PROJECT
MARINUS

INITIAL FEASIBILITY REPORT
Appendices

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Project Marinus economic modelling report

TasNetworks

13 November 2018

Building a better working world

NOTICE

Ernst & Young was engaged on the instructions of Tasmanian Networks Pty Ltd (“TasNetworks”) to provide market modelling (the “Services”) in relation to a proposed second Tasmanian interconnector (the "Project"), in accordance with the contract dated 14 June 2018.

The results of Ernst & Young’s work, including the assumptions and qualifications made in preparing the report, are set out in Ernst & Young's report dated 13 November 2018 ("Report"). The Report should be read in its entirety including the cover letter, the applicable scope of the work and any limitations. A reference to the Report includes any part of the Report. No further work has been undertaken by Ernst & Young since the date of the Report to update it.

Ernst & Young has prepared the Report for the benefit of TasNetworks and has considered only the interests of TasNetworks. Ernst & Young has not been engaged to act, and has not acted, as advisor to any other party. Accordingly, Ernst & Young makes no representations as to the appropriateness, accuracy or completeness of the Report for any other party's purposes.

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Ernst & Young
111 Eagle Street
Brisbane QLD 4000 Australia
GPO Box 7878 Brisbane QLD 4001

Tel: +61 7 3011 3333
Fax: +61 7 3011 3100
ey.com/au

Bess Clark
General Manager – Project Marinus
Tasmanian Networks Pty Ltd
1/7 Maria Street, Lenah Valley
Moonah Tasmania 7009

13 November 2018

Project Marinus economic modelling report

Dear Bess,

In accordance with our Engagement Agreement dated 14 June 2018 ("Agreement"), Ernst & Young ("we" or "EY") has been engaged by Tasmanian Networks Pty Ltd ("you", "TasNetworks" or the "Client") to provide market modelling (the "Services") in connection with Project Marinus, proposed second Tasmanian interconnector (the "Project").

The enclosed report (the "Report") sets out the outcomes of our work. You should read the Report in its entirety. A reference to the report includes any part of the Report.

Purpose of our Report and restrictions on its use

Please refer to a copy of the Agreement for the restrictions relating to the use of our Report. We understand that the deliverable by EY will be used for the purpose of assisting TasNetworks in its investigation into market benefits of the proposed second Tasmanian interconnector (the "Purpose").

This Report was prepared on the specific instructions of TasNetworks solely for the Purpose and should not be used or relied upon for any other purpose.

This Report and its contents may not be quoted, referred to or shown to any other parties except as provided in the Agreement. We accept no responsibility or liability to any person other than to TasNetworks or to such party to whom we have agreed in writing to accept a duty of care in respect of this Report, and accordingly if such other persons choose to rely upon any of the contents of this Report they do so at their own risk. Third parties seeking a copy of this Report will require permission from EY, and will be required to sign an access letter in the format agreed to between EY and TasNetworks.

Nature and scope of our work

The scope of our work, including the basis and limitations, are detailed in our Agreement and in this Report.

Our work commenced on 26 April 2018 and was completed on 13 November 2018. Therefore, our Report does not take account of events or circumstances arising after 13 November 2018 and we have no responsibility to update the Report for such events or circumstances.

This modelling considers a number of combinations of input assumptions relating to future conditions, which may not necessarily represent actual or most likely future conditions. Additionally, modelling inherently requires assumptions about future behaviours and market interactions, which may result in forecasts that deviate from future conditions. There will usually be differences between estimated and actual results, because events and circumstances frequently do not occur as expected, and those differences may be material. We take no responsibility for the achievement of projected outcomes, if any.

We highlight that our analysis and Report do not constitute investment advice or a recommendation to you on your future course of action. We provide no assurance that the scenario we have modelled will be accepted by any relevant authority or third party.

Our conclusions are based, in part, on the assumptions stated and on information provided by TasNetworks during the course of the engagement. The modelled outcomes are contingent on the collection of assumptions as agreed with the Client and no consideration of other market events, announcements or other changing circumstances are reflected in this Report. Neither Ernst & Young nor any member or employee thereof undertakes responsibility in any way whatsoever to any person in respect of errors in this Report arising from incorrect information provided by TasNetworks.

In the preparation of this Report we have considered and relied upon information from a range of sources believed after due enquiry to be reliable and accurate. We have no reason to believe that any information supplied to us, or obtained from public sources, was false or that any material information has been withheld from us.

We do not imply and it should not be construed that we have verified any of the information provided to us, or that our enquiries could have identified any matter that a more extensive examination might disclose. However, we have evaluated the information provided to us by TasNetworks as well as other parties through enquiry, analysis and review and nothing has come to our attention to indicate the information provided was materially mis-stated or would not afford reasonable grounds upon which to base our Report.

This letter should be read in conjunction with our Report, which is attached.

Thank you for the opportunity to work on this project for you. Should you wish to discuss any aspect of this Report, please do not hesitate to contact Ian Rose on 07 3227 1415 or Craig Mickle on 02 9248 5196.

Yours sincerely

Ian Rose
Associate Partner

Craig Mickle
Partner

Table of contents

1. Introduction

TasNetworks has engaged EY to evaluate the potential benefits of Marinus Link (referred to as Marinus), a second interconnector between Tasmania and Victoria. EY has undertaken market modelling to determine benefits of the second interconnector in a Base Case and across a range of sensitivities.

This report provides the outcomes of our analysis and will appear as an appendix to broader work prepared by TasNetworks.

This Report describes the key assumptions, input data sources and methodologies that have been applied in this modelling. This Report also summarises the outcomes of the modelling and provides the key insights from the cases modelled. In particular we highlight the most significant sources of market benefits and describe the drivers of both upsides and downsides for the second interconnector. This Report discusses only market benefits and costs consistent with the RIT-T methodology.[1] In each case these need to be compared with the second interconnector capital and operating costs to determine whether there is a positive net benefit in terms of lowering the relevant electricity market costs. This is outside of the scope of this Report.

Our modelling is closely based on the assumptions from AEMO's Integrated System Plan[2] published in June 2018. Some of the assumptions were amended based on discussion with TasNetworks and captured in the Base Case (as Section 2.6.1 describes) and a number of sensitivities modelled and described in this Report. Our modelling covers the period between 2020-21 and 2049-50. All prices in this Report refer to real 2017 dollars unless otherwise labelled. All annual values refer to the fiscal year (1 July–30 June) unless otherwise labelled. The net present values are discounted to 1 July 2025, unless otherwise stated.

The focus of the modelling has been to determine the market benefits of Marinus under the existing RIT-T[3] methodology.

The Report is structured as follows:

- Section 2 outlines the methodology and input assumptions used in the modelling
- Section 3 provides an overview of the modelling scenarios and outcomes
- Section 4 provides summary of the outcomes and key drivers

[1] The Regulatory Investment Test for Transmission is a cost benefit analysis used to assess the viability of investment options in electricity transmission assets.

[2] https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Integrated-System-Plan

[3] The Regulatory Investment Test for Transmission is a cost benefit analysis used to assess the viability of investment options in electricity transmission assets.

2. Methodology and input assumptions

2.1 Generation development planning

Dispatch in the NEM has become increasingly complex in recent times as a result of the large amount of intermittent generation and storage options. As such, equally complex and innovative methods are required to model capacity and generation developments across the NEM. We used a linear optimisation approach to perform an hourly time sequential least cost long term NEM development optimisation model spanning from 2020-21 to 2049-50.

Based on a set of input assumptions, the time sequential Integrated Resource Planner (TSIRP) makes decisions so as to minimise the overall cost NPV for the NEM over the entire study period, with respect to:

- Capital expenditure (Capex)
- Fixed operation and maintenance (FOM)
- Variable operation and maintenance (VOM)
- Fuel
- Unserved Energy (USE)

For the capex cost component of the NPV calculation, the model only considers new entrant capacity that is installed as a result of a 'decision' of the model itself. Because of this, the total NPV does not include the capex cost associated with projects or capacity that are assumed to be committed as an input into the model. Specifically, this means that the capital expenditure for Marinus and any additional Tasmanian wind or pumped-hydro storage capacity that is specifically an assumption in the scenario is not included in the NPV benefit presented in this Report. To assess the overall net market worth of Marinus, the capex and opex cost for Marinus would need to be considered, as is done in the broader work prepared by TasNetworks.

To determine the least cost NPV solution, the model makes decisions for each hourly[4] Trading Interval (TI) in regards to:

- The generation for each power plant along with the charging and discharging of storage. Stations are assumed to bid at their short run marginal cost (SRMC), which is primarily related to their VOM and fuel cost. The generation for each TI is subject to the availability of power stations in each hour (those that are not on planned or un-planned outages), network limitations and energy limits.
- Commissioning new entrant capacity[5] for wind, solar PV SAT, CCGT, OCGT, large-scale (LS) storage and PSH.
- Retiring capacity from a selection of allowable existing generators so as to reduce the FOM cost component of the total NPV[6].

These hourly decisions take into account constraints that include:

- Supply must equal demand in each region for all TIs, with a violation penalty applied to USE
- Minimum load for generators
- Interconnector flow limits

[4] The model resolution is hourly, so market modelling adopts an hourly trading interval

[5] PV = photovoltaics, SAT = Single Axis Tracking, CCGT = Closed-Cycle Gas Turbine, OCGT = Open-Cycle Gas Turbine

[6] In the event of a binding emissions constraint, high emissions plant are dispatched less in order to meet the emissions target. Capacity may then be retired if it is uneconomic to keep incurring FOM costs for capacity that is not running.

- Maximum and minimum storage (conventional hydro, pumped storage hydro and battery storage) reservoir limits
- New entrant capacity limits for each technology for each region where applicable
- Emission constraints where applicable
- Renewable energy target where applicable.

The model does not include intra-regional constraints as they are generally assumed to be built out via transmission upgrades. Where additional upgrades are necessary due to the presence of Marinus they have been added to the interconnector cost side.

The model incorporates all inputs including assumed fixed retirement dates for existing generation, if not economically retired earlier. The model bids all generation at its incremental or SRMC for fossil plant and the cost of VOM for renewable plant including hydro. The model determines, at the chosen discount rate, the lowest cost of meeting supply over a thirty year period between mid-2020 and mid-2050 including the fuel, VOM and FOM for all generation.

It also factors in the annual costs, including capital costs for all new generation and the model decides how much new generation to build in each region to deliver the least cost market outcome. The model retires generation that is uneconomic to run and replaces it with new generation if the combined capital, fuel, and O&M cost of new generation anywhere in the NEM is lower than the fuel and O&M of existing generation anywhere else in the NEM.

The model builds sufficient capacity to provide reliable supply on an economic basis with unserved energy costed at the value of the customer reliability (VCR)[7]. Intermittent renewable plant is operated according to an hourly production profile. The optimum amount of generation to meet the cost of USE is dynamically calculated, rather than being based on a fixed reserve margin above peak demand, but given the relatively high VCR, it is observed that the reliability target in the NEM is generally easily achieved. The VCR could be lowered, for example to the Market Price Cap (MPC), but that would result in reduced levels of new peaking capacity, and possible breaching of the reliability standard in the NEM[8].

The model implicitly factors in the need to meet the specified emissions trajectory at least cost, which may be either or both building new lower emissions plant or reducing operation of higher emissions plant.

There are three main types of generation that are scheduled under this type of modelling:[9]

- Firstly, the dispatchable generation, typically coal and gas which has unlimited energy in general, and is bid according to its SRMC, although the minimum loads of thermal generators are bid at a negative price to ensure they are always online when available.

- Then the semi-scheduled and non-scheduled wind and solar plant are fully dispatched according to their available resource, unless constrained by oversupply, when they may be curtailed or spilt.

- Thirdly, storage plant of all types (conventional hydro generators with storages, PSH and battery storages) are operated so as to minimise the overall system costs. This means they tend to generate at times when the demand for power is high and fossil plant is dispatched above their minima, and so dispatching energy limited generation will lower system costs. Conversely, at times when there is either a surplus of capacity or the price of power is very low, storage hydro withdraws capacity and PSH and battery storage operate in charging mode. The model

[7] VCR is modelled as $33,460/MWh

[8] The reliability standard is not to exceed 0.002 % in any region in any year.

[9] EY's model is referred to as TSIRP or Time Sequential Integrated Resource Planning

identifies the price at which hydro storages, PSH and battery storage become economic to dispatch, known as the 'water value'. The water value varies over time. The model also identifies the price below which PSH and batteries become economic to charge.

2.2 Treatment of hydroelectric generators

Hydro power stations are the main electricity generators in Tasmania. The operational profile of Hydro Tasmania's hydro generators is a key driver of the utilisation of Basslink and the second interconnector. Hydro Tasmania operates 30 hydro power stations with combined capacity of 2.3 GW[10]. Long-term storages on several of the schemes enable Hydro Tasmania to store inflows and choose when to use the water. They aim to use their limited water resource in the most profitable way, generating when Tasmanian demand is high or when Victorian wholesale prices are high and they can export power across the interconnector.

In reality, most of Hydro Tasmania's generators are part of connected systems of multiple generators and variously-sized storages along various Tasmanian river systems. We used a simplified six pond model of the schemes where all generators within schemes are aggregated, as summarised in Table 1.

Table 1: Details of the six pond model

Scheme	Type of scheme / storage	Total generating capacity (MW)	Total max energy in storage (GWh)	Average annual inflows (GWh)
Gordon	Long-term	354-432[11]	4,699	1,205
King	Long-term	140	234	588
South Esk	Long-term	445	7,362	1,674
Anthony Pieman	Short-term	482	NA	1,857
Derwent	Short-term	469	NA	2,257
Mersey Forth	Short-term	290	NA	1,250

The three schemes with short-term storages have limited ability to store water and consequently generation profiles are primarily driven by inflows. These schemes are operated based on daily energy inflows derived from historical generation[12]. Historical generation on a 30 minute basis was converted into daily energy available for the scheme to be dispatched within 24 hours. Such an approach provides short-term flexibility (within a day) and ability of the schemes to respond to price signals. The modelling reflects TasNetworks and Hydro Tasmania expert advice that all run of river schemes in Tasmania possess energy storage capability for up to 24 hours.

The generation profile is determined by the model, which maximises the value of energy available for a day. The daily total generation achieved by the short-term storage schemes matches daily historical generation. The daily profile was permitted to vary from history as it is expected that the daily operational profile of all generation, including run of river hydro, will vary in the future as load and generation patterns change, particularly as wind generation capacity grows, and with further interconnections, including Marinus.

[10] https://www.hydro.com.au/clean-energy/our-power-stations

[11] The nameplate capacity of Gordon Power Station is 432 MW, however maximum output is dependent on the reservoir level.

[12] Historical generation data was used as proxy for inflows to the schemes. Generation data excluded any energy that was spilled.

For the long-term storage schemes, the operational profiles were again determined by the model. TSIRP plans water use over the study period (i.e. 30 years) given scheme reservoir levels at the start of the period, inflows over the period and specified target reservoir levels by time of year to match long term climatic rainfall patterns. It computes a utilisation plan that uses the water in the optimal way by generating in the highest priced trading intervals such that shifting a megawatt hour (MWh) of generation from one TI to another within the optimisation window would increase the cumulative price across all trading intervals in the window by replacing the marginal (most expensive) NEM generation in that interval. Table 2 presents reservoir limits applied in the modelling of the large scale storages.

Table 2: Storage minimum levels

Scheme	Absolute minimum level	Energy security minimum limit, 1 July	Energy security minimum limit, 1 November
Gordon	15 %	30 %	40 %
King	16 %	30 %	40 %
South Esk	20 %	30 %	40 %

The inflow data used in the modelling of long-term storages was provided by Hydro Tasmania and represents historical monthly energy inflows[13] to the storages. The energy inflows were provided with historical energy spilled excluded.

In the modelling, a sequence of seven historical hydrological years was used. In the case of short-term storages, historical half hourly generation was used to determine daily energy availability[14]. In the case of long-term storages, historical monthly reservoir inflows, provided by Hydro Tasmania, were used. The generation and inflow data covers the period between 1 July 2010 and 30 June 2017, i.e. seven financial years from 2010-11 to 2016-17. These seven years are repeated in the modelling as presented in Figure 1.

Figure 1: Sequence of hydrological years applied to forecast

	Financial year	Hydrological year
	2010-11	2010-11
	2011-12	2011-12
	2012-13	2012-13
historical years	2013-14	2013-14
	2014-15	2014-15
	2015-16	2015-16
	2016-17	2016-17
	2017-18	2010-11
	2018-19	2011-12
	2019-20	2012-13
	2020-21	2013-14
	2021-22	2014-15
	2022-23	2015-16
	2023-24	2016-17
modelling years	…	…
	2045-46	2010-11
	2046-47	2011-12
	2047-48	2012-13
	2048-49	2013-14
	2049-50	2014-15

13 Historical spill is removed from the historical inflows. The model does not allow for hydro power stations spill. If there is excess of supply of renewable energy, wind energy will be curtailed first as it has higher cost (VOM) than solar.

14 Small non-scheduled generators were not modelled explicitly, as their generation is netted off from the demand.

The sequence of seven hydrological years captures a range of conditions observed between 2010-11 and 2016-17 including wet, average and dry years, ranging in total inflows between 7.5 and 10.5 TWh. Figure 2 presents historical inflows to hydro schemes in Tasmania in the last twenty years, indicating averages over the last twenty and last seven years, which are in line with the long term expectations for the inflows. Figure 3 presents assumed inflows to the six ponds over the study period.

Figure 2: Historical energy inflows to hydro schemes in Tasmania

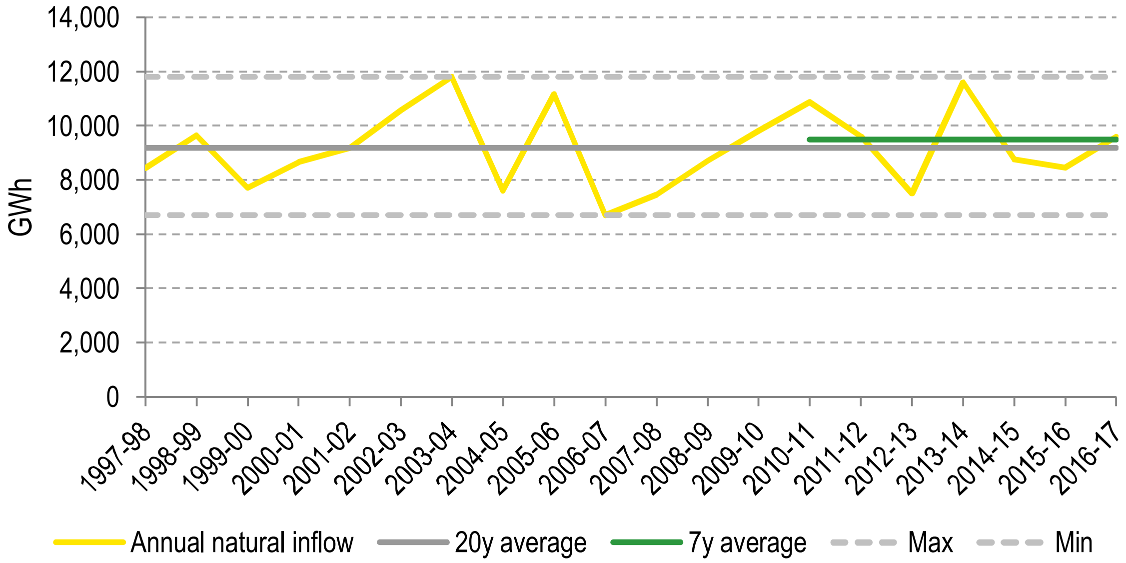
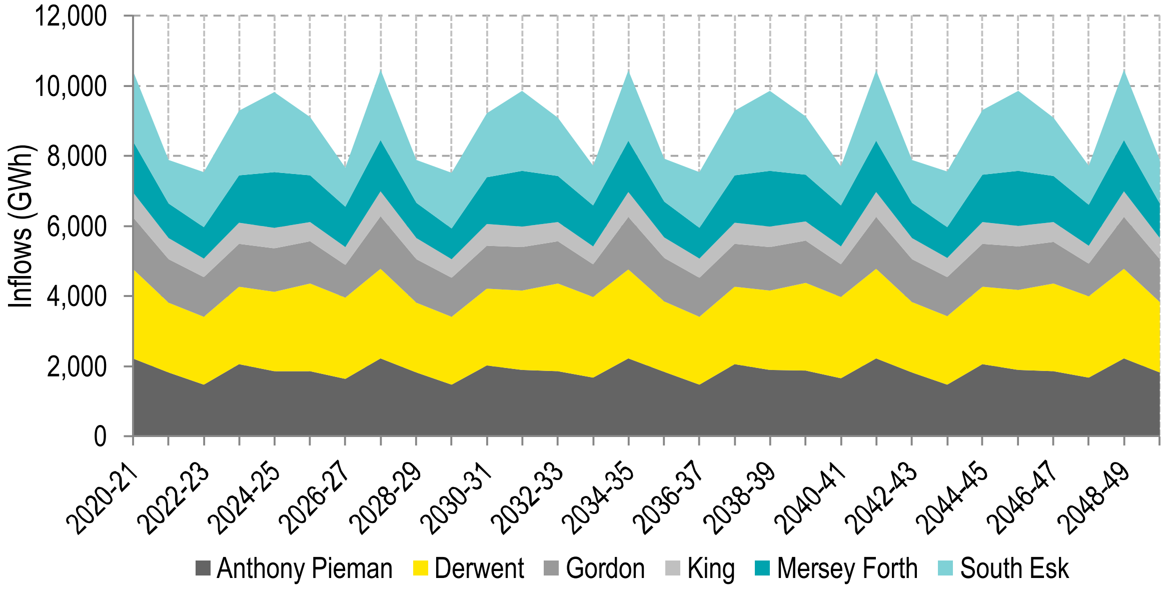


Figure 3: Forecast inflow sequence for Hydro Tasmania catchments



2.3 Wind and solar energy projections

We model all existing and committed large scale wind and solar farms in the NEM on an individual basis i.e. each farm has a location specific availability trace based on historical resource availability. The availability traces are derived using seven years of historical weather data covering financial years between 2010-11 and 2016-17 (inclusive), consistent with the hydro inflow data discussed in Section 2.2. Wind and solar availability traces used in the modelling reflect generation patterns occurring in the seven historical years, and these generation patterns are repeated in the study period as shown in Figure 1.

The availability traces for wind are derived using the methodology of EY's electricity market modelling team, which uses simulated wind speeds and directions from the Australian Bureau of Meteorology's Numerical Weather Prediction systems[15] at a representative hub height. In the next step wind speeds are converted into power using a generic wind farm power curve. The traces are scaled to achieve average target capacity factor across the seven historical years. It means that the traces reflect interannual variations, but at the same time achieve expected long term capacity factors, as presented in Table 3.

