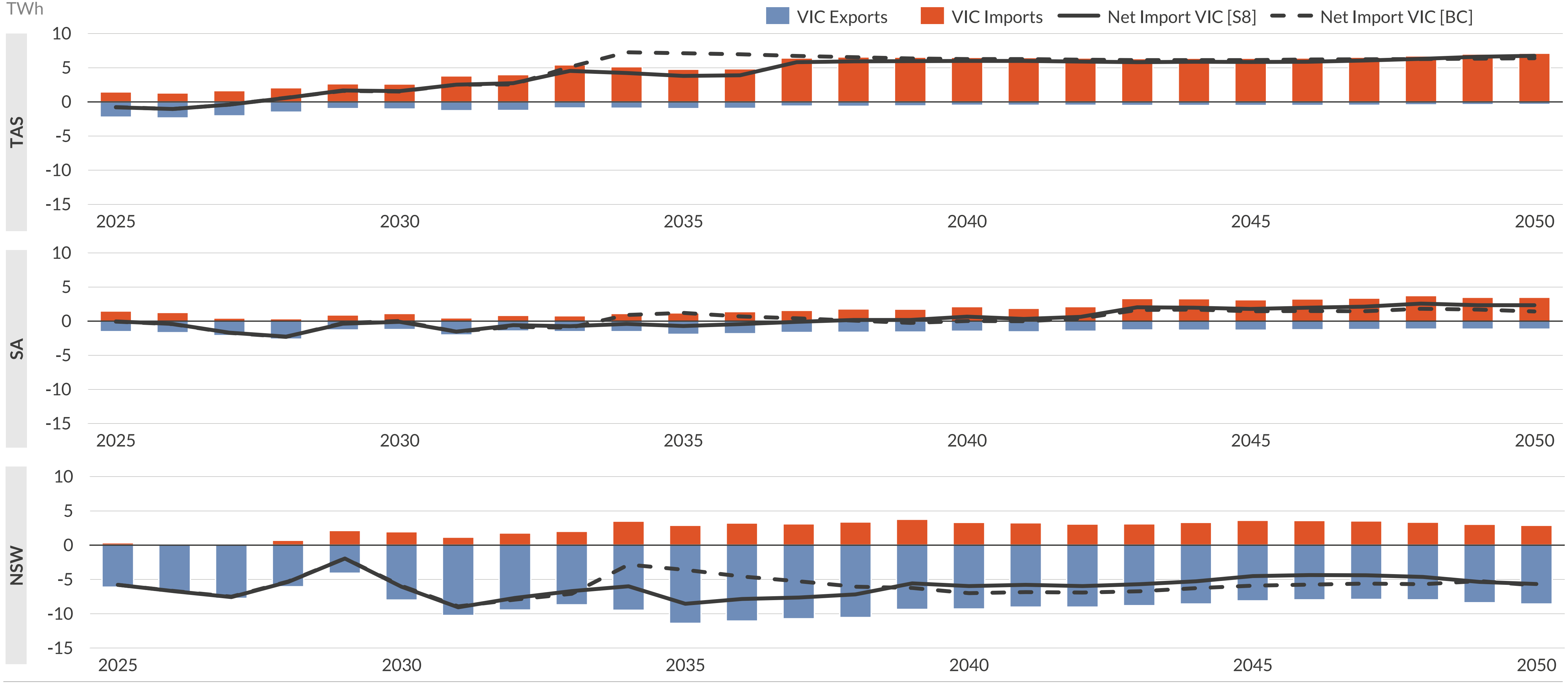
Comparison to Base Case – Interconnector flows between VIC and TAS / SA / NSW



Source: Aurora Energy Research

Agenda

I. Market overview

II. Market modelling scenarios

III. Appendix

While AEMO optimises for lowest total system cost, Aurora's capacity expansion model is focused on ensuring individual investments stack up

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5 Integrated Models

- Global Commodities (AER-GLO)
- Hydrogen (AER-HY)
- Gas (AER-GAS)
- Power markets (AER-ES)
- Nodal/network model (AER-EN)

INPUTS

- Technology
- Policy
- Demand
- Commodity prices[1]
- Weather patterns

Dispatch model

- 30min granularity.
- Iterative modelling.
- Dynamic dispatch of plant.
- Endogenous interconnector flows.

