2024 Victorian Transmission Plan Guidelines

September 2024

Appendix D

Inputs, assumptions and scenarios

Contents

Purpose

This is Appendix D to the 2024 Victorian Transmission Plan Guidelines (2024 VTP Guidelines) originally published as a draft on 22 July 2024.

VicGrid is changing the way energy infrastructure is delivered in Victoria. We are putting in place a long-term strategic plan – the Victorian Transmission Plan (VTP) – to ensure we have the right infrastructure in the right place at the right time to support the energy transition.

As set out in the amendments to the *National Electricity (Victoria) Act 2005* (the Act) passed in May 2024, VicGrid is required to develop and release the inaugural VTP by mid-2025. This will guide Victoria's smooth transition to renewable energy as coal-fired generators retire in the following decade.

VicGrid is required to prepare and publish a set of guidelines called the 2024 Victorian Transmission Plan Guidelines (2024 VTP Guidelines) (this document), which outline how the 2025 VTP will be developed. This appendix provides further technical details on the content included in the main guidelines.

Disclaimer

The publication of the 2024 VTP Guidelines is pursuant to amendments to the *National Electricity (Victoria) Act 2005* passed in May 2024, which implement the first stage of Victorian Transmission Investment Framework reforms and empower the CEO VicGrid to develop a Victorian transmission plan.

The State of Victoria and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this publication.

This publication does not include all of the information that an investor, participant or potential participant in the National Electricity Market might require, and does not amount to a recommendation of any investment.

The information in this document is current at the time of printing and remains subject to change and should not be relied upon. Please visit vicgrid.vic.gov.au for the latest updates.

Copyright

Acronyms

Term	Definition
AEMO	Australian Energy Market Operator
CER	Consumer energy resources
DSP	Distributed solar photovoltaic
EV	Electric vehicles
GW	Gigawatt (one million kilowatts)
GWh	Gigawatt hour (one million kilowatt hours)
IAP2	International Association of Public Participation
IASR	Inputs, Assumptions and Scenarios Report
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISP	Integrated System Plan
MCA	Multi-criteria analysis
MW	Megawatt (one thousand kilowatts)
MWh	Megawatt hour (one thousand kilowatt hours)
NCC	National Construction Code
NEM	National Electricity Market
NER	National Electricity Rules
NEVA	National Electricity (Victoria) Act 2005
ODP	Optimal development pathway
PSS/E	Power system simulation for engineering
PV	Photovoltaic solar
RAP	Registered Aboriginal Parties
REZ	Renewable energy zone
RRN	Regional reference node
TW	Terawatt (one billion kilowatts)
TWh	Terawatt hour (one billion kilowatt hours)
VAPR	Victorian Annual Planning Report
VCR	Value of Customer Reliability
VEU	Victorian Energy Upgrades
VPP	Virtual Power Plant
VRET	Victorian Renewable Energy Targets
VTIF	Victorian Transmission Investment Framework
VTP	Victorian Transmission Plan
WACC	Weighted average cost of capital

Appendix D: Inputs, assumptions and scenarios – content summary

This appendix details the inputs, assumptions and scenarios that we will use to develop and inform the 2025 Victorian Transmission Plan (VTP). It includes inputs and assumptions that will be used for the energy market analysis, power systems analysis and economic cost-benefit analysis.

The format of this appendix has been set out to broadly reflect the format of the Australian Energy Market Operator's (AEMO's) Inputs, Assumptions and Scenarios Reports (IASR), with some headings combined or removed if not relevant. Among other factors, this appendix outlines:

- the policies that VicGrid will consider and their treatment
- energy consumption and demand forecasts
- generator and storage technical assumptions
- fuel cost forecasts
- network modelling
- power system security
- hydrogen infrastructure
- financial and economic parameters.

In general, where inputs and assumptions are consistent with those made by AEMO, this appendix identifies and refers to the appropriate data source rather than report the data here. This approach seeks to minimise the potential for confusion or conflicts across sources. Additional details are provided where the 2024 VTP Guidelines adopted an input or assumption that differs from AEMO or where the inclusion of specific data can support reader understanding.

D.1 Scenarios

As part of the 2024 amendments made to the *National Electricity (Victoria) Act 2005* (NEVA), the Victorian Transmission Plan (VTP) scenarios are required to be high-impact, plausible and establish the electricity system's 25-year investment needs consistent with Victorian energy policy objectives and market outlook. As outlined in the Victorian Transmission Investment Framework (VTIF), the scenarios will be simplified, aligned with AEMO's 2024 Integrated System Plan (ISP) scenarios and adapted to meet Victoria's needs. Aligning with AEMO's ISP scenarios supports consistency of assumptions with national planning bodies, duplication is avoided, and the thorough analysis and stakeholder management processes that inform the national scenarios and planning can be built upon for the VTP.