In Table 3 values in the middle column represent average capacity factor for existing wind farms in each region based on EY's analysis of actual performance in the seven financial years from 2010-11 to 2016-17. Values in the third column represent target capacity factor for new wind capacity in each region over a seven year period (capacity factors vary between the years, but average to the target value over a seven year period, as presented in Table 3). EY expects that capacity factors for new entrants will be higher as a result of improvements in the technology, particularly through the use of higher hub heights and longer blades. This values were agreed between EY and TasNetworks.

Table 3: Wind target average capacity factors

Scheme	Target capacity factor, average for existing wind farms	Target capacity factor, generic new entrants
QLD	33 %	33 %
NSW	34 %	36 %
VIC	34 %	36 %
SA	34 %	38 %
TAS	36 %	40 %

The availability traces for solar are derived using solar irradiation data derived from satellite imagery processed by the Australian Bureau of Meteorology.

2.4 Overview of interconnector modelling

Marinus was modelled as a regulated interconnector. It is effectively bid at $0/MWh in all trading intervals. This brings wholesale prices in the two interconnected regions, Tasmania and Victoria, together to the extent that is it possible. Unless the interconnector is constrained, the wholesale price in the exporting region is equal to the wholesale price in the importing region, adjusted for losses. The presence of additional interconnection can alter the generation development outlook in multiple regions.

2.5 Interconnector assumptions

Losses on interconnectors between Tasmania and Victoria are treated in three components:

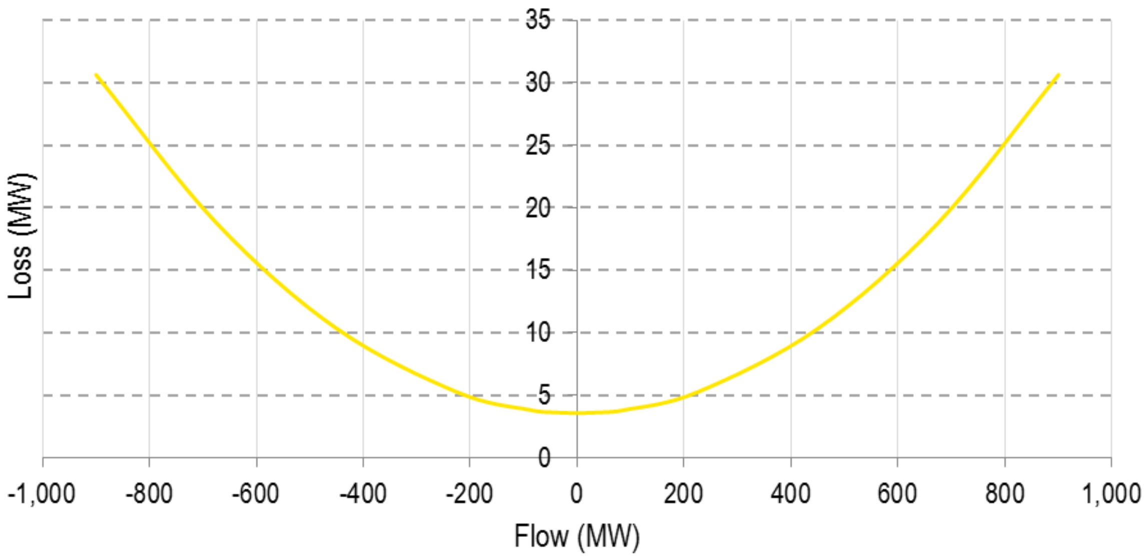
- Losses between the Tasmanian connection point and the Tasmanian Regional Reference Node (RRN) are captured by the connection point Marginal Loss Factor (MLF).
- Losses between the Victorian connection point and the Victorian RRN are captured by the Victorian connection point MLF.
- Losses on the cable and at converter stations are calculated dynamically in each dispatch interval using a loss equation. The loss is apportioned to the two regions using a proportioning factor.

[15] As described by Australian Government Bureau of Meteorology, *ACCESS NSP Data* Information. Available at: http://www.bom.gov.au/nwp/doc/access/NWPData.shtml. Accessed 8 November 2018.

The main assumptions for the Marinus interconnector in the 600 MW cases are summarized below:

- Dynamic losses are proportioned equally between Tasmania and Victoria as assumed for Basslink in the AEMO ISP 2018. Conceptually this means the ‘border’ between the regions is midway along the cable.
- There is a bi-directional flow limit of 600 MW, measured at the midpoint, as requested by TasNetworks. This limit differs from the ISP 2018 MarinusLink assumption of 700 MW (MarinusLink was only incorporated in the Neutral with storage scenario, from 2033).
- There is an MLF for the Tasmanian end of 1.0000 consistent with the ends of the cable being located electrically close to the reference node. In reality this may be lower or higher depending on how Marinus connects to the Tasmanian transmission network.
- There is an MLF for the Victorian end of 1.0000 consistent with the ends of the cable being located electrically close to the reference node. In reality this may be lower or higher depending on how Marinus connects the Victorian transmission network.
- Dynamic loss along the cable is described by the loss equation shown in Figure 4 provided by TasNetworks. This is determined by the type of conductor, voltage of the cable and length of the cable. On the advice of TasNetworks we applied values for a 1,100 mm^2 cable, ±320 kV symmetrical monopole with 320 km overall length. The equation also incorporates converter station losses.

Figure 4: Dynamic loss equation for Marinus



For the sensitivities that assume a 1,200 MW capacity for Marinus we have modelled two 600 MW capacity interconnectors in parallel using the same assumptions described above. This gives a total of 1,200 MW of additional interconnector capacity relative to the Basslink only counterfactual.

The existing Basslink cable was modelled using the same assumptions as the AEMO ISP 2018 including proportioning losses equally between Tasmania and Victoria. Losses are modelled using the loss equation in the AEMO report *Region and Marginal Loss Factors: FY 2018-19*[16].

Basslink and Marinus are modelled so as to share flows to minimise aggregate losses between Tasmania and Victoria, subject to flow limits on each interconnector.

[16] AEMO, 13 July 2018.

2.6 Input assumptions

2.6.1 Base Case

Key input assumptions in the Base Case are listed in Table 4. In general, assumptions are aligned with the AEMO ISP 2018 Neutral scenario. The values underlying all ISP assumptions are published online by AEMO[17]. Departures from these assumptions are itemised and justified in the table. Assumptions differ where new information has come to hand from more recent investigations such as Hydro Tasmania's Battery of the Nation[18] report and performance parameters from wind developers.

Table 4: Overview of key assumptions for the Base Case

Assumption	Base Case	ISP 2018 Neutral scenario
Assumptions affecting demand / energy consumption		
Load – energy and peak demand	Values aligned	
Rooftop PV	Values aligned	
Domestic energy storage	Values aligned	
Electric vehicles (EVs)	Values aligned	
Assumptions regarding market policies		
Large-scale Renewable Energy Target (LRET) and additional schemes	LRET build schedules aligned. Renewable development plan matched AEMO's committed projects list as at 20 April 2018. We understand this list meets an assumed LRET of 33,000 GWh by 2020, and constant until scheme end in 2030, with additional voluntary surrenders capturing demand created by GreenPower scheme, ACT auctions and relevant desalination load. Incorporated in this is the VRET 2020 target of 650 MW and the Queensland 400 MW reverse auction.	
	VRET 2025 target not included[19]	VRET 2025 target of 40 % renewable energy by 2025 included
	QRET 2030 target not included[20]	QRET 2030 target of 50 % renewable energy by 2030 included.
Emissions reduction policy	Values aligned. The electricity sector has been modelled to achieve at least a 28 % reduction in emissions compared to 2005 levels by 2030. Post 2030, a linear reduction of emissions to 70 % reduction compared to 2016 levels by 2050.	
Assumptions affecting market supply		
Thermal retirements	Aligned – announced and end of technical life.	
Tamar Valley CCGT	Tamar Valley CCGT is in a standby state and is not permitted to	No special treatment of Tamar Valley CCGT

[17] *Integrated System Plan Database: 2018 ISP Assumptions workbook* [Microsoft Excel file], Available at: https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Integrated-System-Plan/ISP-database.

[18] April 2018. *Battery of the Nation: Analysis of the future National Electricity Market*. Available at: https://www.hydro.com.au/clean-energy/battery-of-the-nation. Accessed 8 November 2018.

[19] Included in VRET QRET sensitivity

[20] Included in VRET QRET sensitivity

<table>
<tr><th>Assumption</th><th>Base Case</th><th>ISP 2018 Neutral scenario</th></tr>
<tr><td></td><td>operate in the Base Case or sensitivities in EY's model.[21]</td><td></td></tr>
<tr><td>Thermal energy limits</td><td>Energy limit on coal-fired power stations equal to maximum of annual energy from five years 2013-14 to 2017-18 to reflect limitations on annual coal deliveries.</td><td>Limit Liddell to a 50 % capacity factor.</td></tr>
<tr><td>Committed projects in Tasmania</td><td>1,050 MW wind capacity prior to the commissioning of Marinus (existing Musselroe + existing Woolnorth + committed Granville Harbour + committed Wild Cattle Hill + 500 MW).
Reflects actual connection applications being actively progressed which are not conditional upon a second interconnector.
(Additional capacity installed if economic.)</td><td>308 MW wind capacity at start of study: existing Musselroe + existing Woolnorth
(Additional capacity installed if economic.)</td></tr>
<tr><td>Committed projects in other NEM regions</td><td colspan="2">All ISP committed and advanced projects are assumed to be commissioned (despite absence of VRET 2025 and QRET 2030)</td></tr>
<tr><td>New pumped storage hydro (PSH) capex and capacity, Tasmania</td><td>New Tasmanian PSH allowed as option with parameters:
- 1,000 MW limit based on a review of announced projects in the NEM
- Capex of $1,100/kW constant. Chosen by TasNetworks based on Hydro Tasmania's Battery of the Nation report[22]
- Storage capacity 24 hours to align with ISP Battery of the Nation assumption.
PSH only installed if economic.</td><td>In Neutral scenario: Unlimited total allowed as option with parameters:
- Capex in 2017-18 of $1,488/kW
- Storage capacity 6 hours.
PSH only installed if economic.
In Neutral with storage scenario which models additional PSH in Tasmania in the form of the Battery of the Nation: 1,500 MW PSH committed in 2033 with storage capacity of 24 hours.</td></tr>
<tr><td rowspan="2">New PSH capex and capacity, other NEM regions</td><td colspan="2">Allowed as option with parameters:
- Capex values aligned
- Storage capacity 6 hours.
PSH only installed if economic.</td></tr>
<tr><td>Upper limit of 1,000 MW in each region installed if economic. Based on a review of announced projects</td><td>Unlimited</td></tr>
</table>

[21] Tamar Valley CCGT and OCGT are modelled as available only in the event of a Basslink failure, consistent with the Tasmanian Energy Security Taskforce, June 2017, *Final Report*. Available at: https://www.stategrowth.tas.gov.au/__data/assets/pdf_file/0004/151159/Tasmanian_Energy_Security_Taskforce_-_Final_Report.PDF; Accessed 8 November 2018. Basslink failure is not modelled these studies.

[22] April 2018. *Battery of the Nation: Analysis of the future National Electricity Market*. Available at: https://www.hydro.com.au/clean-energy/battery-of-the-nation. Accessed 8 November 2018. This report uses pumped hydro capital costs ranging from $1,050/kW to $1,500/kW.

Assumption	Base Case	ISP 2018 Neutral scenario
	in the NEM. In relevant sensitivities, the NSW limit excludes Snowy 2.0.	
New pumped hydro VOM and FOM, all regions	VOM = $0.15/MWh FOM = $28/kW/year Values reflect Battery of the Nation project data[23].	VOM = $5/MWh FOM = $5/kW/year
New entrant wind VOM, FOM, lifetime	VOM = $6/MWh FOM = $25/kW/year Lifetime = 25 years Reflects other recent data sets and industry consensus for existing wind farms.	VOM = $15.73/MWh FOM = $47.2/kW/year Lifetime = 20 years
Cyclic efficiency for storage technologies (PSH and large-scale battery)	80 %	
New entrant large-scale battery	FOM = $10/kW/year	FOM = $0/kW/year
	Other values aligned	
New entrant parameters including technology capex, operating costs for technologies other than wind, pumped hydro and batteries	Values aligned	
Fuel prices	Values aligned	
WACC	Values aligned Pre–tax, real WACC of 6 %	
Transmission development assumptions		
Vic-NSW interconnector upgrade	870 MW forward limit and 400 MW reverse limit from 2019-20 (ISP option 1)	Outcome in Base development plan
QNI interconnector upgrade	770 MW forward limit and 1,215 MW reverse limit from 2019-20 to 2021-22 (ISP option 3) 770 MW forward limit and 1,593 MW reverse limit from 2022-23 (ISP option 5)	Outcome in Base development plan
NSW to SA interconnector	750 MW forward and reverse limit from 2024-25 (ISP Riverlink)	Outcome in Base development plan
VIC-SA Heywood upgrade	750 MW forward and reverse limit from 2024-25	Outcome in Base development plan

2.6.2 Sensitivities

An overview of the sensitivities selected by the Client are summarised in Table 5.

[23] Hydro Tasmania, April 2018, *Battery of the Nation: Analysis of the future National Electricity Market*. Available at: https://www.hydro.com.au/docs/default-source/clean-energy/battery-of-the-nation/future-state-nem-analysis-full-report.pdf

Table 5: Summary of input assumption differences for sensitivities

Group	Sensitivity	Variation from Base Case
600 MW Marinus Link	EC90	52 % reduction of emissions from 2005 levels by 2030. Post 2030 - linear reduction of emissions to 90 % reduction by 2050.
	Snowy 2.0	Snowy 2.0 commissioned 1/07/2025. AEMO ISP Vic-NSW Option 7A (2,800 MW forward limit and 2,200 MW reverse limits from 1/07/2034). Snowy 2.0 capacity not included in the 1 GW per region limit on economic PSH installations.
	Snowy 2.0 EC90	Snowy 2.0 commissioned 1/07/2025. AEMO ISP Vic-NSW Option 7A (2,800 MW forward limit and 2,200 MW reverse limits from 1/07/2027[24]). Snowy 2.0 capacity not included in the 1 GW per region limit on economic PSH installations. 52 % reduction of emissions from 2005 levels by 2030. Post 2030 - linear reduction of emissions to 90 % reduction by 2050.
	Tas100LoadLoss	100 MW load reduction in Tasmania from the beginning of the study. This is a test case to provide an indication of what could occur if a significant industrial load was to retire or reduce its demand. It does not correspond to a particular industry.
	Tas300LoadLoss	300 MW load reduction in Tasmania from the beginning of the study. This is a test case to provide an indication of what could occur if a more significant industrial load was to retire or reduce its demand. It could be comprised of several smaller load reductions and does not correspond to a particular industry.
	HighGas	AEMO ISP Strong gas price scenario
	BL400	Basslink ±400 MW forward and reverse limit from the beginning of the study. This sensitivity is to investigate the possibility of a de-rating of Basslink's maximum power transfer from to 400 MW, which could be applied following a further cable fault.
	VRET QRET	VRET 2025 target of 40 % of Victorian demand from renewable sources by 2025. QRET 2030 target of 50 % of Queensland demand from renewable sources by 2030.
	AETV	Aurora Energy Tamar Valley OCGT and CCGT are not forced to retire in 2025-26. For the with-Marinus case, Tamar Valley OCGT and CCGT are allowed to retire at any time in the study. For the without-Marinus case, Tamar Valley OCGT and CCGT are required to remain available throughout the entire study reflecting current policy to maintain these assets in a standby state for Tasmanian energy supply security purposes.
	Defer 2028	Marinus Link commissioned on 1/07/2028
	Defer 2032	Marinus Link commissioned on 1/07/2032
	Tas600Wind	Additional 600 MW initial wind capacity in Tasmania (1,650 MW

[24] Vic-NSW interconnector upgrade is commissioned earlier in sensitivities with the higher emission reduction target relative to the Snowy 2.0 sensitivity with the base emissions reduction target. The AEMO ISP 2018 notes the following regarding the timing of the Vic-NSW interconnector upgrade: "The timing… will ultimately be influenced by factors including actual timing of coal-fired generation retirements, renewable energy zone developments and capacities, demand changes, and the development of the Snowy 2.0 scheme". As this sensitivity had earlier coal retirements and Snowy 2.0, an earlier upgrade was assumed.

Group	Sensitivity	Variation from Base Case
		Tasmanian wind capacity at time of Marinus commissioning).
	Tas600PSH	600 MW PSH in Tasmania by 1/07/2025 This amount not included in 1 GW per region limit on economic PSH installations.
	Tas600Wind Tas600PSH	Combined additional 600 MW wind capacity in Tasmania and 600 MW PSH in Tasmania by 1/07/2025.
1,200 MW Marinus Link	Marinus1200	Marinus Link commissioned on 1/07/2025 with forward capability of 1,200 MW and reverse capability of 1,200 MW.
	Marinus1200 Staggered	Marinus Link Stage 1 commissioned on 1/07/2025 with forward capability of 600 MW and reverse capability of 600 MW. Marinus Link Stage 2 commissioned on 1/07/2028 with forward capability of 600 MW and reverse capability of 600 MW.
	Marinus1200 EC90	Marinus Link commissioned on 1/07/2025 with forward capability of 1,200 MW and reverse capability of 1,200 MW. 52 % reduction of emissions from 2005 levels by 2030. Post 2030 - linear reduction of emissions to 90 % reduction by 2050
	Marinus1200 Staggered EC90	Marinus Link Stage 1 commissioned on 1/07/2025 with forward capability of 600 MW and reverse capability of 600 MW. Marinus Link Stage 2 commissioned on 1/07/2027 with forward capability of 600 MW and reverse capability of 600 MW. 52 % reduction of emissions from 2005 levels by 2030. Post 2030 - linear reduction of emissions to 90 % reduction by 2050
	Marinus1200 Snowy 2.0 EC90	Marinus Link commissioned on 1/07/2025 with forward capability of 1,200 MW and reverse capability of 1,200 MW. Snowy 2.0 commissioned 1/07/2025. AEMO ISP Vic-NSW Option 7A (2,800 MW forward limit and 2,200 MW reverse limits from 1/07/2027[25]). Snowy 2.0 capacity not included in the 1 GW per region limit on economic PSH installations. 52 % reduction of emissions from 2005 levels by 2030. Post 2030 - linear reduction of emissions to 90 % reduction by 2050.
	Marinus1200 Snowy 2.0 Vic-NSW 2034 EC90	Marinus Link commissioned on 1/07/2025 with forward capability of 1,200 MW and reverse capability of 1,200 MW. Snowy 2.0 commissioned 1/07/2025. AEMO ISP Vic-NSW Option 7A (2,800 MW forward limit and 2,200 MW reverse limits from 1/07/2034). Snowy 2.0 capacity not included in the 1 GW per region limit on economic PSH installations. 52 % reduction of emissions from 2005 levels by 2030. Post 2030 - linear reduction of emissions to 90 % reduction by 2050.
	Marinus1200 Staggered Snowy 2.0 Vic-NSW 2034 EC90	Marinus Link Stage 1 commissioned on 1/07/2025 with forward capability of 600 MW and reverse capability of 600 MW. Marinus Link Stage 2 commissioned on 1/07/2027 with forward capability of 600 MW and reverse capability of 600 MW. Snowy 2.0 commissioned 1/07/2025. AEMO ISP Vic-NSW Option 7A (2,800 MW forward limit and 2,200 MW reverse limits from 1/07/2034).

[25] Vic-NSW interconnector upgrade is commissioned earlier in sensitivities with the higher emission reduction target relative to the Snowy 2.0 sensitivity with the base emissions reduction target. The AEMO ISP 2018 notes the following regarding the timing of the Vic-NSW interconnector upgrade: “The timing… will ultimately be influenced by factors including actual timing of coal-fired generation retirements, renewable energy zone developments and capacities, demand changes, and the development of the Snowy 2.0 scheme”. As this sensitivity had earlier coal retirements and Snowy 2.0, an earlier upgrade was assumed.

Group	Sensitivity	Variation from Base Case
		Snowy 2.0 capacity not included in the 1 GW per region limit on economic PSH installations. 52 % reduction of emissions from 2005 levels by 2030. Post 2030 - linear reduction of emissions to 90 % reduction by 2050.
	Marinus1200 Tas600Wind	Marinus Link commissioned on 1/07/2025 with forward capability of 1,200 MW and reverse capability of 1,200 MW. Additional 600 MW initial wind capacity in Tasmania (1,650 MW Tasmanian wind capacity).
	Marinus1200 Tas600Wind Tas600PSH	Marinus Link commissioned on 1/07/2025 with forward capability of 1,200 MW and reverse capability of 1,200 MW. Additional 600 MW initial wind capacity in Tasmania (1,650 MW Tasmanian wind capacity). 600 MW PSH in Tasmania by 1/07/2025.
	Marinus1200 Tas600Wind EC90	Marinus Link commissioned on 1/07/2025 with forward capability of 1,200 MW and reverse capability of 1,200 MW. Additional 600 MW initial wind capacity in Tasmania (1,650 MW Tasmanian wind capacity). 52 % reduction of emissions from 2005 levels by 2030. Post 2030 - linear reduction of emissions to 90 % reduction by 2050

2.7 Cost-benefit analysis

From the hourly time-sequential modelling we computed the following costs:

- Capital costs of new generation capacity installed
- Total fixed O&M costs of all generation capacity
- Total variable costs (fuel costs + variable O&M costs) including cost of USE valued at VCR[26].

For each case with Marinus and in a matched Basslink-only counterfactual we compute the difference between the sum of these components. The reductions in costs are the total market benefits due to Marinus. All other assumptions in the Marinus case and matched counterfactual remain identical.

The market benefits also capture the impact on transmission losses to the extent that losses across interconnectors affect the generation that is needed to be dispatched in each trading interval. The market benefits also capture the impact of differences in losses in storages, including PSH and battery storage between the Marinus and Basslink-only counterfactual.

Each component of market benefits is computed annually for each year of the 30 year study period. In this Report, we summarise the benefit and cost streams using a single value computed as the NPV of each stream, discounted to the commissioning year of Marinus at a 6 % real pre-tax discount rate.

The market benefits of Marinus computed in each scenario need to be compared to the second interconnector costs to determine whether there is a positive net benefit. If values of other benefits which cannot be captured by the TSIRP model can be computed, such as ancillary services cost reduction, these should also be added.

Marinus is assumed to be commissioned on 1 July 2025 for the Base Case. Because of this, all NPV benefits presented in this Report are discounted to this date of 1 July 2025.

[26] USE – unserved energy, VCR – Value of Customer Reliability. VCR is modelled as $33,460/MWh.