Continuous iteration until an equilibrium is reached

Investment decisions module

- Resource adequacy modelling.
- Capacity build / exit / mothballing.
- IRR / NPV driven.
- Detailed technology assessments.

OUTPUTS

- Capacity mix
- Generation mix
- Wholesale & imbalance prices
- Capacity market prices
- Profit / loss and NPV
- Electric vehicle charging

ADDITIONAL INPUTS

- Network snapshot - existing & future
- Nodal load map
- Nodal generation map

OUTPUTS

- Power flows & losses
- Nodal prices / loss factors

Up to 70 specifications modelled for each plant	**c. 100k** investment hours on modelling capabilities	**30k** model runs per week	**70+** strength of modelling team globally	**Half-yearly updates** through subscription research

1) Gas, coal, oil and carbon prices fundamentally modelled in-house with fully integrated commodities and gas market model

Source: Aurora Energy Research, AEMO

Market forecasters rely on a variety of methods to incorporate weather years for modelling and analysis – detailed analysis underpins Aurora's 'representative year'

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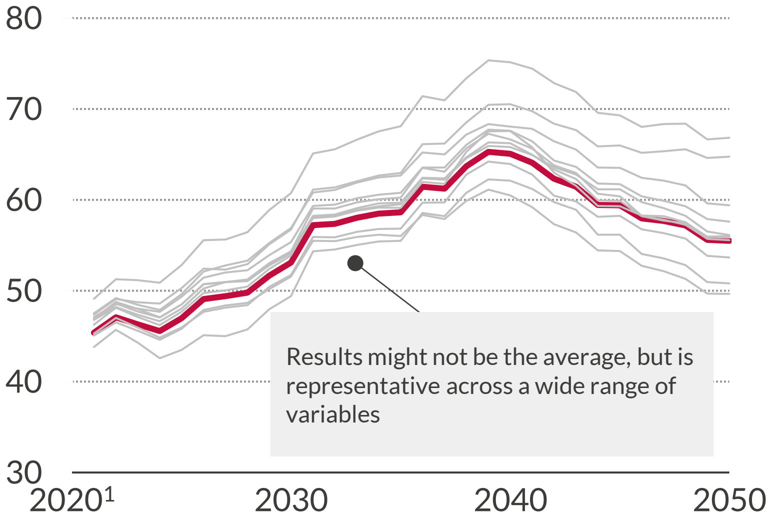
1 Single representative year (Aurora)



- Historical analysis is conducted over multiple weather years to determine the most representative year across a wide range of key performance indicators (TWAs, DWAs, production, gross margins etc).
- Aurora uses the half-hour generation profile based on the representative year, scaled to projected capacity factors for forecasting price curves and capacity expansion decisions.[1]

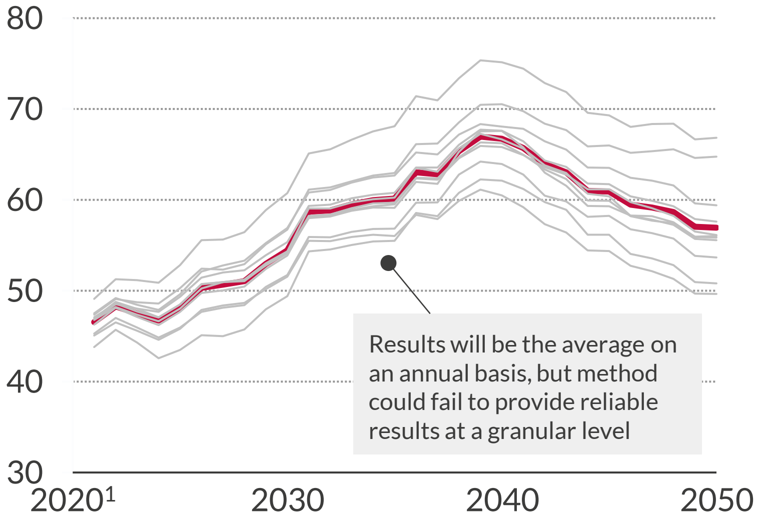
2 Rolling reference year (AEMO)