The NEVA also includes the Victorian transmission planning objective, which aims to promote efficient investment (refer to Section 1.1 of the 2024 VTP Guidelines). To achieve this, the VTP should develop transmission having regard to the risks associated with under-investment and over-investment. VicGrid is required to manage these risks through analysis of least regrets across a range of scenarios to develop a VTP that is robust to future uncertainties.

For the first VTP, VicGrid intends to use 3 scenarios to outline electricity system investment needs for the coming 25 years. These scenarios are aligned with prior work undertaken by AEMO in the 2024 ISP and 2023 Inputs, Assumptions and Scenarios Report (IASR).

The VTP scenarios do not represent VicGrid's view on how the energy transition will occur, nor are they an endorsement of one scenario over another. There are many, plausible and different possible futures, characterised by uncertainty. Instead, scenarios are an important tool to facilitate planning and manage future risks and uncertainty. To support the analysis of robustness (least regrets), the scenarios have been designed to support a broad range of plausible future states and uncertainties.

The 3 scenarios are summarised in Table D-1.

Table D-1: VTP scenarios

Scenario	Description
Scenario 1 **If Victoria experiences a step-change in energy transition**	This scenario considers a potential future where the evolution of the Victorian energy sector evolves in line with AEMO's national step-change trends. The 2024 ISP defines this scenario as reflecting a pace of transition that supports Australia's contribution to limit global temperature rise to less than 2°C, with consumer energy resources modelled to contribute strongly to the transition. This scenario explores what may need to occur if Victoria's energy transition goes according to plan and Victoria's renewable energy targets, offshore wind targets and storage targets are met.
Scenario 2 **If Victoria experiences growth in green industries at scale**	This scenario considers a potential future where new energy-intensive industries are established in regional and central Victoria, such as hydrogen production, green aluminium and data centres. Demand in this scenario is based on AEMO's national green energy export trends forecast.
Scenario 3 **If there are delays in building new energy infrastructure across the National Electricity Market (NEM)**	This scenario considers a potential future where there may be delays of up to a year in delivering new energy infrastructure. This could include delays to Western Renewables Link (WRL), Victoria to New South Wales Interconnector West (VNI West), Marinus Link and offshore wind generation. There is also reduced growth in coordinated consumer energy resources (CER) across Victoria. Reflecting broad challenges across the NEM, other NEM-Government policies/targets are generally delayed.

The scenarios consider a range of factors that could impact the energy sector, including electricity demand, interconnection with other jurisdictions, and government renewable energy policies. The treatment of these parameters is summarised in Table D-2.

Table D-2: Summary of selected parameters for each scenario

Parameters	Scenario 1 If Victoria experiences a step-change in energy transition	Scenario 2 If Victoria experiences growth in green industries at scale	Scenario 3 If there are delays in building new energy infrastructure across the National Electricity Market
Demand			
AEMO demand scenario	AEMO's step-change	AEMO's green exports with revisions to treatment in other states	AEMO's step-change
2050 operational demand (TWh) [1]	73.7	110.3	73.7
Other key factors			
Victorian Renewable Energy Targets (2025, 2030 and 2035)	Achieved	Achieved	Achieved
Storage targets (2030 and 2035)	Achieved	Achieved	Achieved
Offshore wind targets	Achieved	Achieved	Achieved but delayed up to 1 year: 2 GW by 2033, 4 GW by 2036 and 9 GW by 2041.
Gas constraints	As per AEMO's 2024 ISP	As per AEMO's 2024 ISP	As per AEMO's 2024 ISP
Interconnection	As per announcements / AEMO's ISP	As per announcements / AEMO's ISP	WRL, VNI West and Marinus Link (ML) Stage 1 delayed up to 1 year, no ML Stage 2
NEM coal closure	As per announcements / Victorian Renewable Energy Target	As per announcements / Victorian Renewable Energy Target	As per announcements / Victorian Renewable Energy Target
Non-VIC government policies	Aligned with announcements	Aligned with announcements	Generally delayed due to various challenges associated with the energy transition. For example, Snowy Hydro is delayed by 1 year.