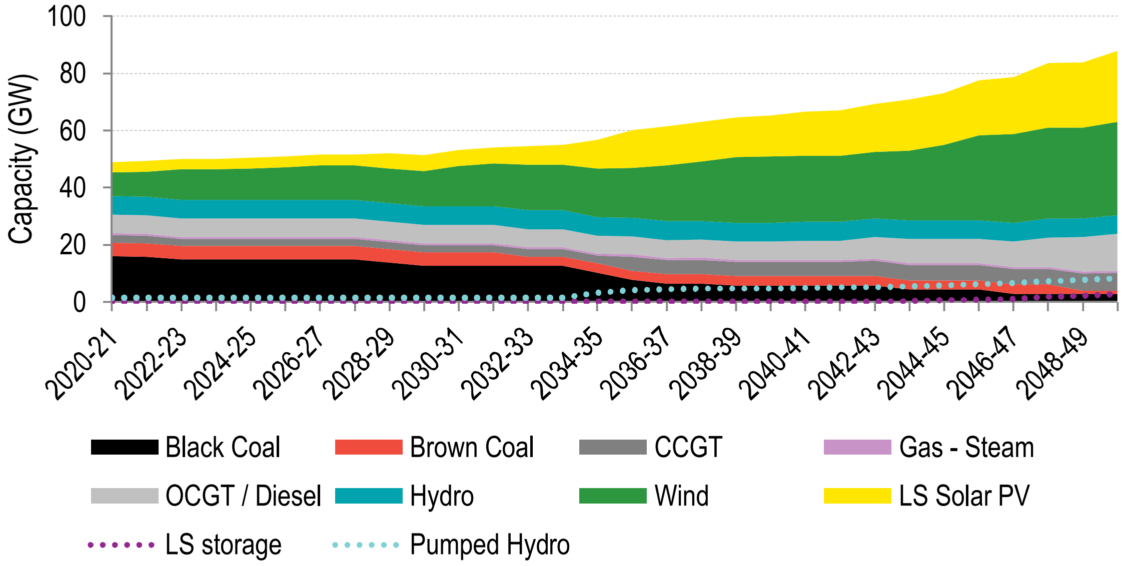
3. Outcomes

3.1 Base Case

3.1.1 Generation development without Marinus

The NEM-wide capacity mix without Marinus is shown in Figure 5. Without Marinus, the forecast generation capacity of the NEM gradually shifts away from a predominantly black and brown coal and hydro grid, with wind and solar developed to meet the LRET, towards increasing capacity of wind, solar, gas generation and storage, both PSH and battery storage.

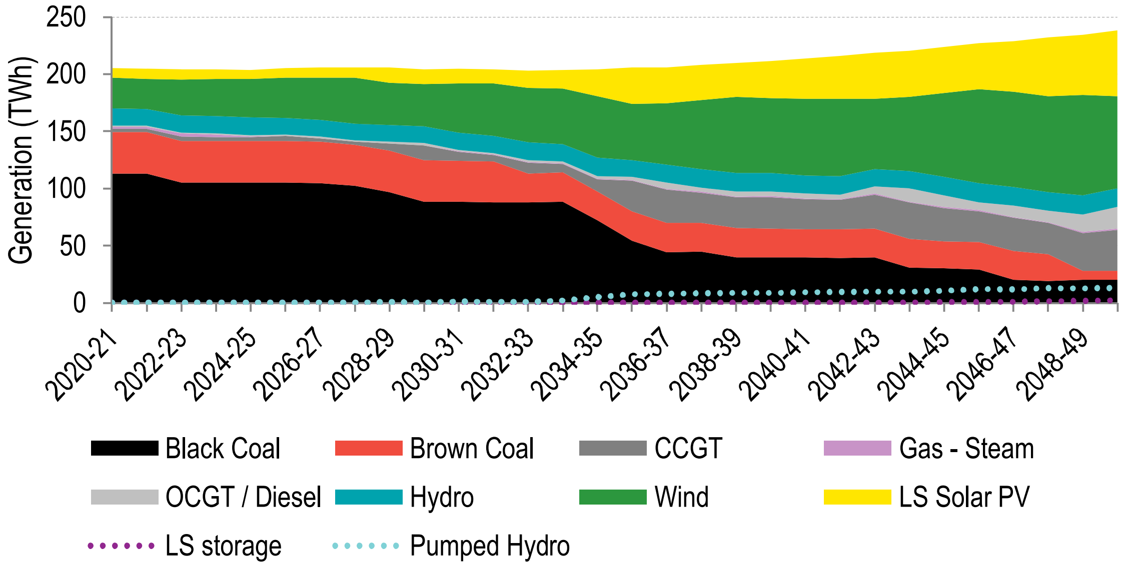
Figure 5: NEM capacity mix[27] forecast for Base Case without Marinus



The energy supplied to the grid, as shown in Figure 6, is forecast by AEMO to grow relatively slowly. The concurrent growth in installed capacity shown in Figure 5 is much faster, due to the relatively lower annual capacity factor available from wind and solar generation compared with the coal fired generation that is retiring. However, the total cost of developing solar and wind resources is trending below that of gas plant, so the mix of generation favours solar, wind and storage over OCGT and CCGT gas plant, except as needed to meet the need for dispatchable peaking generation when solar and wind are not available. The balance of OCGT and CCGT capacity is influenced by the imposition of a 50 % minimum load on CCGTs and no minimum load requirement on OCGTs. Overall the capacity mix in the NEM will be based on providing sufficient dispatchable generation, mainly gas and storage, to balance the increasing volume of intermittent renewables entering the market.

[27] LS Solar PV: large-scale solar excludes rooftop solar PV. The annual generation of rooftop PV is assumed to be constant for both cases. Because of this, it has been excluded from the capacity and generation figures.

Figure 6: NEM generation mix forecast for Base Case without Marinus



Without Marinus, the forecast overall energy production in the NEM, as shown in Figure 6, is an outcome of several factors including:

- Grid energy growth;
- Retirements of major coal and gas generators due to age, with no early coal retirements forecast to be driven by emissions constraint;
- The steeply declining cost of renewable generation relative to the stable costs of fossil generation;
- The emissions path expected to be followed by the electricity sector, by 2030 to meet the Paris Accord, and by 2050 to reduce emissions by 70 %.

The technology mix changes dramatically in the Base Case over the study period. Primarily, it is forecast that:

- From 2020, when the LRET targets are met or exceeded due to the committed generation listed in the AEMO ISP[28], to 2030, when the Paris Accord is agreed to be met, black and brown coal generation will still dominate the energy mix.
- Conventional hydro continues at the present levels indefinitely, as the annual energy available from existing hydro is relatively static.
- Gas powered generation levels are very low in the next decade, due to the high cost of gas relative to black and brown coal, and the expected ongoing focus on exporting gas at the present forecast international price levels, rather than consuming the gas locally.
- Wind and to a lesser extent solar generation continue to meet or exceed the LRET target of 33,000 GWh per annum in Australia, with the NEM making up around 85 % of the total for Australia. The LRET supplies approximately 15 % of NEM energy consumption of about

[28] AEMO ISP renewable generation list https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/ISP/2018/2018-Integrated-System-Plan--Modelling-Assumptions.xlsx, downloaded 25/09/2018

200 TWh/year in the early 2020s, gradually increasing through to 2030, due to improving economic competitiveness of renewables.

- Embedded renewables, particularly rooftop solar, are netted off the energy consumption forecast, and reduce the growth in demand seen by the grid connected generators. While the embedded renewables are not shown on the chart, AEMO forecasts that embedded generation in the NEM will reach 10 GW capacity by 2020, and exert a strong downward influence on daytime grid demand in the NEM, creating a middle-of-the-day trough in demand. This is built into the hourly load curves for the thirty year forecast modelled.

- Low demand during the day and overnight enhances opportunities for both conventional hydro and other storage technologies. Conventional hydro such as Tasmanian hydro and Snowy hydro can avoid operating during low demand periods and thus retain their stored energy for peak periods. New storage technologies such as PSH and batteries also become economic as the daytime demand trough becomes more pronounced. Thus, both conventional hydro and PSH contribute to meeting peaks using either stored river inflows or pumped water.

- From the mid 2030s the generation contribution by coal is forecast to fall markedly, mainly driven by coal fired generators reaching their projected end of life of 50 years operation. No new coal fired generation is forecast to enter during the period to 2050, to enable the emissions trajectory to be met at least cost to the NEM, and also reflecting the falling costs of new technologies relative to mature technologies such as coal fired generation.

- From the mid 2030s there is forecast to be significant growth in gas fired generation from existing and new CCGT capacity. Significantly expanded wind production from existing and new wind generation throughout the NEM is also forecast from that time as shown in Figure 5. Solar generation also grows strongly but does not produce as much energy as wind, due to lower capacity factors, and competition from rooftop PV generation, which has a similar operating profile and erodes the benefits of additional solar. Particularly from the mid 2030s storage, initially PSH and later grid connected battery storage, becomes economic to firm up the intermittent renewable production from wind and solar. This is shown in the dotted lines, which reflect that storage is a load as well as a generator.

Renewable and PSH generation is forecast to develop in all regions. The economic driver for development in each region is to meet the load growth by region using the best resources available within the region. Hence solar develops more strongly in Queensland and less strongly for more southerly locations. Conversely, wind resource is stronger in the south and less strong towards the north. Interconnector losses tend to limit the growth of particular technologies in a region, even if abundant high quality resources are available, because transmission losses grow non-linearly with interconnector flows and constrain the capacity that is economic to develop within a given region.

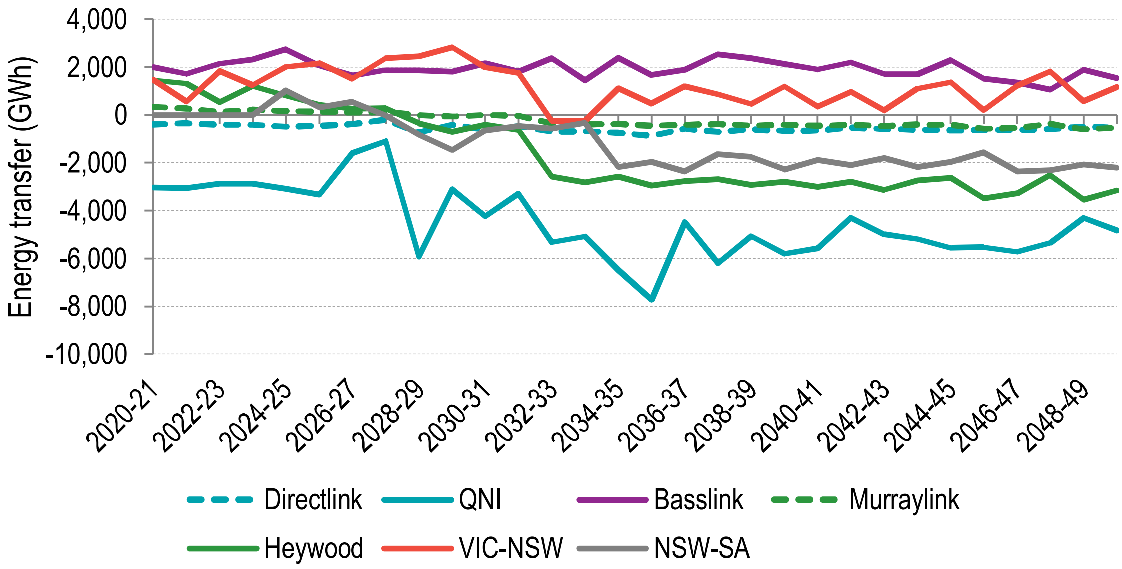
However, even though interconnector losses tend to constrain generation development to within each region, the diversity of resources between distant regions of the NEM can outweigh the impact of transmission losses and lead to high utilisation of interconnectors and expanded growth of renewables in some regions. This is because weather conditions cause considerable diversity in the production profile of wind and solar between regions and thus regions without wind or sun may import from regions experiencing windy and sunny conditions.[29] It is also because losses over interconnectors are generally less than losses for storage technologies.

For the Base Case, Figure 7 shows the forecast net energy transfers by year across all existing interconnectors. This shows that some interconnectors are forecast to transfer more energy between regions than others. Basslink flows are consistently northward reflecting the assumed level of existing and new wind in Tasmania. Victoria to NSW flows are generally in the direction towards NSW, although there is substantial variation as retirements in large coal fired stations in both states

[29] Both wind and solar are modelled using seven years of meteorological changes at the half hourly level, converted to hourly to accord with the model resolution.

cause temporary shifts in flows. SA shifts towards exports owing to favourable renewable generation developments, firstly into Victoria and later into NSW over the NSW-SA (Riverlink) interconnector, which is assumed to be built by 1 July 2024, consistent with the AEMO ISP expectations. Owing to strong solar resources in Queensland and delayed retirement of the Queensland coal portfolio, transfers over the QNI interconnector are strongly in favour of exports from Queensland to NSW.

Figure 7: Average annual interconnector energy transfer forecast for Base Case without Marinus[30]

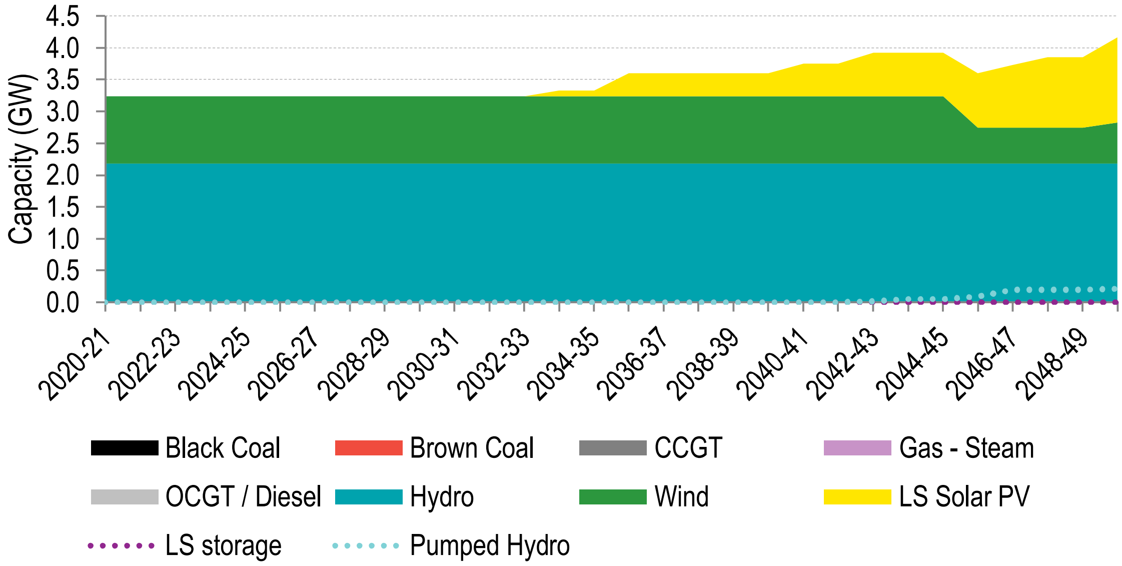


Capacity development in Tasmania without Marinus is shown in Figure 8. We have already shown in Figure 5 that across the NEM, it is forecast that there is a significant increase in solar capacity from the mid 2030s because the decreasing cost of large-scale solar PV favours its development to replace retiring coal. This development is spread by the least cost modelling methodology across in all regions, including Tasmania, to take advantage of diversity in weather conditions and seasonal patterns. In Tasmania, the new solar generation would be used locally allowing Tasmanian hydro generation to be better utilised at higher value at times of higher Victorian demand. Wind assumed to be developed in the early 2020s with a 25 year life will not all expected to be replaced when it is retired in the mid-2040s because the projected cost of solar will be well below wind by that time, based on the ISP cost data. In considering the relative cost of technologies, spill of some wind energy without additional interconnection raises the effective cost per MWh of wind, decreasing its competitiveness with lower capacity factor large-scale solar PV[31].

[30] Positive flow directions for Directlink and QNI are NSW to Queensland, Basslink is Tasmania to Victoria, Murraylink and Heywood are Victoria to South Australia; VIC-NSW is Victoria to NSW; NSW-SA is NSW to South Australia.

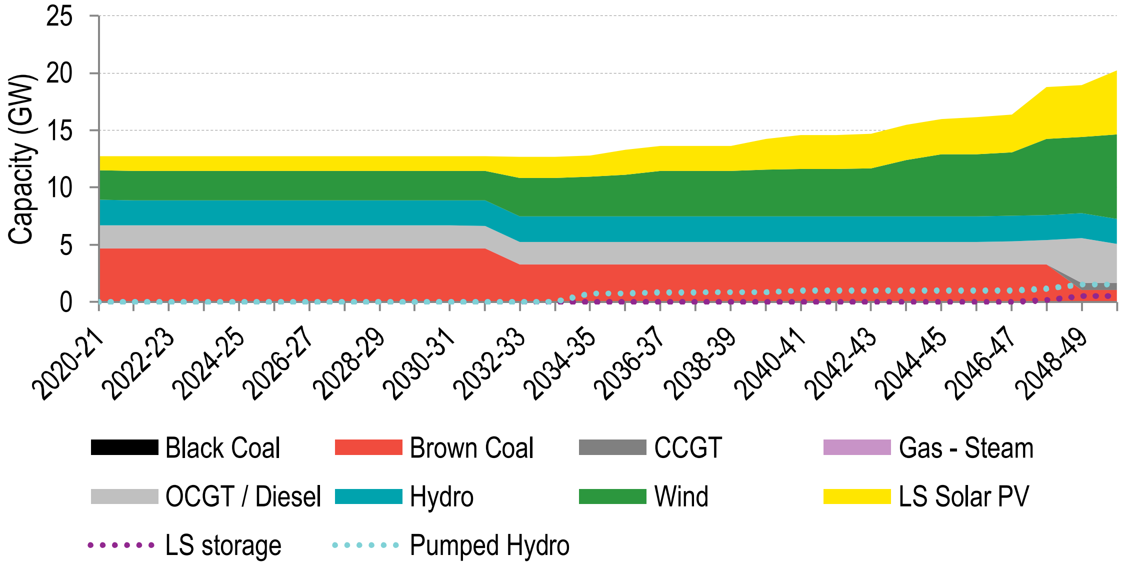
[31] Wind spills before solar is curtailed in the dispatch because solar has zero VOM. However, that is factored into the LCOE of each technology when making the decision as to the installed capacity of each.

Figure 8: Tasmanian capacity mix[32] forecast for Base Case without Marinus



The forecast capacity mix in Victoria without Marinus is shown in Figure 9. The capacity mix in Victoria does not change until 2032-33 when coal retirements commence, as sufficient capacity is available to provide reliable supply following the build out of renewables to meet the LRET.

Figure 9: Victorian capacity mix forecast for Base Case without Marinus



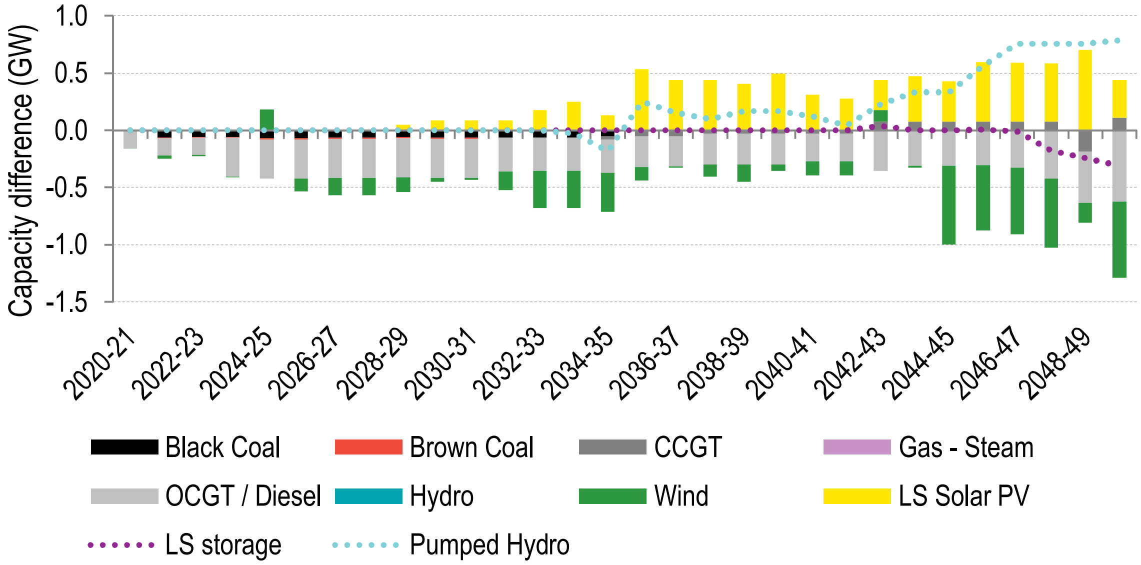
3.1.2 Generation development with Marinus

Figure 10 shows the change in NEM capacity with Marinus relative to the without Marinus case shown in Figure 5. For the NEM overall, the installation of Marinus is forecast to facilitate the deferral of wind development in most years starting in 2025-26, with up to 700 MW less wind by the

[32] Tamar Valley CCGT and OCGT are modelled as available only in the event of a Basslink failure, consistent with the Tasmanian Energy Security Taskforce, June 2017, *Final Report*. Available at: https://www.stategrowth.tas.gov.au/__data/assets/pdf_file/0004/151159/Tasmanian_Energy_Security_Taskforce_-_Final_Report.PDF; Accessed 8 November 2018. Basslink failure is not modelled these studies. As such, Tamar Valley is not displayed in the capacity mix figures presented in this Report.

end of the study. More solar is developed from 2028-29, with up to 300 MW more solar by 2050. More PSH capacity is developed, with up to 800 MW more by 2050. Less OCGT capacity is developed, with up to 600 MW less by 2050, and some OCGT capacity is retired earlier due to improved reliability provided by the expanded interconnector capacity of Marinus[33]. However, all these changes are forecast to occur against a background of tens of GW of wind and solar as shown in Figure 5. In overall terms, Marinus is expected to reduce costs because smaller amounts of less expensive capacity replace larger amounts of more expensive capacity, because of the increased ability to share capacity between regions.