Table 1 Rolling reference years sequence in capacity outlook models

Planning Year	Reference Year	Hydrological Reference Year	Variable Renewable Energy (VRE) Reference Year
2023-24	2017-18	2017-18	2017-18
2024-25	2018-19	2018-19	2018-19
2025-26	2019-20	2019-20	2019-20
2026-27	2020-21	2020-21	2020-21
2027-28	2021-22	2021-22	2021-22
2028-29	2022-23	2022-23	2022-23
2029-30	2014-15[2]	2006-07 (Dry year)	2014-15
2030-31	2010-11	2010-11	2010-11
2031-32	2011-12	2011-12	2011-12
2032-33	2012-13	2012-13	2012-13
2033-34	2013-14	2013-14	2013-14
2034-35	2014-15	2014-15	2014-15
2035-36	2015-16	2015-16	2015-16
2036-37	2016-17	2016-17	2016-17

- Each forecast year is mapped to a single historic year, on a rolling basis.
- A rolling reference year approach captures a wider range of demand scenarios, including hotter summers or colder winters, which may increase the need for gas peaking generation during extreme weather events.
- This is the methodology utilised by Australian Energy Market Operator(AEMO) in their Integrated System Plan (ISP).

3 Average of multiple weather years



- Forecasts are conducted over multiple weather years, and results are reported as the average output of each of the individual weather years.
- This method could be less effective when assessing the economics of variable and flexible assets as averaging over multiple weather years reduces the "shape" of production and price volatility - granular (half-hourly) price curves are therefore less reliable and representative.

1) This methodology ensures the half-hour variation is preserved while accounting for historic and future changes in total generation volume/capacity factors, which prevents a distortion of forecasted prices and capacity expansion decisions due to potential generation-level biases in any given representative year.

Source: Aurora Energy Research, AEMO

By 2050, weather outturns alone could cause renewable output to deviate by more than 8TWh (5%) across the NEM, especially as renewable capacity increases

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Aurora's methodology for weather year analysis

Data collection

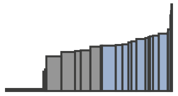
- Demand
- Solar irradiance
- Onshore wind speeds
- Offshore wind speeds
- Hydro levels

▪ An extensive set of recent historical data is collated.

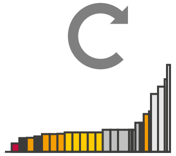
▪ The data covers 8 weather years (2011-2018), up to hourly granularity.

Weather year selection

Dispatch model



Wholesale market



Frequency & Ancillary Services

▪ Data is fed into Aurora's in-house power market model.

▪ We examine and compare results from the model runs and choose the most suitable 'representative weather year'.