Source: VicGrid and AEMO IASR 2023

Notes: Demand encompasses rates of electrification, electric vehicle uptake, CER, amongst others. These factors are further explored in Section D.3. Scenario 3 considers reduced CER coordination - further details are outlined in Section D3.

[1] Data retrieved from AEMO | Electricity Forecasting Data Portal as at August 2024

D.2 Policy settings

D.2.1 Victorian Government policies

Government policies are an important factor driving the energy transition and transmission needs. Policies that have been considered across the scenarios are outlined in Table D-3.

Table D-3: Victorian Government policy settings considered across scenarios.

Policy type	Details
Renewable energy targets	The Victorian Renewable Energy Targets (VRET) are legislated in the *Renewable Energy (Jobs and Investment) Act 2017* (Vic) and are: • 40% of Victorian electricity generation to be renewable by 2025, • 65% of Victorian electricity generation to be renewable by 2030, • 95% of Victorian electricity generation to be renewable by 2035.
Storage targets	Victoria's energy storage targets are legislated in the *Renewable Energy (Jobs and Investment) Act 2017* (Vic) and are, at a minimum: • 2.6 GW by 2030 • 6.3 GW by 2035
Offshore wind energy targets	Victoria's offshore wind energy targets are legislated in the *Renewable Energy (Jobs and Investment) Act 2017* (Vic) and are, at a minimum: • 2 GW by 2032 • 4 GW by 2035 • 9 GW by 2040
Consumer energy resources-related policies	Victorian solar panel rebate, solar battery rebate
Electric vehicles	Zero Emissions Vehicles Roadmap
Energy efficiency policy	Victorian Energy Upgrades (VEU) program, NCC 2022 updates, including 7-star minimum building efficiency requirements.
Other Victorian Government policies	Gas Substitution Roadmap, Renewable Hydrogen Industry Development Policy

The VicGrid scenarios consider alternative futures in which Victorian Government policies are achieved. However, scenario 3 considers a potential future in which there are minor delays in the build-out of energy infrastructure across the NEM.

Victorian Government policies, including the Victorian Energy Upgrades program and Victoria's landholder payments for transmission, are considered within the design of AEMO's scenario demand profiles. By aligning demand to AEMO's scenarios, the impacts of these policies are implicitly incorporated into the VTP analysis.

D.2.2 Emissions

The *Renewable Energy (Jobs and Investment) Act 2017* (Vic) prescribes targets for the shares of Victorian energy generation that must be from renewable sources. For the purposes of the energy market modelling, these targets are assumed to deliver on the energy sector's contribution to Victoria's emissions reduction targets outlined in *Victoria's Climate Change Act 2017* (Vic), including 28-33% below 2005 levels by 2025; 75-80% by 2035; and net zero by 2045.

D.2.3 Other National Electricity Market-jurisdiction policies

Other jurisdictions have developed policies to support the energy transition across the National Electricity Market (NEM), which could have an impact on renewable energy zone (REZ) and transmission outcomes in Victoria. Table D-4 outlines selected policies from interstate that have been considered across scenarios.

Table D-4: Selected NEM-jurisdiction policy settings

Policy type	Details
Renewable energy targets	• NSW Roadmap is implemented in full (12 GW variable renewable energy by 2030) • Queensland Renewable Energy Target (QRET) leads to 400 MW installed in Queensland in round 1; and then 50% of total Queensland generation by 2030; 70% by 2032; 80% by 2035 • Tasmanian Renewable Energy Target of 150% by 2030 and 200% by 2040.
Storage targets	• NSW energy storage tender for 2 GW long duration storage by 2030
New pumped hydro storage	New pumped hydro storage initiatives include: • Snowy 2.0 included from 1 December 2028 • Meeting the requirements as set out by the Queensland Energy and Job Plan. This includes introduction of a 2 GW capacity pumped hydro system in 2033, 3GW in 2035, and 2 GW in 2039.

As a Victoria-specific plan, the VTP scenarios primarily consider Victoria's and other state government policies and do not assume the achievement of Commonwealth policies and/or targets. As a result, the results of the VTP analysis will differ from the ISP at the state level.