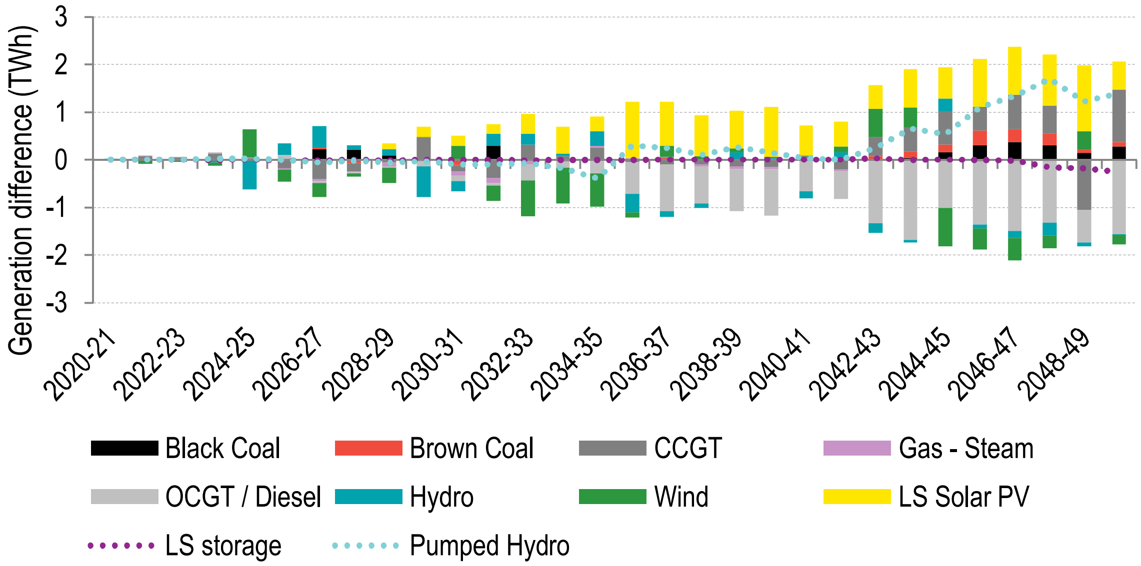
Figure 10: Change in NEM capacity mix due to Marinus 600 MW (Base Case with Marinus minus Base Case without Marinus; difference relative to Figure 5)



The change in generation mix across the NEM for all study years is shown in Figure 11 relative to the without Marinus case shown in Figure 6. The same trends as in the capacity charts are broadly observable in generation. A notable difference is in the OCGT generation. From the study start year until the mid-2030s, there is a sizable OCGT capacity decrease with Marinus but little OCGT generation decrease because this capacity runs only over extreme peaks. However, later in the study, Marinus is forecast to replace significant volumes of high variable cost energy from OCGTs with lower variable cost solar and PSH generation, much of which comes from Tasmania.

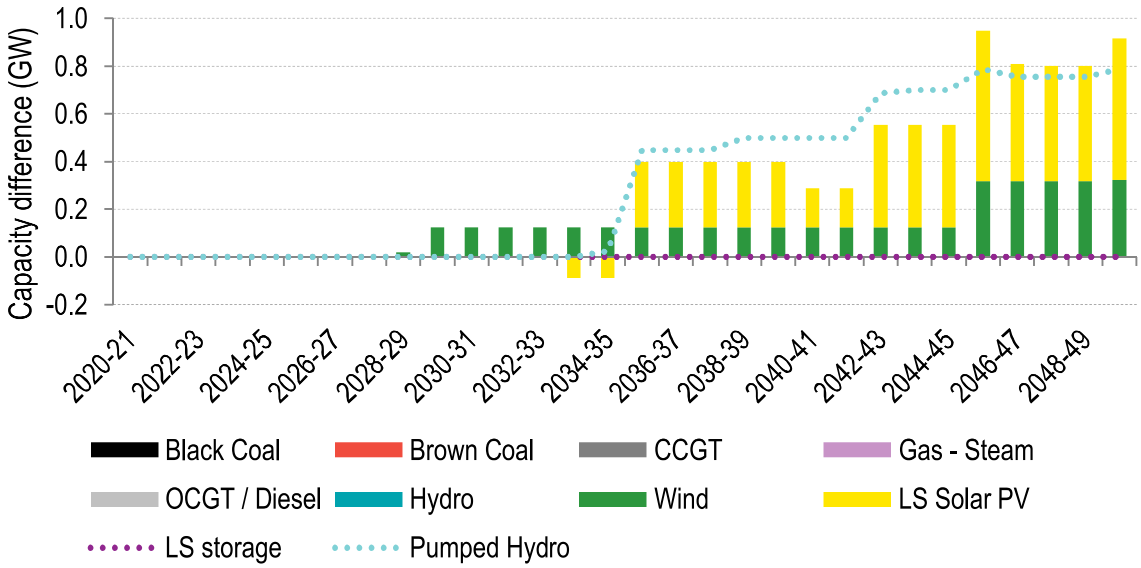
[33] Unused OCGT capacity may be considered as standby reserve, rather than retired generation, since this modelling has not accounted for security measures, in particular FCAS services. TasNetworks advised that FCAS specified in the AEMO ISP dataset was not incorporated in AEMO ISP models.

Figure 11: Change in NEM generation mix due to Marinus 600 MW (Base Case with Marinus minus Base Case without Marinus; difference relative to Figure 6)



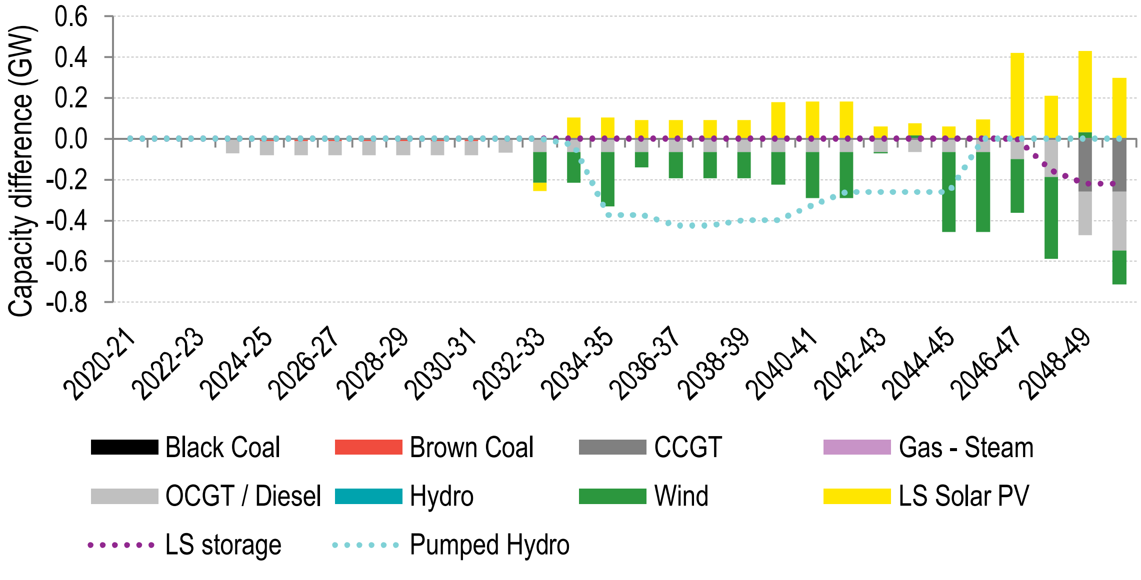
The change in capacity in Tasmania with Marinus is shown in Figure 12, relative to the without Marinus case shown in Figure 8. The additional export capacity at times of high Victorian prices means it is expected to be economic for Tasmania to build more wind from 2028-29, more large-scale solar PV and PSH from 2035-36. The 1,050 MW of wind capacity installed before Marinus is commissioned is augmented by additional capacity to make a total of about 1,200 MW from 2029-30. In the mid 2040s there is still replacement of aging wind, but less capacity is replaced by solar to give an increase in wind with Marinus relative to without Marinus. This is because with Marinus, almost no wind is spilt, lowering the effective cost per MWh for wind and making it more competitive with large-scale solar PV.

Figure 12: Change in Tasmanian capacity mix due to Marinus 600 MW (Base Case with Marinus minus Base Case without Marinus; difference relative to Figure 8)



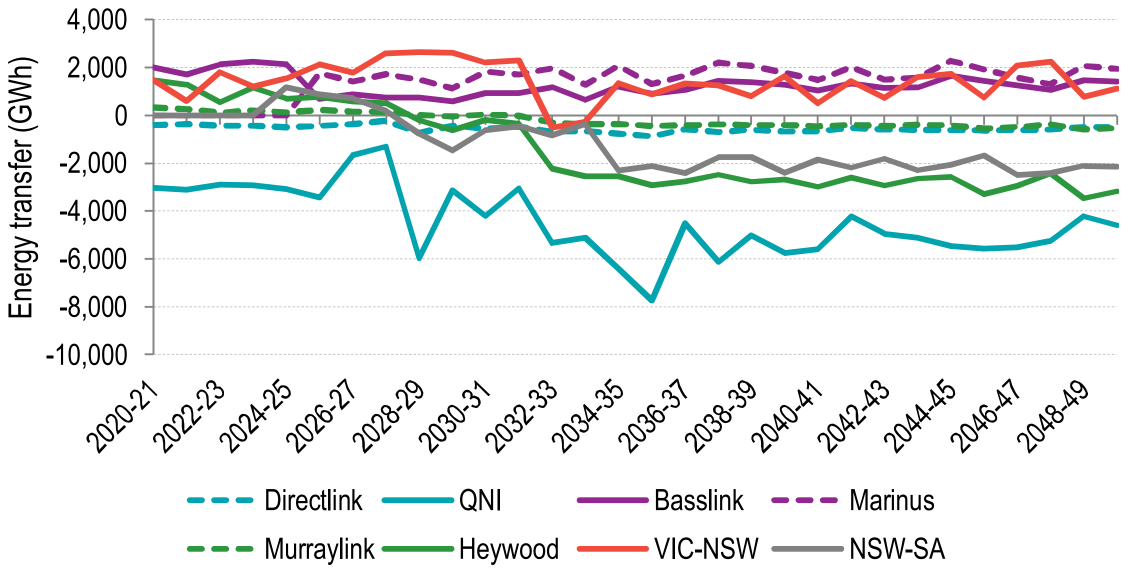
The change in Victoria's capacity mix with Marinus is shown in Figure 13, relative to the mix shown in Figure 9. These figures show that Marinus is only expected to defer a small amount of OCGT capacity in Victoria until 2032-33[34]. From this time, wind and pumped hydro capacity in Victoria reduce but solar capacity increases, because the better wind resource in Tasmania and the advantages of diversity favour additional development there rather than in Victoria.

Figure 13: Change in Victorian capacity mix due to Marinus 600 MW (Base Case with Marinus minus Base Case without Marinus; difference relative to Figure 9)



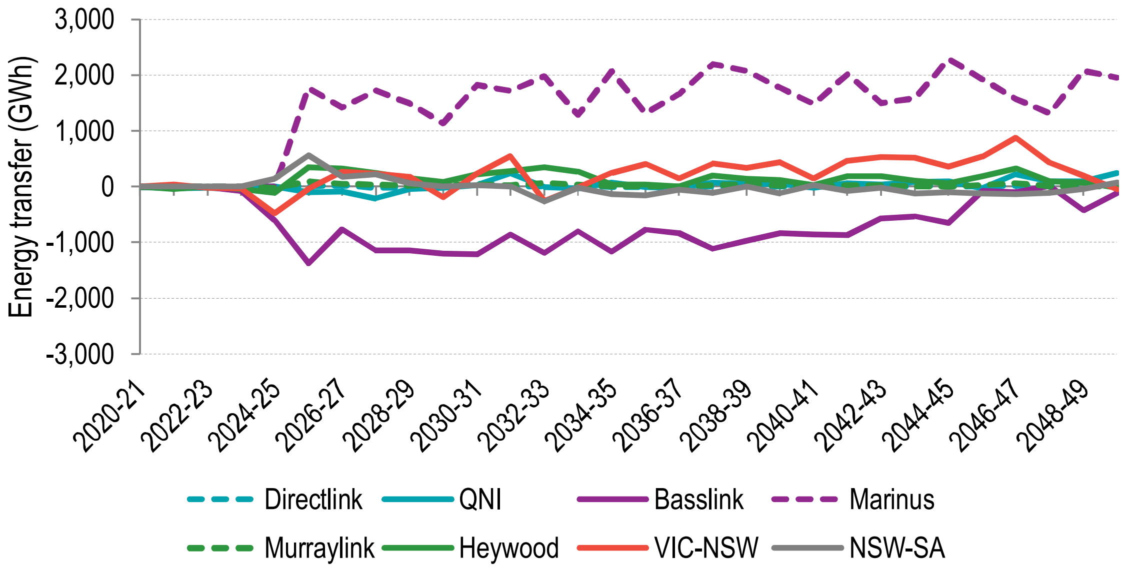
In association with changes in regional capacity development, Marinus is also forecast to change interconnector bidirectional usage. The average net energy transfer by year across all interconnectors is shown in Figure 14, while Figure 15 shows the difference in transfers relative to the without Marinus case (shown in Figure 7). While the average flow on Basslink remains northward, the usage decreases with Marinus. With Marinus, more energy flows out of Victoria into SA and NSW.

Figure 14: Average annual interconnector energy transfer forecast for Base Case with Marinus 600 MW



34 In fact this is a reduction in standby capacity, not deferral of new capacity.

Figure 15: Change in average annual interconnector energy transfer due to Marinus 600 MW (Base Case with Marinus minus Base Case without Marinus; difference relative to Figure 7)



3.1.3 Market benefits of Marinus

Table 6 shows the NPV of the forecast market benefits of Marinus, excluding development costs of Marinus, which are discussed in the broader work prepared by TasNetworks outside of this Report. The NPV of the benefits of Marinus in the Base Case is expected to be $845 million across the NEM. The main component of benefits is the fuel benefit of $598 million, against a background of more than $60 billion in NPV of fuel costs that is forecast for the 30 year period, and thus Marinus is forecast to reduce fuel costs in the NEM by approximately 1 %. This is an outcome of Marinus enabling hydro generation in Tasmania (initially conventional hydro but later new PSH) to reduce the need to burn gas in Victoria and NSW over peaks, by storing surplus energy from the low demand periods and shifting production to the peak periods when it has a much greater value.

Table 6: Base Case NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total
NSW	92	50	145	28	-	314
QLD	108	20	-51	9	2	88
VIC	307	84	410	60	36	896
SA	139	85	94	24	-2	340
TAS	-559	-180	-	-56	-	-794
Total	87	59	598	66	35	845

Benefits in the remaining categories are expected to be much lower, comprising capex savings, FOM and VOM savings and a slight reliability benefit. The reliability benefit is overwhelmingly accrued in Victoria where there is a reduction in USE with Marinus. DSP benefits are the same, with and without Marinus. Emissions reduction differences between Marinus and the counterfactual without Marinus, are forecast to be minimal, since the same emissions trajectory is targeted for both cases, resulting in practically the same CO_2-equivalent emissions in both. However, the value of the difference in emissions could be costed if a price was available. The modelling conducted does not include an emissions price, but allows for a price for emissions reduction to be extracted if needed, as had been envisaged for the National Energy Guarantee (NEG) if it had been adopted for the NEM.

The $845 million in benefits is spread between the regions, with a large positive benefit of $896 million in Victoria and a large negative benefit of $-794 million in Tasmania. Victoria and Tasmania are expected to be the regions most changed by Marinus, then NSW and SA, then finally Queensland.

Comparing the benefits between the regions, with Marinus, the investment capex in generation in Tasmania increases by $559 million, which is represented as a negative benefit to Tasmania. There are savings in capex in all the mainland states, due to the reduced need to build in those states, as Tasmania's resources are able to be unlocked by Marinus at lower cost than developing alternative resources on the mainland.

Table 7 shows the forecast market benefit components by technology across the NEM. The fuel saving of $598 million is predominantly in reduced need for peaking plant to operate, made up of $641 million in OCGT and diesel generation fuel cost reductions. The fuel cost reductions for these thermal technologies are primarily expected to occur in Victoria and NSW, which have a benefit of $354 million and $248 million respectively. There are small changes to other categories of fuel consumption. Marinus provides overall capex reductions of $87 million; wind investment reduces by $344 million across the NEM, but solar PV and pumped hydro increase by $214 million and $81 million respectively. The regional differences in capacity and their timing are discussed in Section 3.1.2.

Table 7: Base Case NPV benefit ($m) by technology

Technology	Capex	FOM	Fuel	VOM	USE	Total
Black Coal	-	43	-31	-2	-	10
Brown Coal	-	16	-3	-	-	13
CCGT	1	-	-39	-5	-	-43
Gas - Steam	-	-	30	5	-	35
OCGT / Diesel	23	76	641	64	-	804
Hydro	-	-	-	3	-	3
Wind	344	55	-	-6	-	393
LS Solar PV	-214	-88	-	-	-	-301
Pumped Hydro	-81	-44	-	7	-	-118
LS Storage	13	2	-	-	-	15
USE	-	-	-	-	35	35
Total	87	59	598	66	35	845

3.1.4 Utilisation of Marinus and Basslink

Figure 16 shows the average time of day flow forecast for Marinus for several years over the forecast period. In all years there is importation of power into Tasmania from the mainland during the day due to high volumes of low-cost solar generation at these times, and exports from Tasmania at other times of the day, reflecting the net energy surplus in Tasmania with 1,050 MW of wind installed.

Figure 16: Time-of-day average Marinus flow for Base Case with Marinus 600 MW

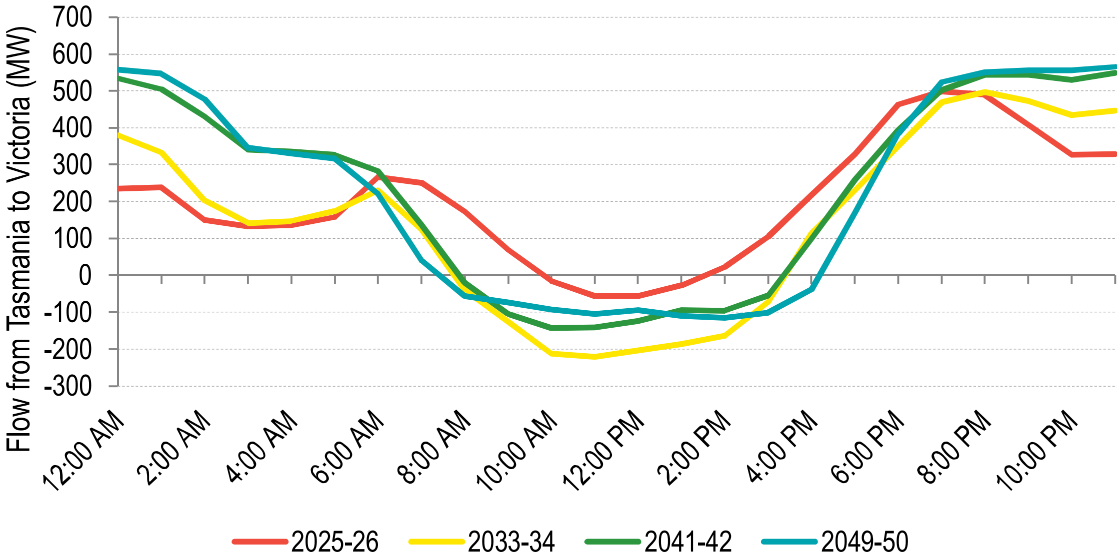


Figure 17 shows an expected duration curve for several different years over the forecast period showing that export flows predominate, with Marinus flows reaching the maximum of 600 MW export for between 30 % and 60 % of the time. Imports into Tasmania are at maximum for up to 10 % of the time). Marinus is operating at capacity in one direction or the other for between 50 % and 70 % of the time, suggesting that the interconnector is highly utilised.

Figure 17: Duration curve for Marinus flow for Base Case with Marinus 600 MW

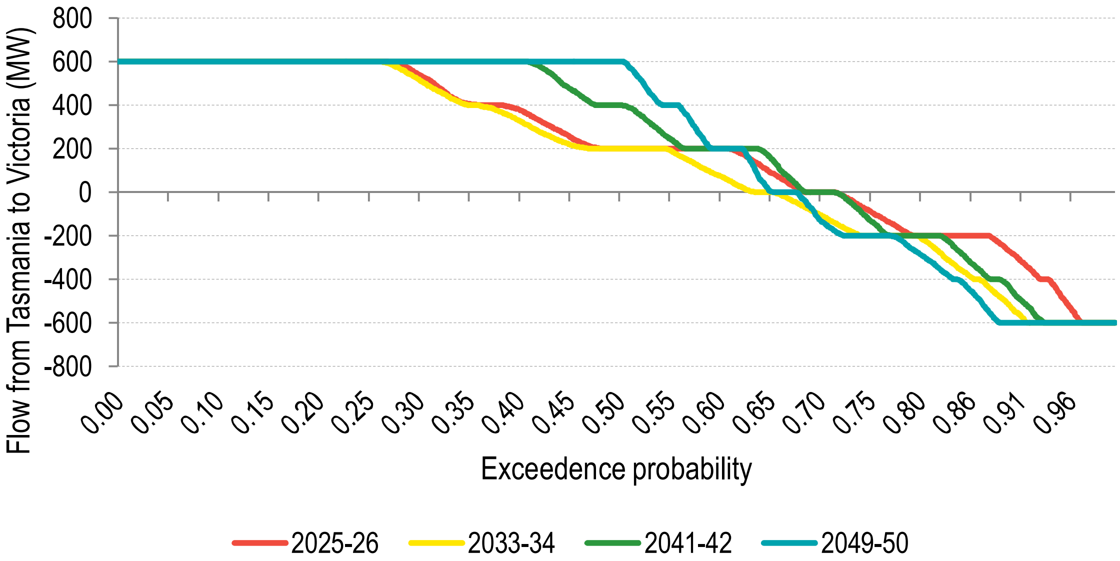


Figure 18 displays the forecast time-of-day flow from Tasmania to Victoria in a selection of years for the Base Case with Marinus. Basslink is less utilised so than Marinus owing to higher losses. This reduces the proportion of time that the total combined interconnector flows are at the limits, as shown in Figure 19 (compared to Figure 17).