Scenario forecast

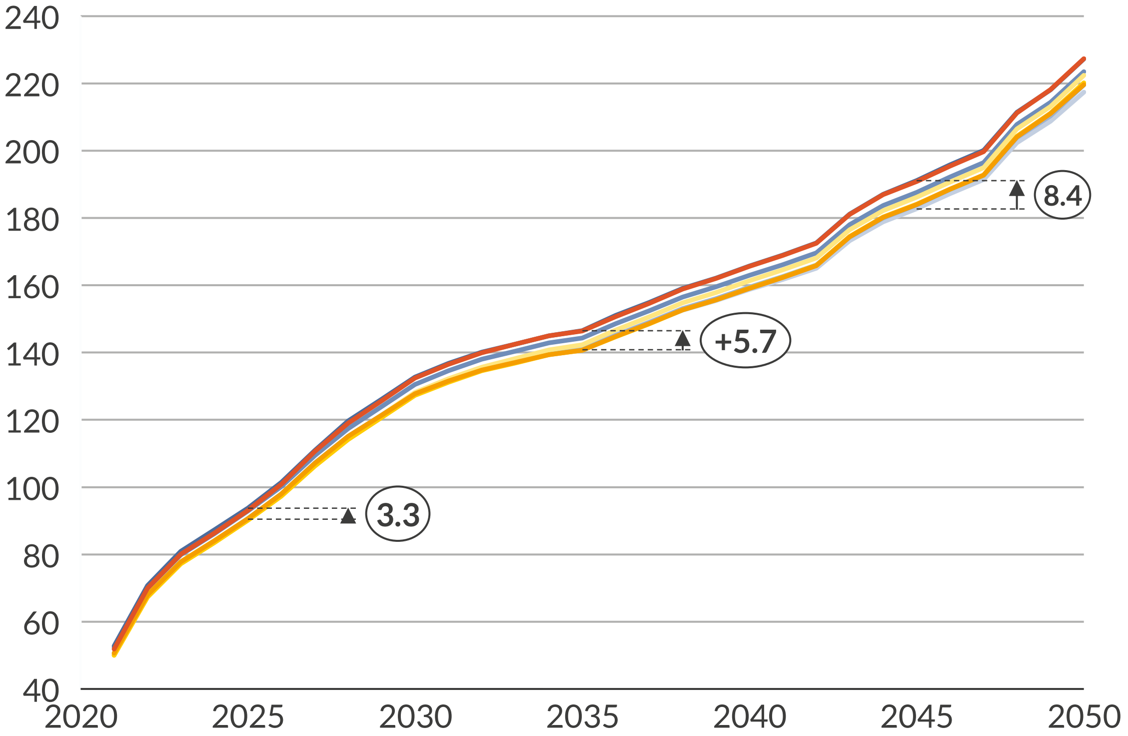
- Wholesale power prices
- Capacity outlook
- Renewable DWA prices

▪ Using Aurora's in-house power model, we model the chosen representative weather year to forecast and analyse long-term market-level outcomes.

▪ Aurora uses **2016** patterns scaled to long-term weather averages, giving the most representative outcome across key metrics[1].

Forecast of NEM renewables output across different weather years

TWh



Renewables capacity proportion of total installed capacity

%

52 60 67

2011 2012 2013 2014 2015 2016 2017 2018

1) Aurora uses the half-hour generation profile based on the representative year, scaled to projected capacity factors for forecasting price curves and capacity expansion decisions. This methodology ensures the half-hour variation is preserved, while accounting for historic and future changes in total generation volume/capacity factors which prevents a distortion of forecasted prices and capacity expansion decisions due to potential generation-level biases in any given representative year.

Source: Aurora Energy Research

Timings of network augmentations and timings are consistent with the AEMO 2024 ISP Step Change Optimal Development Pathway under the Base Case scenario

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Targeted Region	Transmission Project	2024 ISP Commissioning Year[1]	2024 ISP Status[2]
NSW, SA, VIC	Project EnergyConnect	2025 / 2028	Committed
VIC	Western Renewables Link (WRL)	2028	Committed
NSW	Central-West Orana REZ (CWO REZ) Transmission Link	2029	Committed
QLD	Far North Queensland Renewable Energy Zone (REZ)	2025	Committed
QLD	CopperString (Including QEJP SuperGrid Stage 4)	2030	Committed
NSW, VIC	VNI West (Victoria to New South Wales Interconnector West)	2030	Actionable
TAS, VIC	Project Marinus (Stage 1)	2031	Actionable
TAS, VIC	Project Marinus (Stage 2)	2033	Actionable
NSW	Humelink	2028	Actionable
NSW	Hunter Transmission project (Sydney Ring North)	2029	Actionable
NSW	New England REZ Transmission Link	2032	Actionable
QLD	Gladstone Grid Reinforcement	2030	Actionable
QLD	Queensland SuperGrid South	2032	Actionable
NSW	Hunter-Central Coast REZ Expansion	2028	Actionable
NSW, QLD	Queensland-NSW Interconnector (QNI) Connect	2035	Actionable
SA	Mid North South Australia REZ Expansion	2030	Actionable
VIC	Western Victoria Grid Reinforcement	2034	Future
VIC	Eastern Victoria Grid Reinforcement	2036	Future
QLD	Facilitating power to Central Queensland	2036	Future
NSW	Central West Orana REZ Extension	2037	Future
QLD	North Queensland Clean Energy Hub Expansion	2043	Future