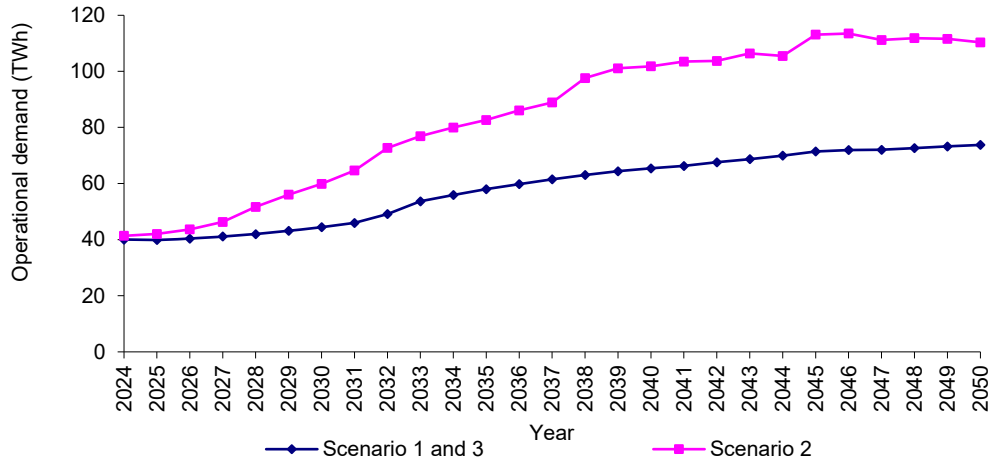
Scenarios 1 and 2 consider potential futures in which policies of other states are achieved. For planning purposes, and to ensure that the VTP is robust in the face of challenges in other jurisdictions, scenario 3 considers a potential future in which there may be delays or revisions in the achievement of interstate commitments. This will allow us to consider how we can plan to meet the energy needs of Victoria under challenging circumstances, including if the transition does not go to plan in other jurisdictions.

D.3 Consumption and demand forecasts

The total operational demand from consumers for electricity in Victoria will result in the need for investment in generation and transmission. In line with the VTIF, our approach is to develop simplified scenarios that align with the demand profiles used by AEMO in the ISP. Transmission planning entities across the NEM adopt a similar approach.

AEMO's total operational demand forecasts for Victoria under step-change and green energy exports are shown in Figure D-1. Operational demand is forecast to grow from 40 TWh currently to 73.7 TWh by 2050 under step-change and 110.3 TWh by 2050 under green energy exports.

Figure D-1: AEMO operational demand forecast for Victoria under step-change (scenario 1 and 3) and green energy exports (scenario 2) scenarios. Source: AEMO



AEMO's green energy exports scenario results in very high energy demand in some NEM-jurisdictions due to hydrogen production. To mitigate this very high energy demand and its impact on Victoria, scenario 2 assumes that hydrogen-related energy demand in other NEM jurisdictions aligns with AEMO's step-change demand instead. For all other components of demand, other NEM jurisdictions are assumed to have levels of demand consistent with AEMO's green energy exports scenario.

The growth in forecast electricity consumption across the scenarios reflects changes in residential, commercial and industrial consumption, uptake in electric vehicles, consumer energy resources and rates of electrification, which impact overall demand. These factors are outlined in Table D-5.

Table D-5: Scenario demand profiles

Parameters	Scenario 1 If Victoria experiences a step-change in energy transition	Scenario 2 If Victoria experiences growth in green industries at scale	Scenario 3 If there are delays in building new energy infrastructure across the National Electricity Market
AEMO demand scenario	AEMO's step-change	AEMO's green exports	AEMO's step-change
2050 operational demand (TWh) [2]	73.7	110.3	73.7
Consumer energy resources uptake (batteries, solar panels and EVs)	High	Higher	High
Consumer engagement such as virtual power plants (VPP) and	High VPP and Moderate DSP	Higher	Low VPP and Moderate DSP

[2] Data retrieved from AEMO | Electricity Forecasting Data Portal as at August 2024

Parameters	Scenario 1 If Victoria experiences a step-change in energy transition	Scenario 2 If Victoria experiences growth in green industries at scale	Scenario 3 If there are delays in building new energy infrastructure across the National Electricity Market
distributed solar photovoltaics (DSP) uptake			
Energy efficiency	Moderate	Higher	Moderate
Hydrogen use	Medium-low production for domestic use, with minimal export	Higher production for domestic and export use	Medium-low production for domestic use, with minimal export
Hydrogen blending in gas distribution network	Up to 10%	Up to 10%	Up to 10%
Biomethane/synthetic methane	Allowed, but no specific targets to introduce it	Allowed, but no specific targets to introduce it	Allowed, but no specific targets to introduce it

Source: AEMO 2024

The uptake in consumer energy resources is a particularly important factor that can impact operational demand and the need for more generation and transmission investment. The Victorian Government has a range of policies designed to support the uptake in consumer energy resources as outlined in Section D.2. AEMO considers the impact of these policies when it forecasts consumer energy resources uptake, including the uptake in distributed rooftop solar panels, battery storage and coordinated virtual power plants (VPP), and their impact on overall demand and consumption. To consider what would need to occur should there be reduced growth in coordinating CER from otherwise assumed, Scenario 3 will adopt 'low' coordination of CER, in line with AEMO's reduced CER coordination sensitivity. This assumes that there is high uptake of consumer energy resources, but no growth in VPP.