Figure 18: Time-of-day average Basslink and Marinus flow for Base Case with Marinus

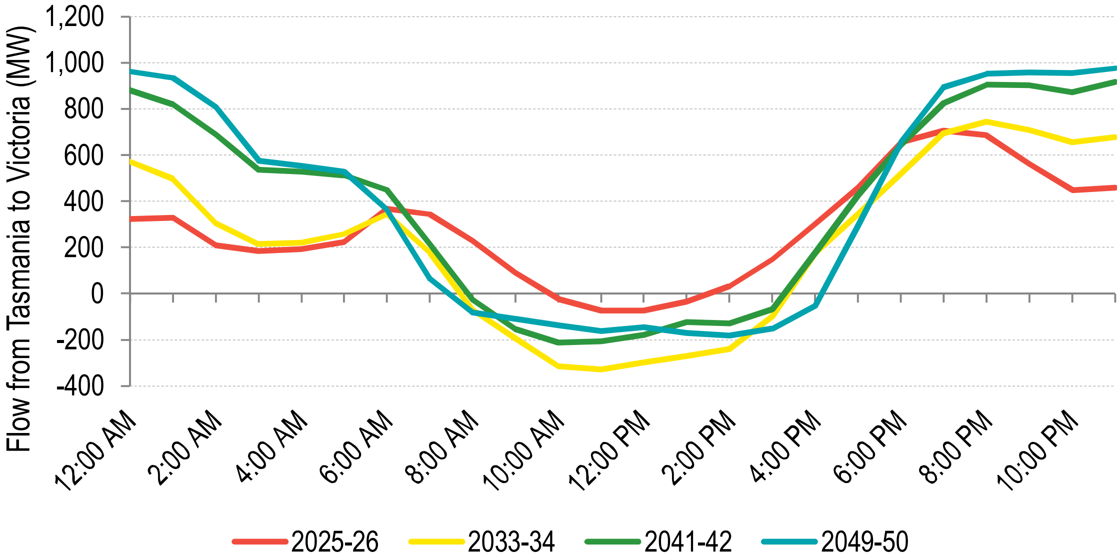


Figure 19: Duration curve for cumulative flow of Basslink and Marinus for Base Case with Marinus 600 MW

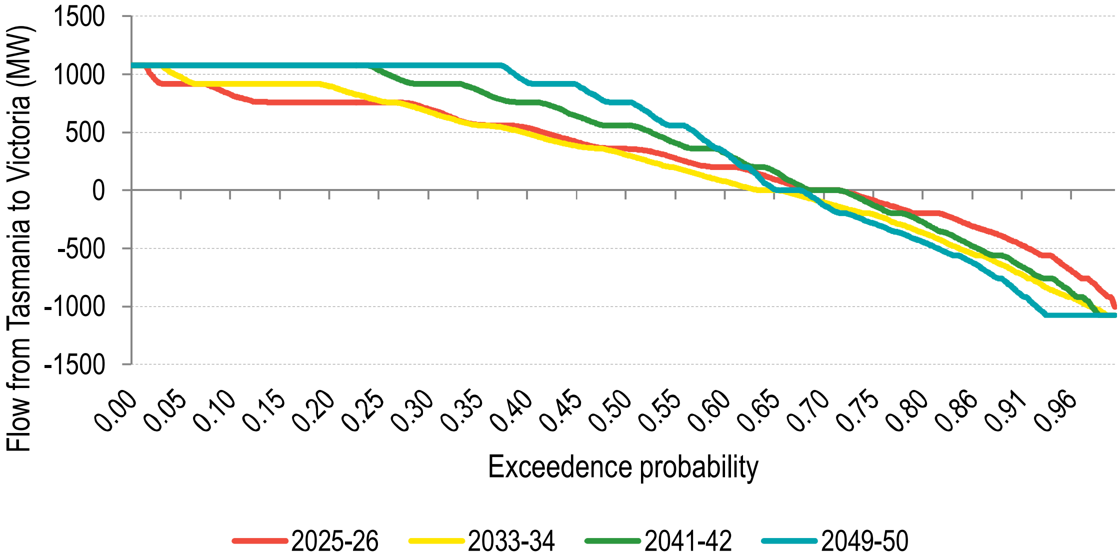


Figure 20 and Figure 21 below show the annual average time-of-day flow and the flow duration curve forecast for Basslink without Marinus. Figure 22 and Figure 23 are equivalent figures for Basslink with Marinus. The figures show that, without Marinus, Basslink is heavily utilised exporting to the mainland, with flows at maximum between 50 % and 60 % of the time, and imports to Tasmania at maximum for 10 % to 15 % of the time. With Marinus, the flows across Basslink are at their maximum in either direction for less of the time, reflecting the lower losses and additional capacity of Marinus reducing the economic transfers on Basslink.

Figure 20: Time-of-day average Basslink flow for Base Case without Marinus

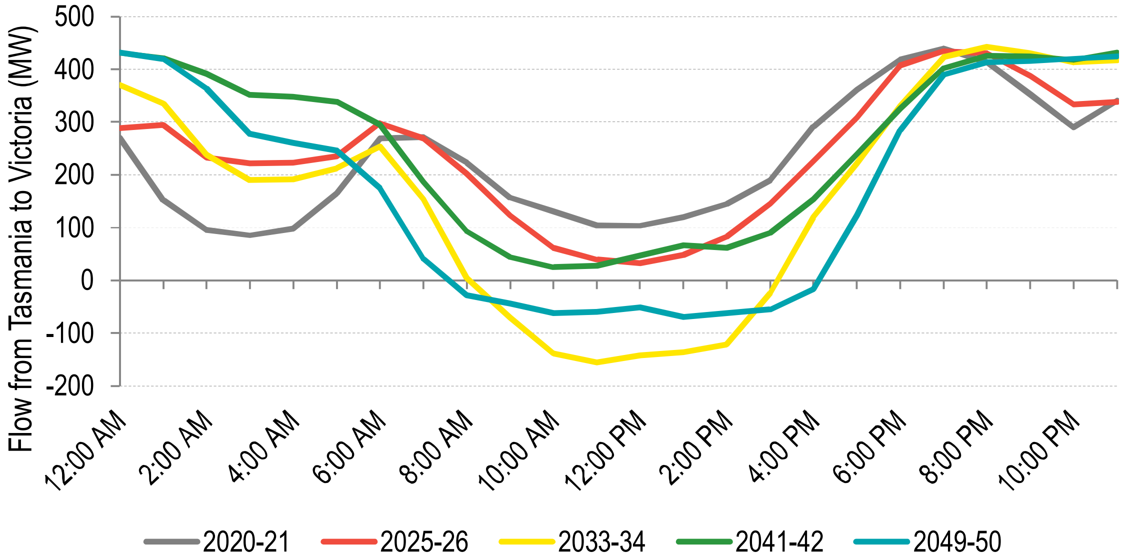


Figure 21: Duration curve for Basslink flow for Base Case without Marinus

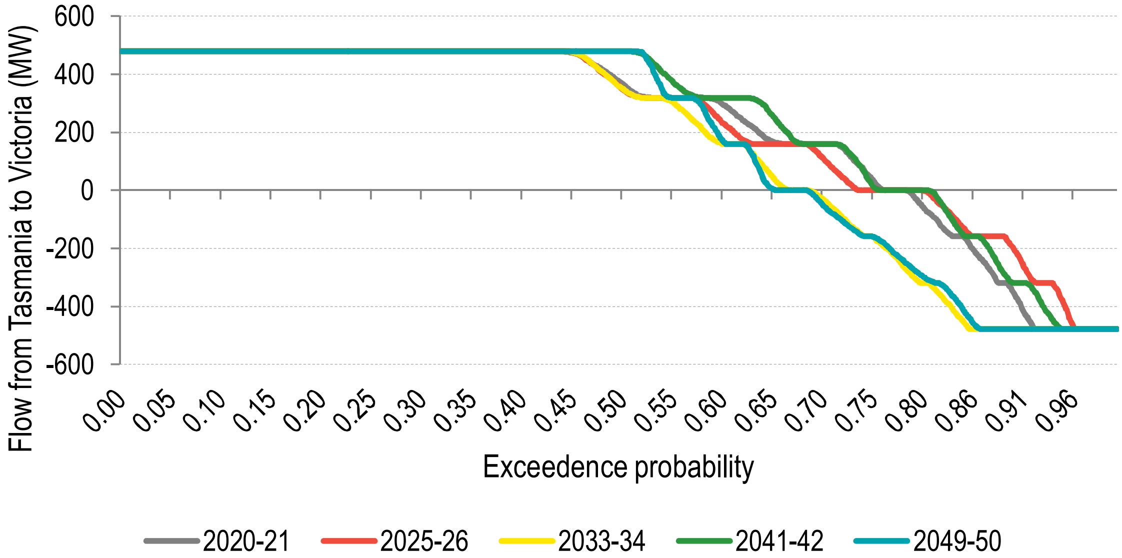


Figure 22: Time-of-day average Basslink flow for Base Case with Marinus 600 MW

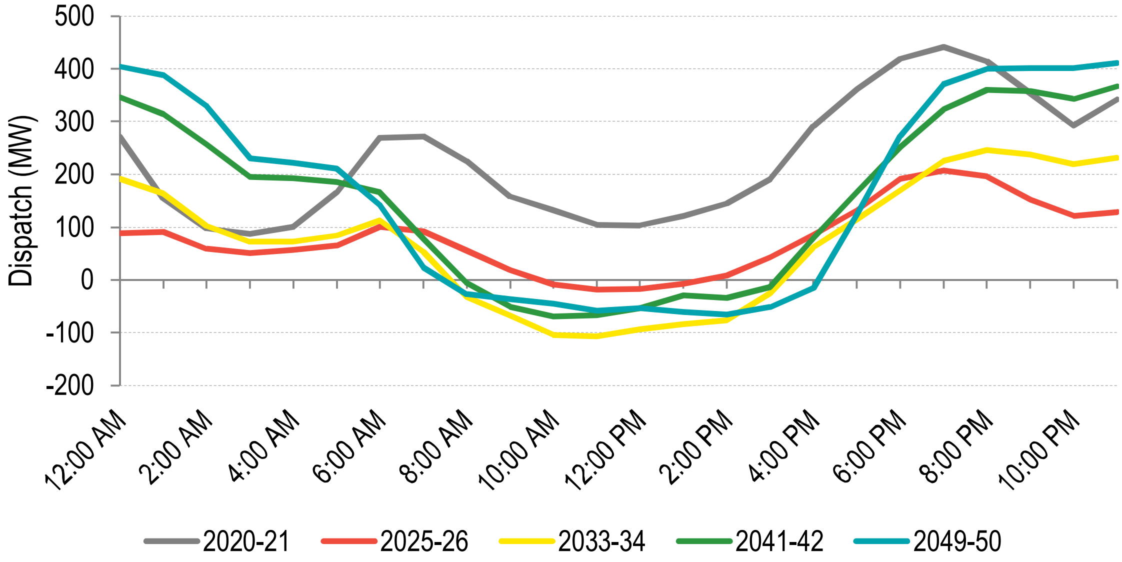
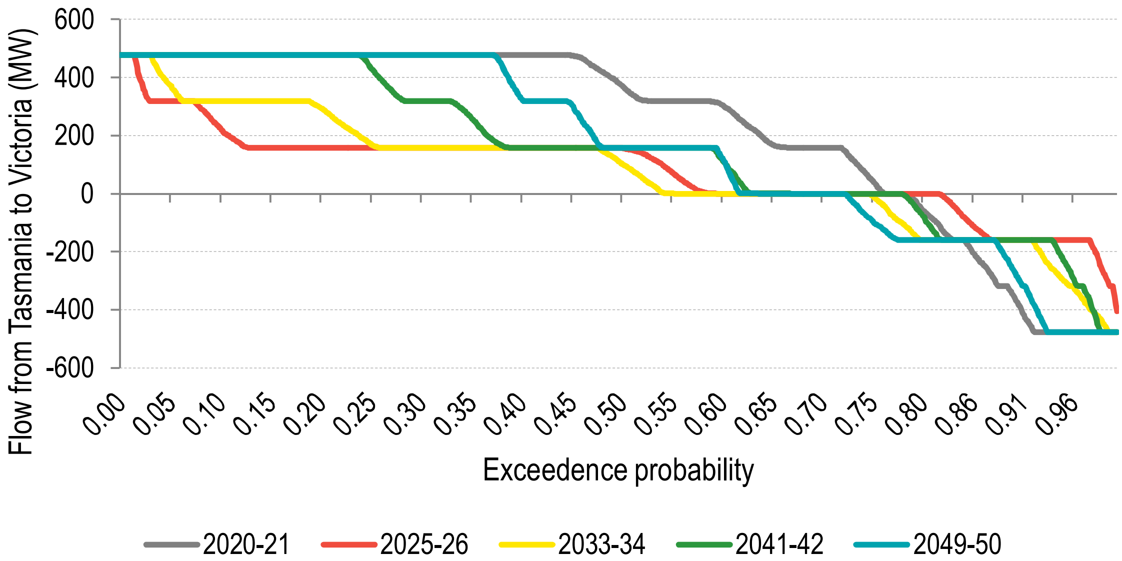


Figure 23: Duration curve for Basslink flow for Base Case with Marinus 600 MW[35]



The forecast effect of Marinus in its first year of operation (2025-26) is to increase exports to the mainland over the evening peak from about 400 MW with Basslink alone to about 650 MW with Marinus and Basslink combined. Furthermore Marinus and Basslink combined import on average 100 MW to Tasmania during the day, whereas Basslink alone cannot store sufficient energy to allow daily imports. Marinus therefore allows greater arbitrage between Tasmania and the mainland than Basslink alone.

[35] Positive flows represent Tasmania to Victoria, negative flows are Victoria to Tasmania.

3.2 Marinus 600 MW sensitivities

3.2.1 EC90

3.2.1.1 Generation development without Marinus

In the EC90 sensitivity, the emissions target follows a strong continuous downward trend over the 30 year period. This reflects directly on the production of coal fired generation, which has by far the largest emissions levels per unit of generation and therefore must fall continuously in line with the emissions. The model is forecast to reduce emissions by reducing dispatch of high emissions plant. The model then retires this high emissions capacity to avoid FOM costs incurred for plant that is not operating, if that is the least cost outcome. The production of wind and solar increases continuously to replace the falling production from coal generation, shown in Figure 24 and Figure 25. In the final years of the study without Marinus the mainland PSH limits are reached and approximately 30 GW of large-scale storage is forecast to be installed to compensate for the nearly complete retirement of existing coal capacity in the NEM.

Figure 24: NEM capacity mix forecast for EC90 without Marinus

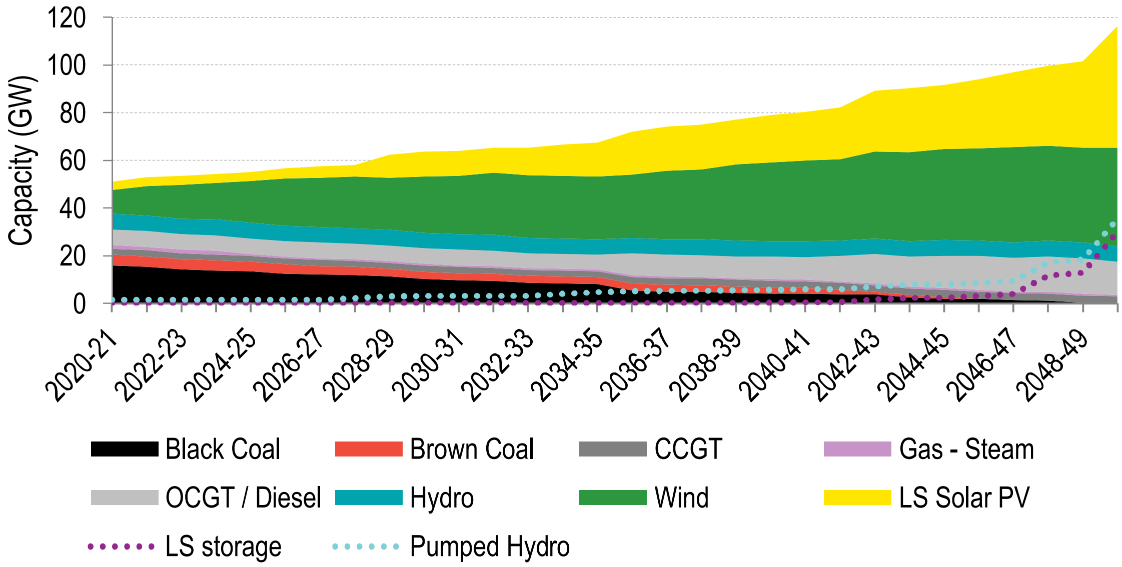
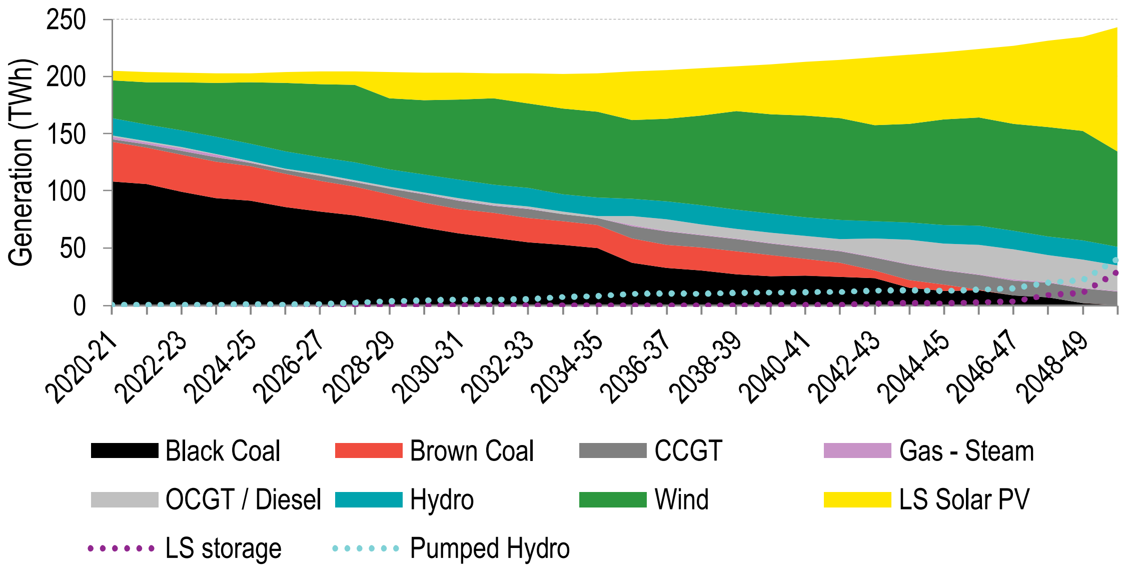
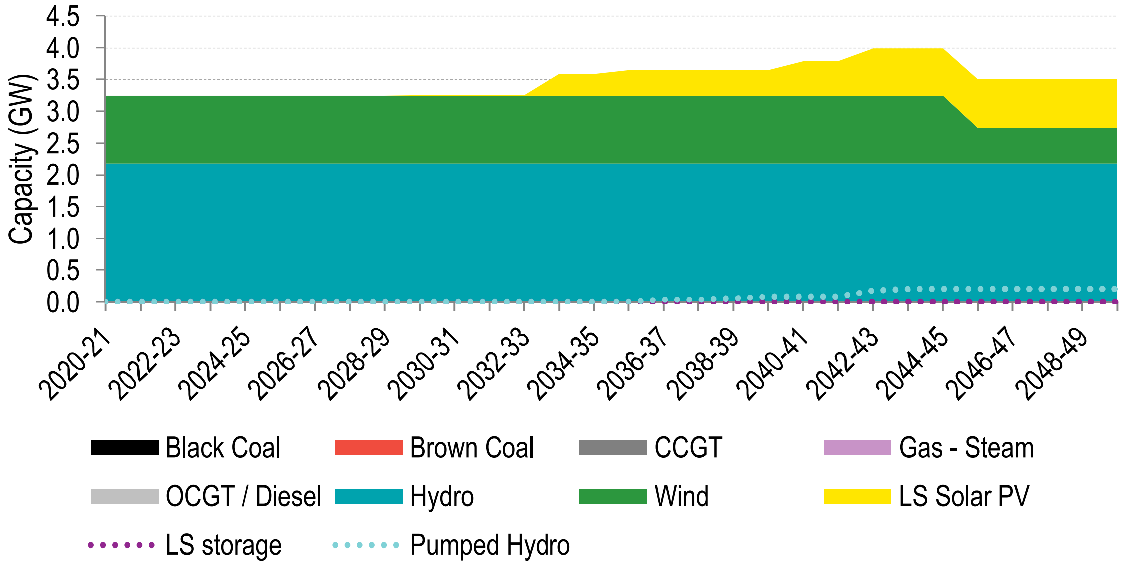


Figure 25: NEM generation mix forecast for EC90 without Marinus



Without Marinus, the development in Tasmania is expected to be relatively limited. The additional renewable and storage capacity in the NEM, compared to the Base Case, result in Basslink being expected to import energy from the mainland to Tasmania for approximately 50 % of the time. Additionally, renewable capacity in Tasmania cannot be exported to the mainland to displace coal generation which reduces the benefit of additional Tasmanian capacity, seen in Figure 26.

Figure 26: Tasmanian capacity mix forecast for EC90 sensitivity without Marinus



3.2.1.2 Generation development with Marinus

Figure 27 shows the change in NEM capacity due to Marinus 600 MW under the more ambitious emissions abatement trajectory. Figure 28 shows the equivalent chart for change in NEM generation. While it is forecast that there are differences in the annual generation mix, the amount of emissions is almost identical with or without Marinus as both cases closely track the strong emissions trajectory.