Vic-specific projects

1) Commissioning year refers to the first financial year in which the project is scheduled to be operational at full capacity; 2) Committed – a project that has fully met all five commitment criteria (planning, construction, land, contracts, finance), in accordance with the AER's Cost Benefit Analysis Guidelines, Actionable – a transmission project identified as part of the ODP and having a delivery date within an actionable window, Future – a transmission project that addresses an identified need in the ISP, that is part of the ODP, and is forecast to be actionable in the future.

Source: Aurora Energy Research

AEMO Inputs, Assumptions and Scenarios (IASR) CapEx Assumptions by technology type

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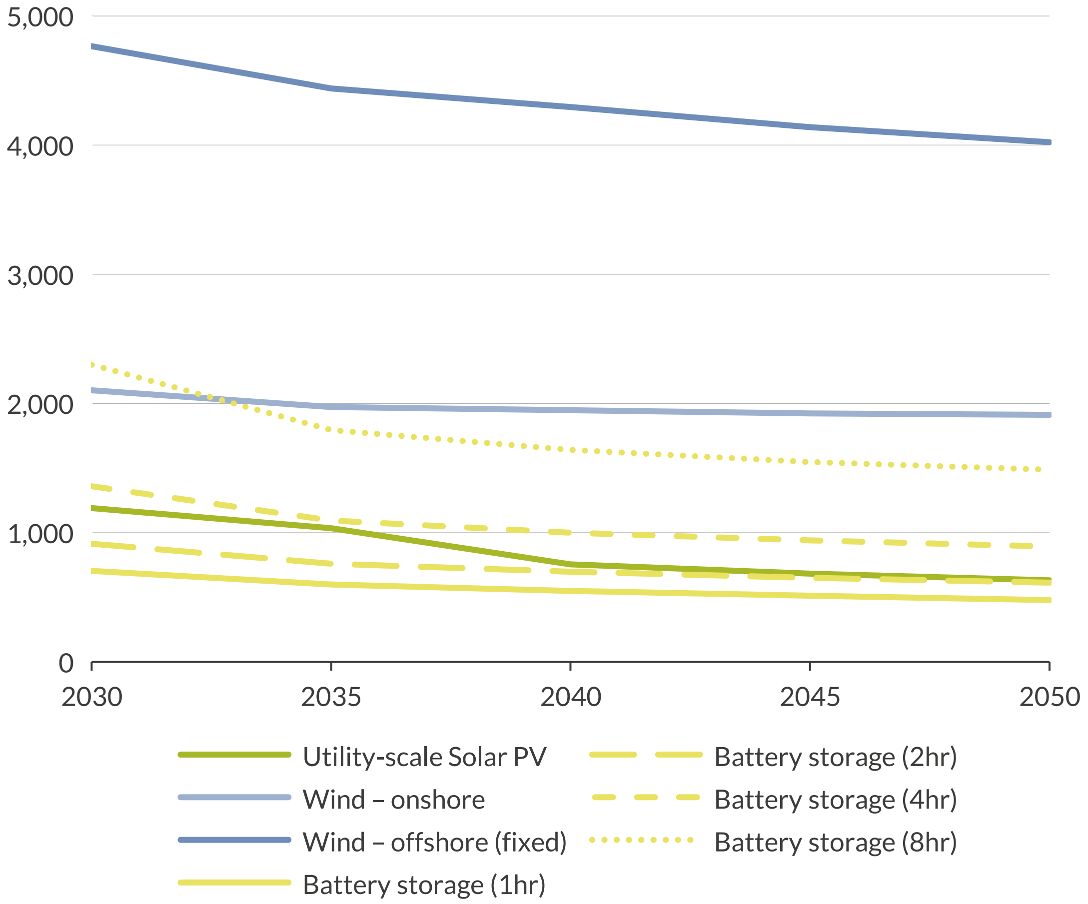
AEMO IASR Build-Cost Assumptions , FY30 to FY50
$/kW

- The capital cost estimates provided are developed by CSIRO (see GenCost 2022-23 Final report for more details) based on technology-specific capital cost estimates provided by Aurecon.
- Build costs below are in real June 2023 dollars.