By way of example, AEMO's step-change scenario assumes rooftop solar panels and distributed storage will experience strong growth in the long term in Victoria and the rest of the NEM. Victorian rooftop solar panel generation is expected to grow from 4.5 TWh in FY2024 to nearly 22 TWh in FY2050. Victorian distributed battery energy storage system (BESS) uptake is expected to reach 9 GW by FY2050, with 80% of them being coordinated in VPPs. By aligning with AEMO's demand forecasts, such growth is incorporated into our planning.

D.4 Generator and storage plants

Existing and committed generators and storage assets, including key technical parameters such as generator capacities and operating costs, will be sourced from AEMO's latest generation information data. This information will be used throughout energy market modelling to identify new generation and storage entrants to meet future demand and renewable targets at least cost.

Further details on coal-fired power station operating schedules and new entrant generator assumptions are included below.

D.4.1 Coal-fired power station retirements

Across the NEM, coal-fired power stations are becoming unreliable and retiring as the energy system continues to transition. The closure of existing coal-fired generation will be an important factor in Victoria's transition.

Coal-fired power station retirement dates will be based on publicly announced retirement schedules and/or AEMO's published generator expected closure dates.[3] This includes, for example, the planned closure of the Yallourn coal power station from financial year 2028. It is also assumed that coal-fired power station retirement will be aligned with the achievement the Victorian Renewable Energy Target (VRET) of 95% renewable energy generation by 2035.

D.4.2 New entrant generator assumptions

New entrant capital costs will be sourced from the Gencost report by the CSIRO, which is provided alongside AEMO's IASR. In general, renewable energy and battery storage costs are expected to continue to decrease over the next 10 to 15 years, albeit at variable rates.

AEMO's Generation Information includes generation projects at various stages of their development lifecycle. Generation projects identified as existing or committed as of July 2024 will be included as an input in energy market modelling. Additional projects, sufficiently advanced, may be included on a case-by-case basis.

New gas-powered generation (GPG) capacity will be limited to that outlined in AEMO's 2024 ISP. This is consistent with the overall approach for the first VTP in aligning key inputs and assumptions with AEMO, adapted for Victoria, where possible.

D.5 Fuel costs

Prices are assumed to vary by scenario. Under AEMO's step-change scenario, gas prices are expected to fall from current high levels over time.

Brown coal fuel prices are expected to remain stable at below $1/GJ due to their low production cost and lack of international market access.

D.6 Network modelling

The aims of the VTP methodology, set out in Section 3 of the 2024 VTP Guidelines, are to identify the optimal transmission and generation required to service Victoria's needs. An important baseline assumption is the committed and anticipated projects that can be assumed as an input for the VTP, on which other projects can be identified and assessed in the analysis.

D.6.1 Transmission projects

The VTP will set out the Victorian transmission needs over the forecast period. As such, transmission projects under way are an important baseline input for the modelling.

In developing the ISP, AEMO categorises transmission options as committed, anticipated, actionable or future projects. For these categories, VicGrid will assume:

- **Committed and anticipated projects** represent the transmission and generation projects that are already well progressed and are included as baseline inputs for the VTP.
- **Actionable projects** are included as baseline inputs for the VTP, with timing as identified by AEMO or more recent project announcements and vary by scenario.

3 https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/generation_information/2024/generating-unit-expected-closure-year-apr-2024.xlsx?la=en

- **Future projects** have not been included as an input in the modelling of the existing system. Future projects can be considered as candidate options for the VTP as described in Appendix B.