Figure 27: Change in NEM capacity mix due to Marinus 600 MW for EC90 (EC90 with Marinus minus EC90 without Marinus; difference relative to Figure 24)

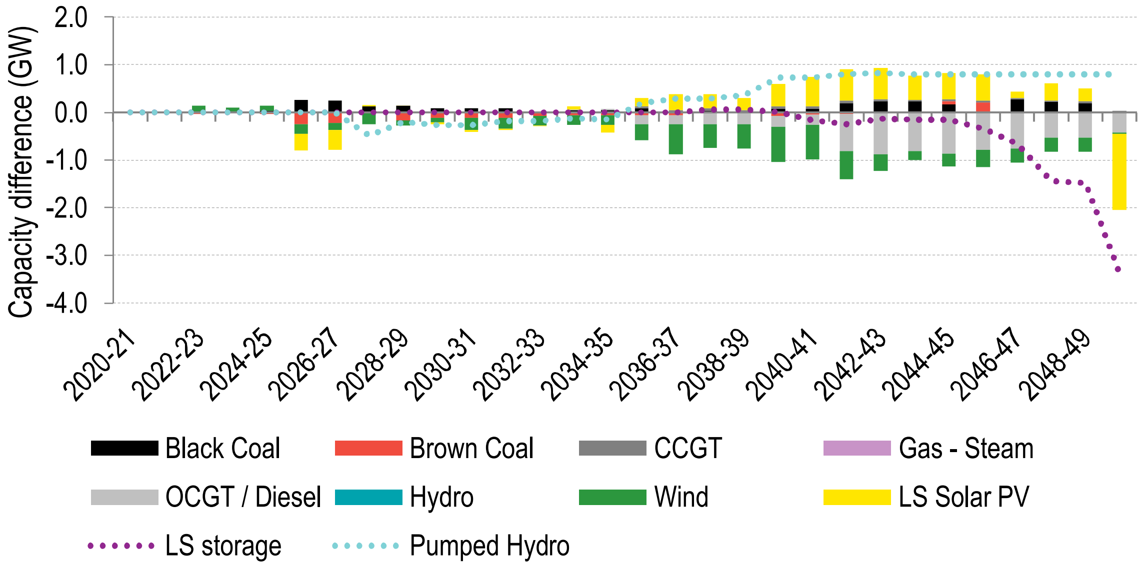
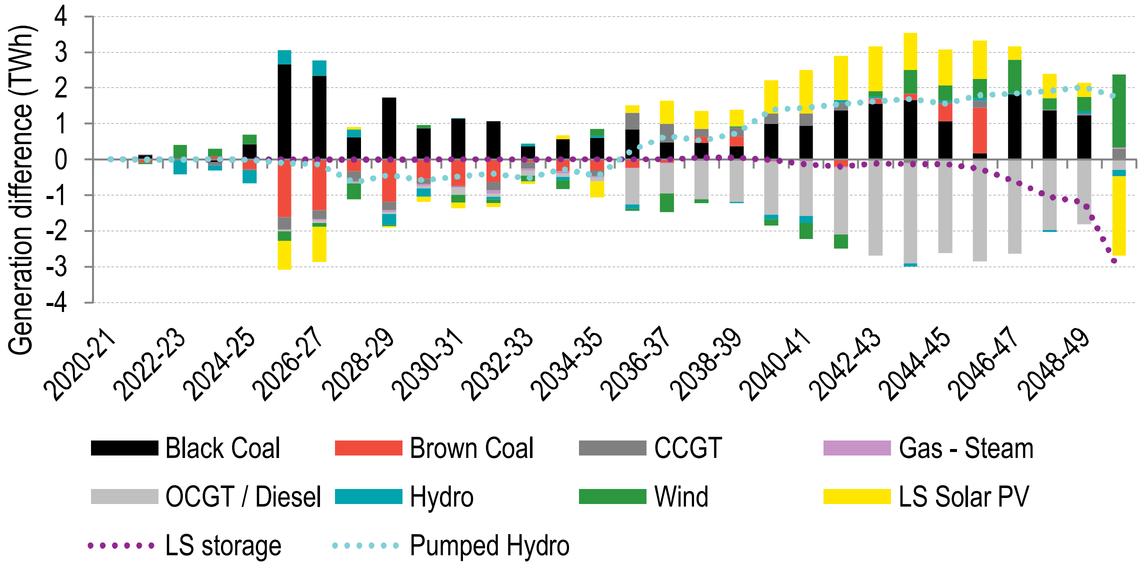


Figure 28: Change in NEM generation due to Marinus 600 MW for EC90 (EC90 with Marinus minus EC90 without Marinus; difference relative to Figure 25)



It is forecast that the key effects of Marinus in the EC90 sensitivity are to:

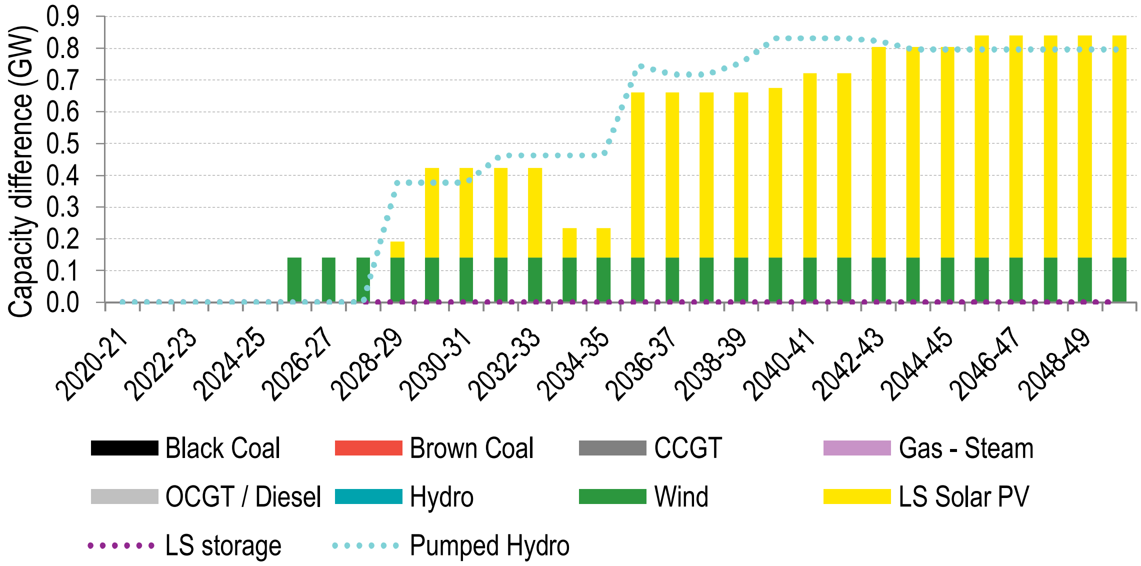
- Decrease generation from brown coal, and therefore advance retirements, in Victoria;
- Increase generation from black coal, and therefore delay retirements, in Queensland and NSW;
- Decrease investment in new peaking capacity on the mainland and use of that capacity;
- Increase PSH capacity and energy;
- Decrease large-scale battery capacity and energy in the 2040s.

In general, Marinus swaps brown coal and OCGT/Diesel generation for black coal[36]. The flexibility provided by Marinus allows the emissions constraint to be met more cheaply using energy from existing black coal instead of brown coal up to the mid 2030s, and instead of new peaking capacity from then until the study end.

The effect of Marinus in Tasmania is to facilitate some new entrant wind capacity from the time Marinus is operational in 2025-26 and to bring forward the development of new large-scale solar PV and PSH capacity by 5 to 10 years as shown in Figure 29. The additional generation supplied from Tasmania to the mainland as a result of Marinus is forecast to reduce the need for the combination of wind and OCGT capacity to be developed on the mainland in the 2030s and 2040s. By unlocking the potential for Tasmanian pumped hydro storage, there is also a reduced need for new large-scale storage installed in the mainland in the 2040s, shown in Figure 27.

[36] OCGTs and black coal have a similar emissions intensity; gas is less emissions intensive than black coal, but OCGTs are less thermally efficient than coal-fired plant.

Figure 29: Change in Tasmanian capacity mix due to Marinus 600 MW for EC90 (EC90 with Marinus minus EC90 without Marinus; difference relative to Figure 26)



3.2.1.3 Market benefits of Marinus

The NPV of the benefits of Marinus in the steeper emissions reduction target sensitivity is forecast to be $1,605 million across the NEM (Table 8), up from $845 million in the Base Case. The fuel benefit is $692 million, and the capex benefit is $734 million; all significant increases on the Base Case benefits. The remaining categories of benefits are much lower in magnitude. The reliability benefit of Marinus is lower than in the Base Case but is entirely accrued in Victoria.

Table 8: EC90 sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case
NSW	273	60	1	27	-6	354	314
QLD	588	33	-144	23	-4	495	88
VIC	713	292	713	77	17	1,813	896
SA	200	64	123	-	-	386	340
TAS	-1,039	-346	-	-57	-	-1,443	-794
Total	734	102	692	71	6	1,605	845
Total Base Case	87	59	598	66	35	845	

The $1,605 million in benefits is unevenly spread between the regions (Table 8), with a large positive benefit of $1,813 million in Victoria and a large negative benefit of $-1,443 million in Tasmania. Comparing the benefits between the regions, with Marinus, the investment capex in generation in Tasmania increases by $1,039 million, which is represented as a negative benefit to Tasmania. There are corresponding savings in capex in all the mainland states, due to the reduced need to build in those states, as Tasmania's resources are able to be unlocked by Marinus.

The introduction of Marinus provides overall capex reductions because wind investment reduces by $518 million across the NEM, but large-scale solar PV and pumped hydro increase by $29 million and $38 million respectively (Table 9) due to the additional capacity of the technologies that are able to be installed in Tasmania and exported to the mainland. Large scale battery storage also reduces by $171 million with Marinus, since less capacity is needed to be installed in the mainland;

the model favours PSH development in Tasmania over mainland battery storage if Marinus is installed as it is cheaper.

Table 9: EC90 sensitivity NPV benefit ($m) by technology

Technology	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case
Black Coal	-	-88	-398	-32	-	-517	10
Brown Coal	-	155	49	6	-	210	13
CCGT	-27	-2	35	3	-	8	-43
Gas - Steam	-	-	34	6	-	40	35
OCGT / Diesel	140	16	972	102	-	1,230	804
Hydro	-	-	-	5	-	5	3
Wind	518	83	-	-25	-	576	393
LS Solar PV	-29	-29	-	-	-	-58	-301
Pumped Hydro	-38	-54	-	6	-	-86	-118
LS storage	171	21	-	-	-	192	15
USE	-	-	-	-	6	6	35
Total	734	102	692	71	6	1,605	845
Total Base Case	87	59	598	66	35	845	

The fuel saving of $692 million is predominantly in reduced need for peaking plant, made up of $972 million in OCGT and diesel generation fuel cost reductions. There is a substantial increase in black coal consumption costing $398 million, from using more black coal for energy storage. There are small changes to other categories of fuel consumption. The ability to more flexibly use energy from black coal accelerates brown coal retirements and delays installation and reduces use of new OCGT capacity.

In summary, the high emissions reduction target drives a rapid transition of the generation mix in the NEM towards renewables, with and without Marinus. The addition of Marinus allows the diversity of renewable resource in Tasmania relative to the mainland to be more effectively utilised. In addition, Marinus allows black coal to be used more flexibly in place of brown coal and OCGT. These effects combine to allow Marinus to deliver a much lower cost outcome for the NEM.

3.2.2 Snowy 2.0

Snowy 2.0 is a 2,000 MW project modelled with one week of storage at full output, as stated in the AEMO ISP assumptions book, and confirmed by the proponent. It is assumed in the model to be capable of pumping or generating at up to its capacity if economic to do so. This has a suppressing effect on the benefits of Marinus because the ability of the energy storage in Tasmania accessible by Marinus to reduce costs is diminished by competition with Snowy 2.0. Snowy 2.0, performing its role as a pumped storage hydro plant, is capable of both flattening the peaks, and driving price down, and also filling the demand troughs, which drives price up. Hence the expanded arbitrage made available by Marinus to trade across Bass Strait is reduced by the presence of Snowy 2.0. Snowy 2.0 operation is also increased by an expansion of the interconnector between Victoria and NSW by 2034-35, which allows much expanded trade between NSW and Victoria.

Prior to the expanded Victoria to NSW transmission in 2034-35, Marinus mainly helps to support Tasmania and Victoria, while Snowy 2.0 helps to support NSW and Queensland, in terms of expanded storage capability. Thus Marinus benefits are not much affected by Snowy 2.0 until the transmission is expanded, but after that the large expansion in diversity in the NEM means Marinus is expected to be less beneficial as it has to share the value adding with the NSW to Victoria upgrade.

A detailed review of the findings of the Snowy 2.0 case with and without Marinus shows that, with Marinus, Tasmania builds more wind from 2028-29, more large-scale solar from 2035-36, and more PSH from 2035-36. For the overall NEM, with Marinus, wind, large-scale solar and PSH (in addition to Snowy 2.0) are developed, replacing both CCGT and OCGT gas fired generation. However, Snowy 2.0 levels the demand in the NEM and reduces the benefits of the Tasmanian storages, and therefore the value of Marinus is somewhat reduced.

Compared to the Base Case, the Snowy 2.0 sensitivity generally defers wind and solar until after the Victoria to NSW interconnector upgrade in 2034-35, but then builds wind and large-scale solar PV more rapidly, particularly in NSW and Victoria, so that the overall NEM capacity for these technologies is greater by 2050, regardless of whether Marinus is commissioned or not.

The NPV of the benefits of Marinus in the scenario with Snowy 2.0 developed is $738 million across the NEM, a $107 million reduction from the base case NPV of $845 million (Table 10). The fuel benefit is $851 million, which is an increase from $598 million in the Base Case. In contrast, there are capex and FOM costs of $-152 million and $83 million respectively (a reduction from benefits of $87 million and $59 million in the Base Case). The remaining categories are a small increase in VOM benefit and a small reduction in reliability benefit. Similarly to the Base Case, the reliability benefit is entirely accrued in Victoria.

Table 10: Snowy 2.0 sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case
NSW	-7	-34	642	90	-2	689	314
QLD	56	15	-45	5	-4	27	88
VIC	229	33	176	41	30	509	896
SA	117	65	78	22	-	282	340
TAS	-547	-163	-	-59	-	-769	-794
Total	-152	-83	851	99	23	738	845
Total Base Case	87	59	598	66	35	845	

The $738 million in benefits is unevenly spread between the regions, with positive benefits of $689 million in NSW and $509 million in Victoria and a large negative benefit of $-769 million in Tasmania (Table 10). Comparing the benefits between the regions, with Marinus, the investment capex in generation in Tasmania increases by $547 million, which is represented as a negative benefit to Tasmania. There are corresponding savings in capex in all the mainland states, except NSW, due to the reduced need to build in those states, as Tasmania's resources are able to be unlocked by Marinus. The introduction of Marinus provides overall capex reductions because wind investment reduces by $87 million across the NEM, but large-scale solar PV and pumped hydro increase by $340 million and $108 million respectively (Table 11).

The fuel saving of $851 million is predominantly in reduced need for combined cycle generation which delivers $723 million in savings. There are small changes to other categories of fuel consumption.

Table 11: Snowy 2.0 sensitivity NPV benefit ($m) by technology

Technology	Capex	FOM	Fuel	VOM	USE	Total
Black Coal	-	41	-18	-1	-	23
Brown Coal	-	12	-	-	-	12
CCGT	185	16	723	80	-	1,004
Gas – Steam	-	-	30	5	-	35
OCGT / Diesel	3	28	115	11	-	158
Hydro	-	-	-	1	-	1
Wind	87	10	-	-22	-	75
LS Solar PV	-340	-143	-	-	-	-483
Pumped Hydro	-108	-51	-	24	-	-135
LS storage	21	3	-	-	-	24
USE	-	-	-	-	23	23
Total	-152	-83	851	99	23	738

3.2.3 Snowy 2.0 EC90

Modelling shows that Snowy 2.0 is expected to supress market benefits of Marinus (Section 3.2.2) while an emissions target of 90 % reduction by 2050 is expected to greatly increase market benefits (Section 3.2.1). This sensitivity combines Snowy 2.0 and the higher emissions target. It was designed to explore a market condition where Snowy 2.0 and the associated Vic-NSW upgrade are built, and shows that Marinus still delivers large market benefits in this situation. Note that in this sensitivity, the Vic-NSW interconnector upgrade is commissioned on 1/7/2027 while in the Snowy 2.0 alone sensitivity, it is commissioned on 1/7/2034. It was brought forward in this sensitivity due to earlier coal retirement, assisting the case for expanded interconnections throughout the NEM.

Figure 30 and Figure 31 show respectively the effect of Marinus and Snowy 2.0 on NEM capacity development with a high emissions target. The magnitude of the effect of Marinus is much smaller than that of Snowy 2.0 (noting the difference in y-axis scale). Regarding specific technologies:

- In general, both projects mean less peaking capacity and battery capacity are developed in the long-term.
- The two projects have somewhat opposing effects on pumped hydro capacity. Snowy 2.0 causes a delay in the development of pumped hydro across the NEM from the late 2020s to the early 2040s. However, by the study end, pumped hydro capacity in all mainland regions is at the maximum allowed. Meanwhile, Marinus causes a delay in pumped hydro capacity development in SA and Victoria in the late 2030s that catches up from early 2040s, while capacity in Tasmania increases consistently from the early 2030s.
- As noted in other sensitivities, Marinus reduces the total amount of wind developed in most years by reducing capacity installed in mainland regions and increasing the amount developed in Tasmania (by a smaller amount). Meanwhile, Snowy 2.0 generally increases the amount of wind developed each year by increasing the volume in Tasmania, Victoria and NSW, counterbalanced by smaller decreases in Queensland and SA.
- Marinus generally increases the capacity of large-scale solar PV in the NEM by the study end. A large increase in Tasmania from 2035-36 and more modest increase in Victoria from 2028-29 are counterbalanced by modest decreases in NSW and Queensland. Meanwhile, Snowy 2.0

causes less solar PV to be developed in the NEM by the study end. Generally solar development is advanced in NSW from 2028-29 until the study end, decreases in Queensland and Victoria, is delayed in SA until mid 2030s from when it exceeds the no Snowy 2.0 counterfactual, and is delayed in Tasmania until 2044-45 from when it exceeds the counterfactual.

Figure 30: Change in NEM capacity mix due to Marinus 600 MW for Snowy 2.0 EC90 (Snowy 2.0 EC90 with Marinus minus Snowy 2.0 EC90 without Marinus)[37]

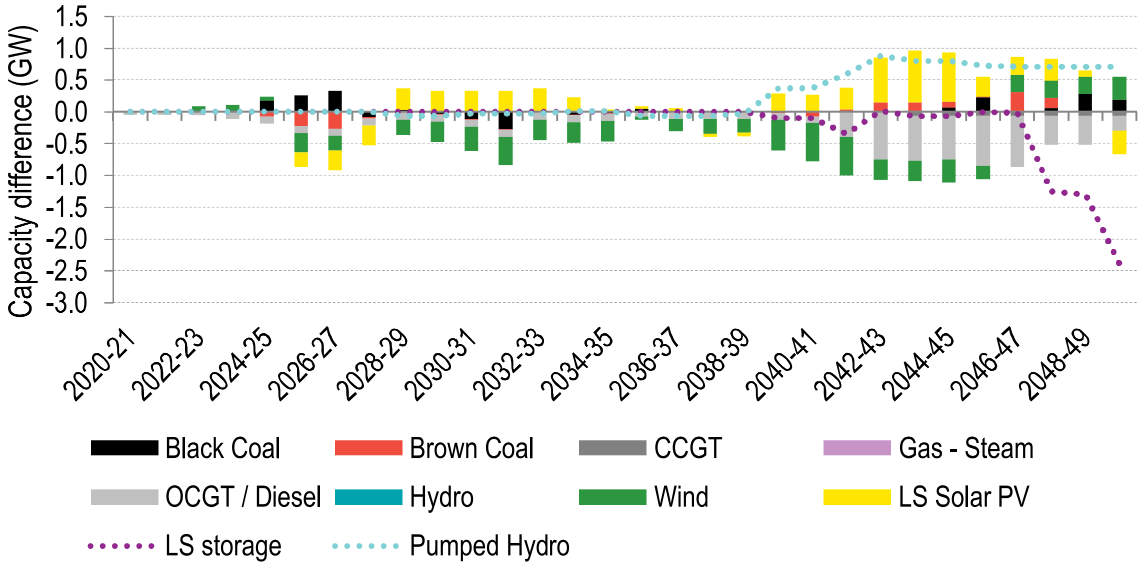
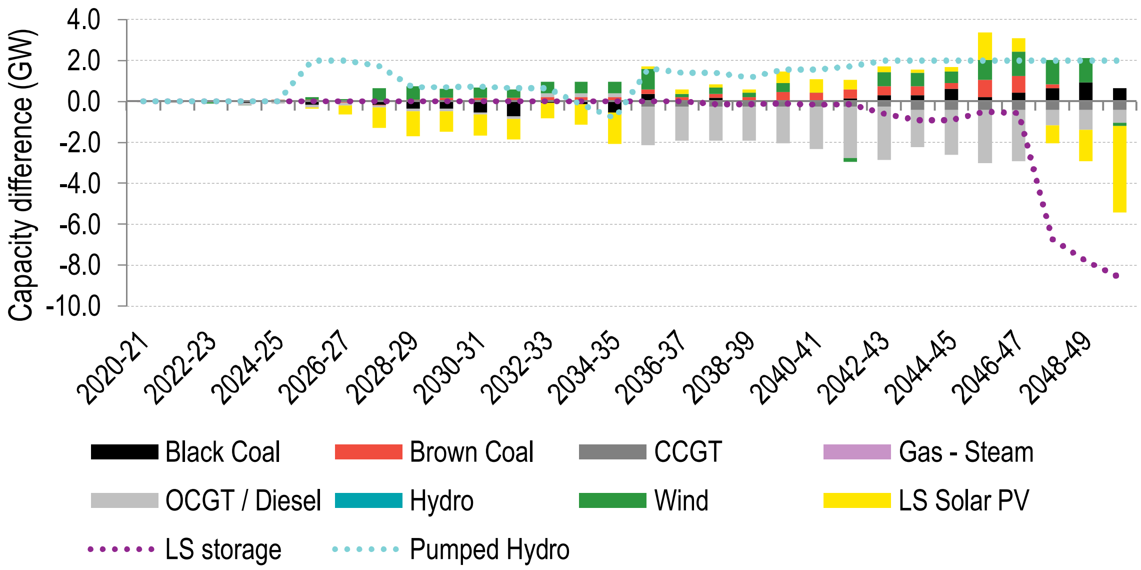


Figure 31: Change in NEM capacity due to Snowy 2.0 for EC90 and Marinus 600 MW (Snowy 2.0 EC90 with Marinus minus EC90 with Marinus)



The combined effect of both Marinus and Snowy 2.0 relative to the EC90 sensitivity without either project is shown in Figure 32. In general, the effects of the two projects are additive and so sometimes counteract each other when they push in opposite directions. The key overall trends of note are:

- Both projects tend to reduce the amount of peaking capacity and battery capacity and the effect is roughly additive.

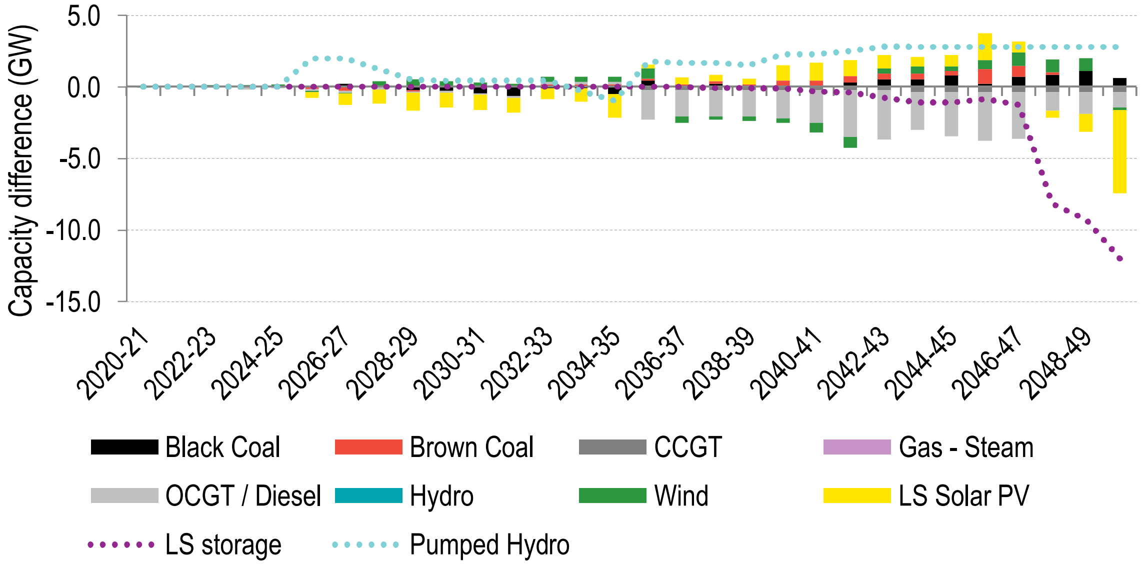
[37] Note the pumped hydro capacity includes 2 GW of Snowy 2.0 capacity from 2025-26.