Technology	2030	2035	2040	2045	2050
Utility-scale Solar PV	1,191	1,035	755	683	632
Wind – onshore	2,103	1,974	1,948	1,924	1,913
Wind – offshore (fixed)	4,766	4,438	4,295	4,140	4,023
Battery storage (1hr storage)	705	600	551	512	479
Battery storage (2hr storage)	915	761	699	652	614
Battery storage (4hr storage)	1,360	1,095	1,001	941	894
Battery storage (8hr storage)	2,301	1,796	1,642	1,548	1,488

Time series of AEMO IASR Build-Cost Assumptions by technology type, FY30 to FY50
$/kW



Figures are in real June 2023 dollars

Source: AEMO 2023 Inputs Assumptions and Scenarios (IASR)

Glossary of key NEM and modelling terms

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Abbreviation	Explanation
A$	▪ Australian Dollars (assumed to be real 2023 terms unless otherwise stated)
AEMO	▪ Australian Energy Market Operator
AER	▪ Australian Energy Regulator
ARENA	▪ Australian Renewable Energy Agency
Bn	▪ Billion
BTM	▪ Behind-the-Meter
Capex	▪ Capital Expenditure
CCGT	▪ Combined Cycle Gas Turbine
CEFC	▪ Clean Energy Finance Corporation
CER	▪ Consumer Energy Resources
CfD	▪ Contract for Difference
CIS	▪ Capacity Investment Scheme
CISA	▪ Capacity Investment Scheme Agreement
CO_2e	▪ Carbon Dioxide emissions
CSIRO	▪ Commonwealth Scientific and Industrial Research Organisation
DER	▪ Distributed Energy Resources
DWA	▪ Dispatch Weighted Average

Abbreviation	Explanation
EOI	▪ Expression of Interest
ESOO	▪ Electricity Statement of Opportunities
EVs	▪ Electric Vehicles
FCAS	▪ Frequency Controlled Ancillary Services
FY	▪ Financial Year
GJ	▪ Gigajoule
GW	▪ Gigawatt
IASR	▪ Inputs Assumptions and Scenarios
kW	▪ Kilowatt
LGCs	▪ Large-scale Generation Certificates
LNG	▪ Liquefied Natural Gas
MLF	▪ Marginal Loss Factor
Mt	▪ Mega tonne (one million metric tonnes)
MWh	▪ Megawatt Hour
MW	▪ Megawatt
NEM	▪ National Electricity Market

Abbreviation	Explanation
NVES	▪ New Vehicle Efficiency Standard
ODP	▪ Optimal Development Pathway
Opex	▪ Operational Expenditure
PPA	▪ Power Purchasing Agreement
REGO	▪ Renewable Energy Guarantee of Origin
RES	▪ Renewable Energy System(s)
RETA	▪ Renewable Energy Transformation Agreement
REZ	▪ Renewable Energy Zone
RFP	▪ Request for Proposal
RRN	▪ Regional Reference Node
SECV	▪ Victorian State Electricity Commission
STC	▪ Small-scale Technology Certificate(s)
TWA	▪ Time-weighted Average
TWh	▪ Terawatt Hour
VEU	▪ Victoria Energy Upgrade
VPP	▪ Virtual Power Plant(s)
VRE	▪ Variable Renewable Energy
VRET	▪ Victoria Renewable Energy Target

Source: Aurora Energy Research

Explanation of key concepts [1/2]