Other projects that will be considered within the VTP methodology are included in Table D-6

Table D-6: Transmission projects included as a baseline input for the VTP

Classification	Definition	Details
Committed and anticipated	Committed projects are those that meet all 5 planning criteria under the Australian Energy Regulator's (AER's) RIT-T guideline.[4] Anticipated projects are those that meet 3 of the planning criteria.	These categories represent the transmission projects that are already well progressed and are included as baseline inputs for the VTP. An example is the Western Renewables Link (WRL) project, with its commissioning date delayed in scenario 3.
Actionable projects	Actionable projects are those that AEMO has included in an ISP optimal development path and which it has identified should be progressed through a RIT-T.	Actionable projects are included as baseline inputs for the VTP, with timing as identified by AEMO or more recent project announcements. Victoria to New South Wales Interconnector West (VNI West) is assumed to be constructed in 2029 in scenarios 1 and 2, and delayed by 1 year in scenario 3. To ensure the VTP is robust to future delays or decisions regarding Marinus Link, the scenarios vary its timing and scope. In scenario 1, Marinus Link is assumed to be completed in 2030 (Stage 1) with Stage 2 in 2032. In scenario 2, Marinus Link is assumed to occur in line with AEMO's 2024 ISP optimal development path. In scenario 3, Marinus Link Stage 1 is delayed for up to 1 year and Stage 2 is assumed to not occur given it is subject to an investment-decision by owner-governments in late 2024.

[4] AER 2020, *Regulatory investment test for transmission,* pg 13.

Classification	Definition	Details
Initial offshore wind transmission projects	VicGrid is currently planning for shared transmission to connect 2 GW of offshore wind energy to Victoria's network.	VicGrid is consulting on offshore wind transmission infrastructure to be located in Gippsland to support achievement of the initial offshore wind legislated target of 2 GW by 2032. All of the scenarios include 2 GW of offshore wind connecting to Victoria within the first 10 years of the planning period with some variation in timing. Consistent with VicGrid's current plans, transmission infrastructure will be required in accordance with these timeframes. Projects progressed via an Order under section 16Y of NEVA or other processes will be considered as baseline inputs.
Other transmission projects in planning	Victoria's energy transition continues to progress while the VTP is being developed and there are a range of projects (including grid augmentations) under consideration by VicGrid and other proponents that may be progressed through other processes, including Orders under section 16Y of NEVA.	Projects progressed via an Order under section 16Y of NEVA, or other processes, will be considered as baseline inputs.

Other identified projects (for example future ISP projects) can be considered as candidate options for the VTP as described in Appendix B.

D.6.2 Network-related technical inputs

Technical parameters for the transmission network modelling, including existing network capacities, reliability obligations, marginal loss factors, network losses (both intra-regional losses and inter-regional losses), and unplanned transmission line outage rates will be sourced from AEMO where applicable. A simplified sub-regional model may also be considered to improve modelling detail as required.

D.7 Power system security

Power system analysis will be undertaken using the Victorian Annual Planning Report (VAPR) model developed by AEMO Victorian Planning in the PSS/E model environment.

Network performance (including system security and generator performance, where required) will be assessed for the optimised generation and transmission build against the network planning, operation and performance criteria specified in the National Electricity Rules (NER). Key inputs relating to thermal transmission limits, fault levels, and temperature limits will be sourced from the VAPR power system model.

D.8 Hydrogen infrastructure and other demand sources

Consumption and demand forecast data includes factors such as hydrogen production-related demand, which will be sourced from AEMO scenarios. Hydrogen demand is assumed to stem from electrolysers located at key sites in Victoria. In scenarios 1 and 3, electrolysers are assumed to be located at the regional reference node (RRN). Scenario 2 considers a potential future of high demand, resulting from data centres or hydrogen electrolysers that may be located across the state, including in regional Victoria.

Locations for hydrogen-related infrastructure may be located in regions identified in the Victorian Renewable Hydrogen Industry Development Plan, including for example, Barwon South West (Portland and Geelong), Hume (e.g. Hydrogen Park Murray Valley in Wodonga), Gippsland and Loddon Mallee.

D.9 Financial and economic parameters

The cost-benefit analysis will include key financial data sourced from AEMO, including adopting a 7% real, pre-tax weighted average cost of capital (WACC) for both generation and transmission assets. The value of customer reliability (VCR) will be based on the AER's most recent value.

Contact us

Phone: 1800 418 341
Email: vicgrid@deeca.vic.gov.au
Deaf, hearing or speech impaired? Please contact the National Relay Service on 133 677 or communications.gov.au/accesshub/nrs

Need an interpreter? Contact Translating and Interpreting Service (TIS) on 131 450 (within Australia) or visit **www.tisnational.gov.au**

Victorian Transmission Plan Guidelines
Appendix D: Inputs, assumptions and scenarios
ISBN 978-1-76136-921-6 **(Print)**
ISBN 978-1-76136-922-3 **(pdf/online/MS word)**