- The delay in pumped hydro development in mainland regions due to Snowy 2.0 persists in the presence of Marinus, as does the final increase in pumped hydro capacity in Tasmania due to Marinus in the presence of Snowy 2.0.

- Both projects tend to increase the amount of wind capacity installed in Tasmania by the study end, but this appears to cap out at around 400 MW.

- Both projects tend to increase the amount of large-scale solar PV capacity installed in Tasmania so that the total in the presence of both Snowy 2.0 and Marinus is roughly equal to the cumulative total of the additional capacity due to either project individually.

Figure 32: Change in NEM capacity mix due to combined effect of Marinus 600 MW and Snowy 2.0 for EC90 (Snowy 2.0 EC90 with Marinus minus EC90 without Marinus; differences relative to Figure 24)



The NPV of the benefits of Marinus with Snowy 2.0 developed and a high emissions reduction target is forecast to be $1,229 million. This is a $376 million reduction in benefits relative to the case where Snowy 2.0 is not developed. (This outcome parallels those with the lower emissions reduction target, where benefits of Marinus were reduced from $845 million without Snowy 2.0 to $738 million with Snowy 2.0.) Snowy 2.0 erodes the benefits of Marinus by shifting capacity changes to mainland sites with similar retirement/build outcomes regardless of Marinus' presence or absence.

Table 12: Snowy 2.0 EC90 sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total EC90
NSW	180	75	117	49	8	429	354
QLD	472	37	-125	19	1	404	495
VIC	549	123	526	97	20	1,315	1,813
SA	118	43	114	5	-	280	386
TAS	-876	-240	-	-83	-	-1,199	-1,443
Total	444	38	632	86	29	1,229	1,605
Total EC90	734	102	692	71	6	1,605	

The largest change in benefit category relative to the EC90 sensitivity that did not contain Snowy 2.0 is in capex, which sees a $290 million reduction in savings from $734 million to $444 million. With Snowy 2.0 built, there are reduced capex savings due to Marinus in all mainland regions. This is somewhat offset by less capital cost incurred in Tasmania as the competitive advantage of new wind, solar PV and pumped hydro in Tasmania is eroded by Snowy 2.0. The presence of Snowy 2.0 shifts the relative contribution of benefit categories from capex and FOM benefits to fuel and VOM benefits.

Relative to the EC90 sensitivity, there are reduced capex and overall benefits due to Marinus for OCGT, wind and large-scale storage technologies (Table 13 compared to Table 9). The presence of Snowy 2.0 increases the costs for large-scale solar PV and pumped hydro due to complementary effects of Snowy 2.0 and Marinus on driving additional investment in capacity of these technologies in Tasmania.

Table 13: Snowy 2.0 EC90 sensitivity NPV benefit ($m) by technology

Technology	Capex	FOM	Fuel	VOM	USE	Total	Total EC90
Black Coal	-	-31	-211	-24	-	-267	-517
Brown Coal	-	66	17	2	-	85	210
CCGT	14	1	189	20	-	225	8
Gas - Steam	-	-	34	6	-	40	40
OCGT / Diesel	91	31	603	62	-	788	1,230
Hydro	-	-	-	2	-	2	5
Wind	457	71	-	-10	-	517	576
LS Solar PV	-133	-58	-	-	-	-191	-58
Pumped Hydro	-108	-57	-	28	-	-136	-86
LS storage	123	15	-	-	-	137	192
USE	-	-	-	-	29	29	6
Total	444	38	632	86	29	1,229	1,605
Total EC90	734	102	692	71	6	1,605	

3.2.4 Tas100LossLoad

The sensitivity of market benefit outcomes to a reduction in Tasmanian load was examined by imposing a 100 MW reduction in all intervals of all years. All other assumptions regarding the NEM demand are unchanged from Base Case assumptions. This reduction was a test case and does not correspond to a particular industry.

As demand decreases, there is energy spilt without additional interconnection for two reasons:

- ► In some intervals, Tasmanian wind generation exceeds Tasmanian demand and this energy is spilt if there is insufficient interconnector capacity to export all the excess.
- ► The flexibility of Tasmanian hydro storages to shift water usage to times of higher value begins to reach its limits. Consequently at times, energy must be spilt in order to maintain reservoir limits.

Additional interconnection reduces both the frequency of intervals with wind or hydro spill and volume of energy spilt. The lower value of Tasmanian energy in the Tasmanian load reduction case with Basslink only means the benefits of additional interconnection are greater. Overall, the NPV of the benefits of Marinus in this sensitivity is forecast to increase to $985 million (Table 14), up from $845 million in the Base Case.

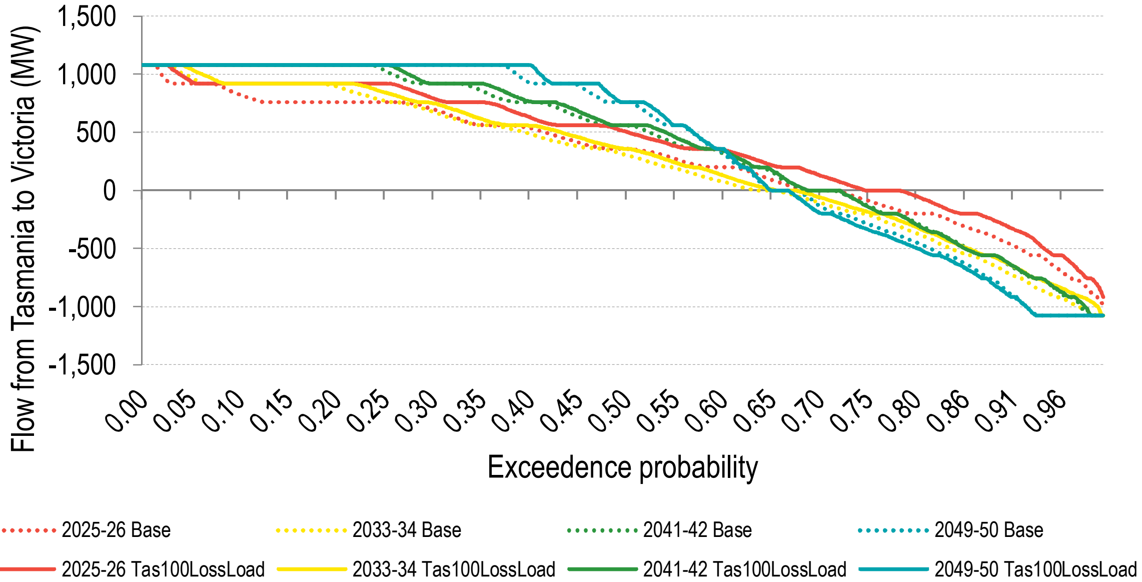
Table 14: Tas100LossLoad sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case
NSW	64	70	124	23	-1	280	314
QLD	108	23	-56	10	2	86	88
VIC	291	80	432	61	39	902	896
SA	133	84	121	28	-1	364	340
TAS	-434	-170	-	-44	-	-648	-794
Total	161	87	621	78	38	985	845
Total Base Case	87	59	598	66	35	845	

The trends in capacity development across the NEM with and without Marinus are generally similar to those observed in the Base Case, but the magnitudes are slightly larger. This is reflected in the increase in capex savings, from $87 million in the Base Case to $161 million. The trends in generation are also similar to those in the Base Case, but with slightly larger magnitudes. This causes an increase in the fuel benefit and VOM benefits relative to the Base Case. All benefit categories represent an increase relative to the Base Case. As in the Base Case, the reliability benefit is overwhelmingly accrued in Victoria.

As in the Base Case, Marinus enables better utilisation of Tasmanian energy to reduce use of existing mainland gas generation and defer building new mainland capacity. With reduced Tasmanian demand, there is more excess Tasmanian energy to export and more often, but this energy can only be utilised – and the flow-on benefits realised – with additional interconnection. The increased export flow on Marinus and Basslink with reduced demand can be seen in the duration chart in Figure 33.

Figure 33: Duration curve for cumulative flow of Basslink and Marinus for Tas100LossLoad with Marinus 600 MW



The $985 million in benefits is unevenly spread between the regions (Table 14). Much of the change in benefit relative to the Base Case arises from a large increase in the negative benefit in Tasmania (a decrease in costs), and a large proportion of that arises from a large increase in the negative capex component from $-559 million in the Base Case to $-434 million here. The reduced

Tasmanian capex derives from a reduced ability to install additional Tasmanian capacity to export to Victoria at times of high Victorian prices because the additional interconnector capacity of Marinus is already being heavily utilised by existing Tasmanian capacity.

3.2.5 Tas300LossLoad

Imposing a 300 MW demand reduction in Tasmania in all intervals significantly increases the benefits of Marinus relative to the Base Case and the 100 MW demand reduction (Table 15). The trends and reasoning are similar to the 100 MW demand reduction sensitivity (Section 3.2.4), but more exaggerated:

- ► With a 300 MW demand reduction there is a large excess of energy in Tasmania. This means without additional interconnection, larger volumes of energy are spilt.
- ► Additional interconnection allows the greater excess of Tasmanian energy to be used on the mainland to further reduce gas generation and defer the building of new capacity.
- ► Tasmanian capex cost reduces further below the 100 MW demand reduction sensitivity because there is a further reduction in space on the interconnector for energy from new Tasmanian capacity to be exported to Victoria at times of high Victorian prices.

Table 15: Tas300LossLoad sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Tas100 LossLoad
NSW	182	91	316	72	-1	660	280
QLD	180	38	-25	19	4	217	86
VIC	68	28	577	79	45	796	902
SA	11	31	272	52	-2	364	364
TAS	-235	-103	-	-70	-	-408	-648
Total	206	85	1,139	153	47	1,630	985
Total Tas100 LoadLoss	161	87	621	78	38	985	

3.2.6 HighGas

In the high gas price case, relative to the Base Case, the advantage of Marinus is to greatly drive savings in fuel at the expense of higher investment in capital. Renewable energy production of both wind and solar increase and gas consumption decreases. The high gas prices drive expanded wind capacity in Tasmania relative to the neutral gas price scenario, and on the mainland high gas prices favour more solar relative to the neutral gas price scenario. This reflects the relative locational strengths of wind and solar resources. This increases the benefits of Marinus relative to the counterfactual.

The NPV of the benefits of Marinus in this scenario with higher gas prices is forecast to be $930 million across the NEM (Table 16), which is an $85 million increase in benefits relative to the Base Case. The higher gas price is consistent with the AEMO ISP 2018 strong gas price scenario. The fuel benefit is $1,004 million, a substantial increase compared with the Base Case. The capex benefit is $-189 million, reflecting an increase in the justification to expend further capital due to higher fuel costs. The remaining categories of benefits are less, comprising FOM and VOM savings and a slight reliability benefit.

Table 16: HighGas sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case
NSW	3	35	505	56	-	599	314
QLD	80	7	-23	11	2	77	88
VIC	221	119	356	46	16	758	896
SA	125	66	166	28	-6	378	340
TAS	-618	-212	-	-53	-	-882	-794
Total	-189	15	1,004	87	13	930	845
Total Base Case	87	59	598	66	35	845	

The $930 million in benefits is widely spread between the regions (Table 16), with a large positive benefit of $758 million in Victoria, benefits of $599 million in NSW and $378 million in SA, all of which are significantly related to lowering fossil fuel consumption to avoid the impact of higher gas costs, and a large negative benefit of $-882 million in Tasmania. Comparing the benefits between the regions, with Marinus, the investment capex in generation in Tasmania increases by $618 million, which is represented as a negative benefit to Tasmania. There are corresponding savings in capex in all the mainland states, due to the reduced need to build in those states, as Tasmania's resources are able to be unlocked by Marinus. The introduction of Marinus provides overall capex increases because large-scale solar PV and pumped hydro increase by $320 million and $123 million respectively across the NEM, which outweighs the reduction in wind investment by $212 million (Table 17).

The fuel saving of $1,004 million is from the reduced need for gas fired plant of all types, particularly CCGT and OCGT capacity, including $369 million reduction in CCGT fuel cost and $613 million in OCGT and diesel generation fuel cost reductions due to Marinus. There are small increases in both black and brown coal fuel costs due to transfer to the lower cost fuels away from higher cost gas.

Table 17: HighGas sensitivity NPV benefit ($m) by technology

Technology	Capex	FOM	Fuel	VOM	USE	Total
Black Coal	-	47	-23	-1	-	22
Brown Coal	-	12	-4	-	-	7
CCGT	75	7	369	37	-	488
Gas – Steam	-	-	49	8	-	57
OCGT / Diesel	-32	110	613	54	-	745
Hydro	-	-	-	2	-	2
Wind	212	33	-	-19	-	226
LS Solar PV	-320	-131	-	-	-	-451
Pumped Hydro	-123	-62	-	7	-	-178
LS storage	-	-	-	-	-	-
USE	-	-	-	-	13	13
Total	-189	15	1,004	87	13	930

A detailed review of the findings of the higher gas price case with and without Marinus shows that, with Marinus, Tasmania builds more wind from 2028-29, more solar from 2035-36, and more PSH from 2035-36. For the overall NEM, with Marinus, wind development is deferred in most years starting in 2025-26, with up to 200 MW less wind by the end of the study; more solar is developed from 2028-29, with up to 700 MW more solar by 2050; more PSH capacity is developed, with up to 700 MW more by 2050; less OCGT capacity is developed, with up to 800 MW less by 2050, and 200 MW more CCGT capacity is built, reflecting a shift to more efficient use of gas driven by the higher gas prices.

Overall the benefits of Marinus increase in this scenario, which reflects higher prices for export gas markets which then set the price in Australia through netback from international market prices.

3.2.7 BL400

If another Basslink cable fault was to occur, a possible outcome is a 20 % derating of Basslink upon its return to service to reduce the risk of further faults occurring. This sensitivity investigates the outcomes of the possibility by de-rating Basslink's bi-direction power transfer limit to 400 MW.[38]

In this scenario, the NPV benefits of Marinus is forecast to increase from $845 million in the Base Case to $992 million (Table 18). Increases in capex and fuel benefits of $51 million and $55 million respectively account for a large proportion of the total increase of $147 million. All other categories also increase by a smaller magnitude, in the range $11 million to $16 million.

Table 18: BL400 sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case
NSW	82	66	125	26	-	299	314
QLD	106	19	-57	10	2	81	88
VIC	310	79	468	64	52	972	896
SA	148	89	118	29	-3	379	340
TAS	-507	-180	-	-52	-	-740	-794
Total	138	73	653	77	51	992	845
Total Base Case	87	59	598	66	35	845	

Without Marinus, reducing Basslink capacity increases gas usage on the mainland. Capex on new gas capacity, large-scale solar PV and large-scale storage on the mainland is also higher, but outweighed by reduced wind capex in Tasmania. Reducing Basslink flow reduces the ability of Tasmanian capacity to be exported to Victoria at times of high Victorian prices and thus lowers the value of Tasmanian generation and increases the amount of Tasmanian generation spilt relative to the Base Case.

Against this background, the benefits of Marinus are larger in all categories. However, the same key overall trends remain the same as the Base Case: reduced fuel use on the mainland, capex savings through a deferral of new gas capacity on the mainland, a shift in wind development from the mainland to Tasmania (and an overall reduction in MW) and an increase in large-scale solar PV and pumped hydro capex. Overall, Victoria and SA increase their positive benefit, and Tasmania reduces its negative benefit.

[38] The sensitivity does not include any outage of Basslink, only the consequences of a derating.

3.2.8 VRET QRET

This sensitivity investigates the benefits for Marinus under the assumption that the full VRET and QRET are to be met. The addition of these two renewable energy targets is forecast to drive a number of differences in the capacity developments throughout the NEM, compared to the Base Case. Regardless of whether Marinus is commissioned, the majority of these differences occur in the mainland throughout the 2020s and 2030s. The model is allowed to decide the optimal timing for the capacity build for Victoria and Queensland to achieve these targets by the specified target date. As such, all capex costs associated with the new entrant capacity required to meet these targets are accounted for in the modelling process.

To achieve the VRET of 40 % renewable generation in Victoria by 2025, approximately 3 GW of wind and large-scale solar PV capacity is brought forward from the 2030s and 2040s to 2024-25. Similarly, in Queensland the installation of approximately 5 GW of wind and solar capacity is forecast to be brought forward from the late 2030s to 2029-30 so as to achieve the QRET of 50 % renewable generation in Queensland by this time. By 2029-30 it is forecast that there is approximately 7 GW of additional wind and solar capacity in the NEM for the VRET QRET sensitivity compared to the Base Case, regardless of whether Marinus is installed. Subsequently, in both the with and without Marinus cases for VRET QRET it is forecast that new entrant wind and solar capacity in NSW and SA is deferred from the 2020s until the 2030s and 2040s.

Overall, the $834 million benefit of Marinus that is forecast for the VRET QRET sensitivity is quite similar to that of the Base Case (Table 19). However, the differences in regional capacity developments leads to corresponding differences in the spread of benefits for each region. To meet the assumed renewable energy targets it is forecast that a large amount of wind and large-scale solar PV capacity will already be installed in the mainland by the 2030s. As such, there is approximately 100 MW less wind capacity in Tasmania from 2029-30 for the VRET QRET sensitivity with Marinus compared to the Base Case with Marinus. This implies that the excess mainland renewable generation slightly reduces Marinus' effectiveness in unlocking the potential for new entrant Tasmanian generation to be exported to the mainland.

Table 19: VRET QRET sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case
NSW	89	60	244	40	-	432	314
QLD	145	12	-28	11	6	146	88
VIC	179	82	355	35	29	681	896
SA	47	49	95	5	-	196	340
TAS	-422	-165	-	-34	-	-621	-794
Total	38	38	666	57	35	834	845
Total Base Case	87	59	598	66	35	845	

3.2.9 AETV

The AETV Scenario investigates the benefit of Marinus under the assumption that Aurora Energy Tamar Valley OCGT and CCGT are not forced to retire by 2025-26. In addition to this, it is further assumed that without Marinus, both generators will remain available for service throughout the entire study period. Without Marinus, the Tasmanian OCGT and CCGT are rarely forecast to operate. As such, the annual development of new entrant capacity for this scenario is very similar to that of the Base Case without Marinus.

With Marinus, both generators are given the option to retire. Because of this, the Tamar Valley OCGT is forecast to retire in the first year of the study as the FOM contribution of $16 million towards the overall NPV outweighs the potential befit for keeping it operational. Alternatively, the Tamar Valley CCGT is not chosen to retire. The primary benefit for this Tasmanian CCGT occurs after the assumed retirements of large coal power stations from the 2030s onward, starting with Yallourn in 2032-33.

The additional CCGT generation from Tasmania allows for a deferral of approximately 300 MW of new entrant capacity to be installed across the NEM from the early 2030s to the late 2040s. This deferral of new entrant capacity primarily occurs in Tasmania, with approximately 200 MW less solar capacity and 100 MW less pump storage hydro capacity in 2035-36, compared to the Base Case with Marinus. By the end of the study there is approximately 100 MW less solar capacity in Tasmanian compared to that of the Base Case. The amount of pump storage hydro capacity is roughly the same.

The NPV of the benefits of Marinus with Tamar Valley allowed to remain operation after 2025-26 is forecast to be $904 million. The additional benefit compared to the Base Case is primarily driven by the saving in capex cost for Tasmania and Victoria that Marinus allows for by unlocking the potential for additional CCGT generation (Table 20). The CCGT generation that is unlocked by Marinus is seen as a negative benefit in fuel cost of $-271 million for Tasmania.

Table 20: AETV sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case
NSW	83	48	220	36	-1	386	314
QLD	116	20	-45	12	2	104	88
VIC	359	90	426	65	41	981	896
SA	138	85	117	26	-1	365	340
TAS	-457	-126	-271	-78	-	-933	-794
Total	239	116	447	61	41	904	845
Total Base Case	87	59	598	66	35	845	

As mentioned, the Tamar Valley OCGT is allowed to retire for the scenario with Marinus. The retirement of this generator in the first year of the study results in a FOM saving of approximately $16 million. For the case without Marinus, the generator is not given the option to retire; however, it is almost never forecast to be operated. This indicates that if the generator was allowed to retire without Marinus, the benefit of Marinus may reduce to at least $888 million.

3.2.10 Defer2028 and Defer2032

The RIT-T requires consideration of the optimal timing for proposed developments. To investigate the potential benefit for a deferred commissioning of Marinus, two different commissioning dates were chosen: 1 July 2028 and 1 July 2032.

For comparative purposes, the NPV benefits that are discussed in this section have been discounted to the date that Marinus is assumed to be commissioned. This is, the NPV benefits for the Defer2028 and Defer2032 sensitivities are discounted to 1 July 2028 and 1 July 2032 for this section, respectively.

Since the study period ranges from 2020-21 to 2049-50, it must also be noted that Marinus is installed for 22 years in Defer2028 scenario and for 18 years in the Defer2032 scenario, as opposed to the Base Case which has Marinus installed for 25 years.

The benefits of Marinus if it is deferred to 1 July 2028 and 1 July 2032 are forecast to be \$881 million[39] and \$905 million[40], respectively. The majority of the additional benefit compared to the Base Case is related to the fuel benefit, which primarily occurs in Victoria (Table 21 and Table 22).

For both scenarios with Marinus deferred, there is minimal difference in the generation and capacity mix for the NEM compared to the Base Case by the late 2040s. The main differences occur throughout the 2020s and 2030s. In the Base Case, the earlier commissioning of Marinus allows for the retirement of approximately 300 MW of existing OCGT capacity in SA and Victoria from the early 2020s, since Marinus will allow Tasmania to supply additional hydro generation. With Marinus deferred to a later date, it is not beneficial to retire this gas capacity on the mainland. Because this OCGT capacity is not retired, the installation of between 200 MW and 400 MW of large-scale solar PV and pumped hydro storage capacity is deferred from the early 2030s to the 2040s for both the Defer2028 and Defer2032 scenarios.

Table 21: Defer2028 sensitivity NPV benefit[41] (\$m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case
NSW	123	58	130	30	2	344	314
QLD	151	27	-63	9	1	126	88
VIC	392	96	472	70	34	1,064	896
SA	109	74	75	15	-2	270	340
TAS	-654	-213	-	-55	-	-923	-794
Total	121	42	613	69	35	881	845
Total Base Case	87	59	598	66	35	845	

Table 22: Defer2032 sensitivity NPV benefit[42] (\$m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case
NSW	104	37	147	28	3	320	314
QLD	114	20	-47	10	1	98	88
VIC	564	118	569	86	11	1,349	896
SA	104	53	41	-2	-	195	340
TAS	-745	-259	-	-53	-	-1,057	-794
Total	141	-31	710	69	15	905	845
Total Base Case	87	59	598	66	35	845	

The reduced amount of OCGT retirement in SA and Victoria results in a slight decline in the FOM cost contribution to the overall benefit. As with the Base Case, the majority of Marinus' benefit stems from the interconnector's ability to enable hydro generation in Tasmania to reduce the need

[39] To calculate the NPV benefit discounted to 1 July 2025, apply a scaling factor of $(1 + WACC)^{-3} = 1.06^{-3} \approx 0.8396$
[40] To calculate the NPV benefit discounted to 1 July 2025, apply a scaling factor of $(1 + WACC)^{-7} = 1.06^{-7} \approx 0.6651$
[41] Discounted to 1 July 2028, when Marinus is assumed to be commissioned in this scenario
[42] Discounted to 1 July 2032, when Marinus is assumed to be commissioned in this scenario

to burn gas in Victoria and NSW over peaks, by storing surplus energy from the low demand periods and shifting production to the peak periods when it has a much greater value. The majority of this benefit occurs once existing coal capacity begins to retire from the early 2030s onward. Because Marinus is assumed to be commissioned later in these scenarios (and therefore closer to the retirement dates of existing coal generators) this benefit for fuel cost in Victoria is comparatively higher.