Key Terms	Description
LGCs	▪ Large-scale generation certificates (LGCs) are created on a yearly basis based on the amount of power generated by an accredited and registered renewable energy power station. An LGC represents one megawatt hour (MWh) of net renewable energy generated. Registered LGCs can be sold or transferred to entities with liabilities under the Renewable Energy Target or other companies looking to voluntarily surrender LGCs.
LCOE	▪ The levelised cost of electricity (LCOE) is the Net Present Value (NPV) of the unit-cost of electrical energy over the lifetime of a generating asset. It is effectively a simplified assessment of the cost competitiveness of an electricity-generating system that incorporates all costs over an asset's lifetime: initial investment, operations and maintenance, cost of fuel, cost of capital.
MLFs	▪ Marginal loss factors (MLFs) reflect the impact of electricity losses along the network and are applied to market settlements in the National Electricity Market (NEM), and so affect generator revenues. They represent electricity losses along the transmission network between a connection point and the regional reference node (RNN), which is used to represent the regional centre of the transmission network.
Non-volatile / fundamental prices	▪ Aurora's standard power market model only includes "fundamentals-based" volatility and therefore the power prices do not include extreme price events above approximately $1,000/MWh (as these typically cannot be explained by generator short run marginal cost (SRMC) / shadow pricing).
"Typical volatility" prices	▪ Revenues from +$1,000/MWh price periods are a material factor in the investment case of flexible assets, such as batteries. To capture this market feature, Aurora has a fourth step to price formation (not to be confused with "uplift" which is the second step to price formation). This fourth step is a "post-model" process to add +$1,000/MWh price periods in line with what has been seen historically over the last 3-5 years in each state (but excluding any major/minor system incidents from the calibration – hence the term "typical" volatility, as this approach does not try to recreate persistent, significant market events that may be driven by long-term network outages or coal plant explosions). This "post-model" processing involves using a stochastic (Markov Chain) approach where spiky prices are probabilistically added to half-hours according to spare capacity margin in that half-hour.

Source: Aurora Energy Research

Explanation of key concepts [2/2]

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Key Terms	Description
TWA	▪ The time-weighted average price is the simple average of all half hourly power prices during a given period.
DWA	▪ Dispatch-weighted average price is the average of the regional reference node price achieved by an asset (or type of technology) where the average price is weighted by the asset's generation in a given period. ▪ There are a number of different ways of defining the dispatch-weighted average prices. Aurora's forecast DWA prices are defined as follows: – ***Pre-MLF and Post-Curtailment*** – This means that losses due to MLFs are not accounted for and assumes that assets economically curtail at 0$/MWh to avoid negative prices. – ***Pre-MLF and Pre-Curtailment*** – This means that losses due to MLFs are not accounted for and assumes that assets still generate through negative price periods. ▪ Final asset revenues can then be calculated according to the following formula: – **[Post-curtailment final revenues] = [Pre-mlf, post-curtailment DWA] x [MLF] x [(1 - curtailment rate) x Pre-Curtailment Generation]** – **[Pre-curtailment final revenues] = [Pre-mlf, pre-curtailment DWA] x [MLF] x [Pre-Curtailment Generation]**
Price cannibalisation	▪ Price cannibalisation is the price impact of high levels of zero-marginal cost renewable generation on dispatch-weighted prices. When solar and wind output is high, it tends to bring down prices in those periods as lower cost technologies set the margin in the wholesale market ('merit order effect').
Inflation	▪ Aurora's forecast prices are published in real 2023 calendar year prices as at 30th June 2023. Aurora models all forecasts in real terms and provides the International Monetary Fund's future Consumer Price Index (CPI) expectation as a possible metric to use to convert our forecasts to nominal terms. However, CPI has not historically been strongly and consistently correlated with electricity prices and Aurora's subscribers typically apply a range of in-house views on future inflation rates.
Financial years	▪ Aurora's forecasts are in financial years and follow the federal financial year (1 July to 30 June). Years refer to the end of the financial year, so e.g. FY 2026 refers to 1 July 2025 to 30 June 2026.
Reference weather years	▪ Aurora's half-hourly renewable generation and demand traces are based on the FY2016 reference weather year. The alignment of each of these input traces to the same reference weather year is critical due to the impact that weather has on renewable generation and demand, and the knock-on impact on half-hourly wholesale prices.

Source: Aurora Energy Research

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