3.2.11 Tas600Wind

Tasmania has excellent wind resource in comparison to other NEM regions. The Tas600Wind sensitivity examines a possible scenario where an additional 600 MW of wind capacity is commissioned in Tasmania by 2025-26, whether or not Marinus is commissioned. This means that a total of 1,650 MW of wind capacity is assumed to be installed in Tasmania by the time Marinus would be operational. In this analysis, the capital cost of the additional wind is not accounted for.

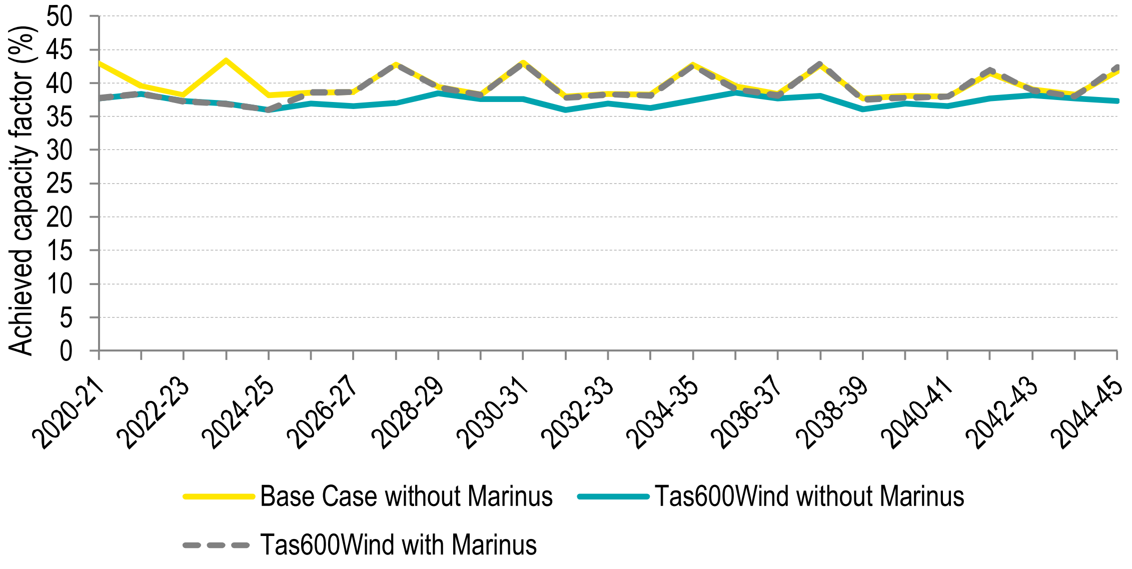
As for the Base Case, the majority of NEM capacity is expected to be comprised of black and brown coal and hydro until the mid 2020s. As the study progresses, capacity in the NEM primarily shifts towards wind and solar, with some installation of OCGT, CCGT storage capacity for dispatchable generation to balance the increasing amount of intermittent renewables.

The additional 600 MW of wind capacity in Tasmania is expected to allow Basslink to be utilised to export generation from Tasmania to Victoria more frequently and therefore reduces the amount of new entrant capacity in the mainland. This persists until the retirement of this additional Tasmanian wind capacity after its 25-year lifetime is reached. The reduction in new entrant mainland capacity is spread between Victoria, NSW and SA since Victoria is able to export much of the surplus generation from Tasmania to these two regions. The capacity difference between the Tas600Wind and Base Case for Victoria is most noticeable in 2032-33 when it Yallourn power station in Victoria is anticipated by the ISP to retire. The additional Tasmanian wind generation allows for a deferral of approximately 200 MW of new entrant wind and solar PV capacity until the mid 2040s.

Towards the end of the study, in the late 2040s, it is forecast that there are only small differences in the capacity mix in the NEM when compared to the Base Case without Marinus. This is because Tasmania cannot fully utilise the additional wind generation if Basslink is the only interconnector between Tasmania and the mainland. The large amount of spilt Tasmanian renewable generation reduces its competitiveness compared to renewables options in mainland regions.

Figure 34 summarises the spillage of wind generation associated with the additional 600 MW of wind capacity in Tasmania by comparing the achieved capacity factor of new entrant wind generation in Tasmania for the Tas600Wind compared to the Base Case without Marinus. For the Base Case there is no significant amount of wind spill in any of the years. As such, the annual achieved capacity factor is determined by the historical generation profile used in the model. With Marinus commissioned in the Tas600Wind scenario, the frequency of intervals with wind and hydro spillage is reduced to similar levels to the Base Case without Marinus (Base Case with Marinus is also similar).

Figure 34: Achieved capacity factor forecast for new entrant wind commissioned in Tasmania[43]



The NPV of the benefits of Marinus in this scenario with 600 MW additional wind committed from the first year of modelling is $1,280 million across the NEM (Table 23). These benefits stand only under the key assumption that the additional wind capacity would be installed in Tasmania regardless of the development of Marinus. As such, the costs of the additional capacity and FOM are not included here since the costs are equivalent with and without Marinus.

Table 23: Tas600Wind sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case
NSW	100	78	114	28	-	319	314
QLD	99	19	-39	11	3	93	88
VIC	424	108	431	77	41	1,082	896
SA	205	83	130	40	-2	456	340
TAS	-418	-163	-	-89	-	-670	-794
Total	409	125	637	66	42	1,280	845
Total Base Case	87	59	598	66	35	845	

The primary difference for Tas600Wind compared to the Base Case relates to the increased benefit of capex and FOM, with some additional benefit to fuel cost and reliability. The additional 600 MW of wind capacity that is assumed to be built regardless of Marinus is not expected to be fully utilised without an increase in the transfer limit between Tasmania and Victoria, which is allowed for by Marinus. With Marinus commissioned the amount of new entrant capacity built on the mainland is reduced during the 2020s and 2030s, whereas without Marinus commissioned new entrant capacity build on the mainland does not reduce as the additional 600 MW of Tasmanian wind cannot be effectively utilised. This sensitivity delivers a total savings of $729 million in capex and $116 million in FOM for wind, which primarily occurs in Victoria and SA (Table 24).

[43] The achieved capacity factor for the Base Case with Marinus also follows the yellow line of the Base Case without Marinus, since there is an insignificant amount of wind spill in either case

Table 24: Tas600Wind sensitivity NPV benefit ($m) by technology

Technology	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case
Black Coal	-	74	-44	-2	-	28	10
Brown Coal	-	9	-1	-	-	7	13
CCGT	-3	-	-27	-3	-	-34	-43
Gas - Steam	-	-	41	7	-	48	35
OCGT / Diesel	25	81	668	67	-	842	804
Hydro	-	-	-	4	-	4	3
Wind	729	116	-	-13	-	832	393
LS Solar PV	-282	-117	-	-	-	-399	-301
Pumped Hydro	-72	-39	-	7	-	-104	-118
LS storage	12	2	-	-	-	14	15
USE	-	-	-	-	42	42	35
Total	409	125	637	66	42	1,280	845
Total Base Case	87	59	598	66	35	845	

Compared to the Base Case, it is forecast that there is less new entrant wind and solar PV capacity installed in Tasmania until the mid 2040s due to the 600 MW of wind capacity that is already assumed to be commissioned. This results in a reduction in the magnitude of the negative benefit for Tasmania to $-670 million (primarily comprised of a negative benefit of $-418 million for capex), compared to $-794 million in the Base Case.

Figure 35 shows an expected duration curve for several years throughout the study. The additional 600 MW of Tasmanian wind capacity allows the flow from Tasmania to reach its maximum limit of 1,078 MW for approximately 20 % of the time from the first year of Marinus' operation.

Figure 35: Duration curve for cumulative flow of Basslink and Marinus for Tas600Wind with Marinus 600 MW

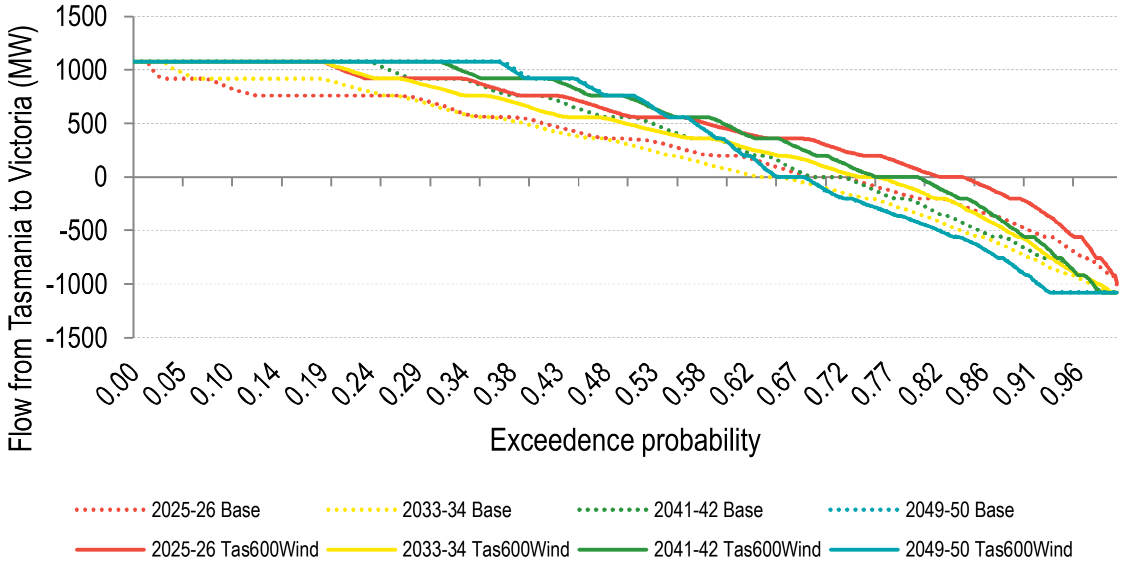
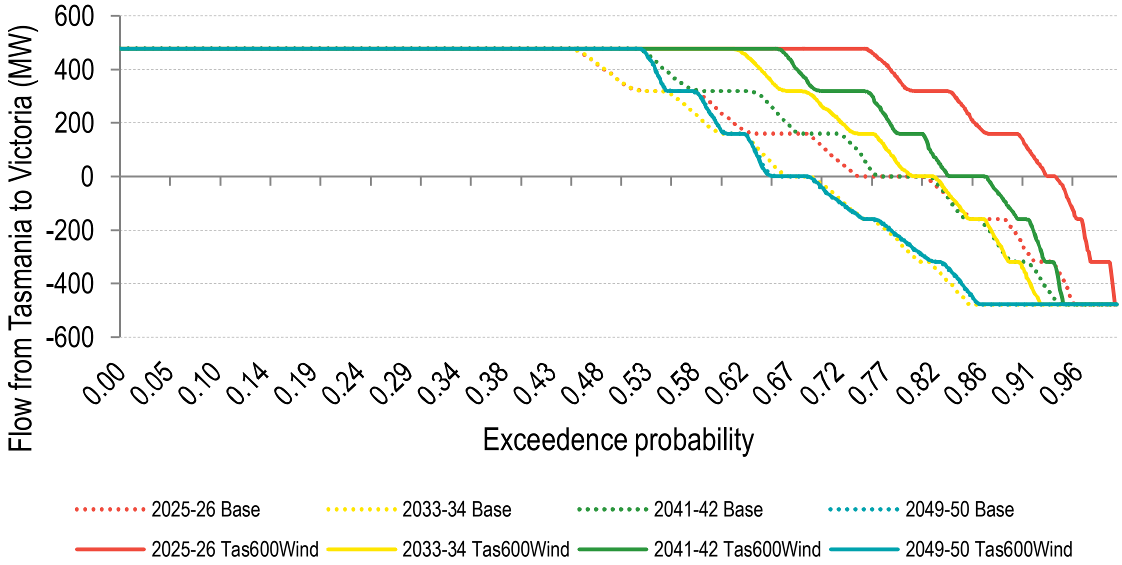


Figure 36 shows that without Marinus, Basslink is expected to be heavily over-utilised for exports for this sensitivity. This is especially evident in 2025-26 which is primarily driven by the annual variation in wind generation. The forecast generation profile for wind generators in NSW in 2025-26 has a lower than average capacity factor. Alternatively, the profiles used for wind generation in Tasmania and Victoria tend to be higher than average in 2025-26. This results in more flow from Victoria to NSW and a corresponding increase in flow from Tasmania to Victoria across Basslink. In general, larger interconnector capacity, including Marinus, allow for the variability of intermittent renewables to be accommodated, reducing the waste of renewable resources, and saving fuel costs.

By the end of the study period a similar duration curve is observed as seen in the Base Case since the additional 600 MW of Tasmanian wind is assumed to have retired by this time.

Figure 36: Duration curve for Basslink flow for Tas600Wind without Marinus



3.2.12 Tas600PSH

This sensitivity is focussed on the outcomes for Marinus if an additional 600 MW of PSH is committed in Tasmania above the Base Case capacity prior to the commissioning of Marinus. The NPV of the benefits of Marinus in this scenario is forecast to be $1,061 million across the NEM (Table 25).

As for the Tas600Wind scenario, some of the addition benefit for Tas600PSH over the Base Case is associated with a reduction in capex cost for pumped hydro in Tasmania with Marinus, since additional capacity is already committed at the start of the study. This reduces the magnitude of the negative benefit for Tasmania to $-576 million (primarily a negative benefit of $-416 million for capex), compared to $-794 million in the Base Case.

Table 25: Tas600PSH sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case	Total Tas600 Wind
NSW	41	53	152	34	-	280	314	319
QLD	103	20	-27	15	3	113	88	93
VIC	251	96	414	64	33	857	896	1,082
SA	124	82	152	32	-4	386	340	456
TAS	-416	-123	-	-37	-	-576	-794	-670

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case	Total Tas600 Wind
Total	103	129	691	107	31	1,061	845	1,280
Total Base Case	87	59	598	66	35	845		
Total Tas600 Wind	409	125	637	66	42	1,280		

The additional benefit comes from Marinus being able to better utilise the extra 600 MW of PSH to reduce the need to burn gas in Victoria and NSW over peaks, by storing imports to Tasmania from the mainland that can be exported back to the mainland and displace high priced gas generation over peaks. The fuel benefit increases from $598 million in the Base Case to $691 million for the Tas600PSH scenario (Table 25).

With Marinus, and with the increased PSH capacity, imports to Tasmania are able to be absorbed, as the imported energy can be exported back to the mainland and displace high priced gas generation over peaks.

With less gas generation forecast to be dispatched in the NEM, capacity from existing gas generators can be retired in favour of additional solar capacity which complements the PSH. A detailed review of the findings of the case with 600 MW of committed PSH in Tasmania with and without Marinus shows that, with Marinus, Tasmania builds more wind from 2025-26, more solar from 2032-33, and more PSH from 2042-43. Compared with the Base Case, this is an advancement in the development of both wind and solar in Tasmania, but a deferment in further PSH development.

For the overall NEM, with Marinus, wind development is deferred in most years starting in 2025-26, with up to 500 MW less wind by the end of the study. This leads to a benefit of $313 million for wind capex cost for Marinus, compared to the $344 million benefit for the Base Case. With Marinus commissioned, more solar is developed from 2029-30, with up to 200 MW more solar by 2050. Since solar capacity is installed sooner in the Tas600PSH compared to the Base Case, the magnitude of the negative contribution the overall NPV benefit is higher, resulting in a cost of $-321 million compared to $-214 million for the Base Case.

In summary, the effects of 600 MW committed PSH in Tasmania on the forecast development of the NEM, with and without Marinus, relative to the Base Case are subtle, compared with the more obvious case of 600 MW of wind. However, the NPV of benefits of Marinus improves due to the ability to make better use of Marinus to reduce system costs throughout the NEM.

3.2.13 Tas600Wind Tas600PSH

This sensitivity is focussed on the outcomes for Marinus if additional development of both 600 MW wind and 600 MW PSH are committed in Tasmania above the Base Case, prior to the commissioning of Marinus. As identified in Sections 3.2.11 and 3.2.12, the expected benefits of 600 MW of additional wind alone is $435 million and the benefits of 600 MW of additional PSH alone is $216 million. The modelling of this sensitivity shows the combined total additional benefits of an additional 600 MW of wind *and* 600 MW of PSH are $601 million (Table 26, $1,446 million minus $845 million), which is only $50 million less than the sum of the individual incremental benefits. This suggests that increased wind and increased pump storage are complementary to each other, rather than materially eroding the benefits. These benefits stand only under the key assumption that both the additional wind and PSH capacities would be installed in Tasmania regardless of the development of Marinus. In addition the costs of the additional capacity are not included here.

Without Marinus, the 600 MW of additional wind and 600 MW of PSH in Tasmania would deliver an almost constant flow at the limit from Tasmania to Victoria. This would reduce the potential for importing from the mainland during low price periods, particularly the middle of the day, because Basslink, already operating at its export limit, would have no opportunity to export more energy during a high priced period.

With Marinus, and with the increased PSH capacity, imports to Tasmania are able to be absorbed, as the imported energy can be exported back to the mainland and displace high priced gas generation over peaks.

The NPV of the benefits of Marinus in this sensitivity with 600 MW of PSH commissioned in Tasmania from 1 July 2025 and 600 MW additional wind committed from the first year of modelling is forecast to be $1,446 million across the NEM (Table 26). However, this does not include the capital expenditure associated with the PSH generation or additional wind, which is taken as committed whether or not Marinus proceeds.

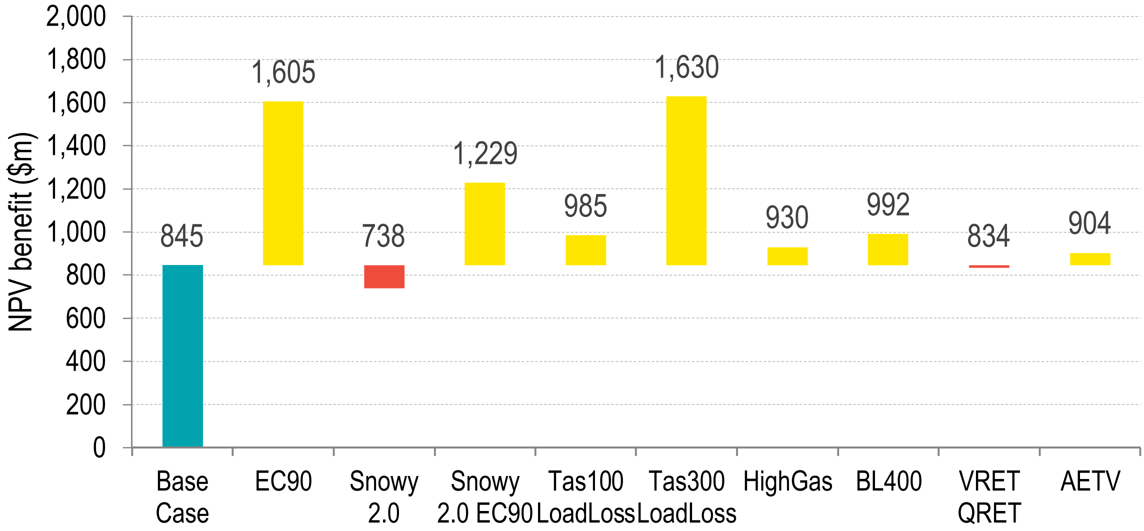
Table 26: Tas600Wind Tas600PSH sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case	Total Tas 600 Wind	Total Tas 600 PSH
NSW	63	82	151	40	-1	335	314	319	280
QLD	119	28	-26	14	3	138	88	93	113
VIC	366	115	438	80	37	1,037	896	1,082	857
SA	99	63	206	46	-3	411	340	456	386
TAS	-301	-115	-	-60	-	-476	-794	-670	-576
Total	346	174	770	120	37	1,446	845	1,280	1,061
Total Base Case	87	59	598	66	35	845			
Total Tas600Wind	409	125	637	66	42	1,280			
Total Tas600PSH	103	129	691	107	31	1,061			

3.2.14 Summary of Marinus 600 MW sensitivities

Figure 37 displays the influence of different market conditions on the benefit of Marinus. A large increase in benefit is forecast for Marinus under a high emissions target of 52 % reduction in emissions by 2030, followed by a linear reduction to 90 % by 2050. Compared to the Base Case, Marinus' benefit in the EC90 sensitivity increases by $760 million to $1,605 million. The assumption that Snowy 2.0 will be commissioned detracts from Marinus' benefit with the lower emission trajectory (Snowy 2.0 sensitivity) and the high emissions trajectory (Snowy 2.0 EC90). Snowy 2.0 decreases benefit by $107 million with the lower emission trajectory. While the $1,229 million benefit for Marinus in the Snowy 2.0 EC90 sensitivity is considerably higher than the Base Case, it is also $376 million lower than the EC90 Scenario without Snowy 2.0.

Figure 37: Waterfall chart of total benefits of Marinus 600 MW in Base Case and sensitivities (EC90, Snowy 2.0, Snowy 2.0 EC90, Tas100LoadLoss, Tas300LoadLoss, HighGas, BL400, VRET QRET, AETV)



While the Tas100LoadLoss sensitivity is forecast to cause Marinus' benefit rise by $140 million compared to the Base Case, if Tasmania's load was to decrease by 300 MW Marinus' benefit is forecast to increase by $785 million compared to the Base Case. This is the most beneficial of the Marinus 600 MW cases in this Report.

For the HighGas, BL400 and AETV sensitivities, minor increases in benefit of $59 million to $147 million are forecast compared to the Base Case. A slight reduction of $11 million in benefit is forecast for the VRET QRET sensitivity due to the additional mainland capacity installed to achieve the renewable energy targets.

Figure 38 shows the NPV benefits for deferring Marinus when discounted to the assumed commissioning date of Marinus. It is forecast that deferring Marinus closer to the assumed retirement of most Victorian and NSW coal power stations leads to a slight increase in benefit.

Figure 38: Waterfall chart of total benefits[44] of Marinus 600 MW in Base Case and Marinus deferral sensitivities (Defer2028 and Defer2032)

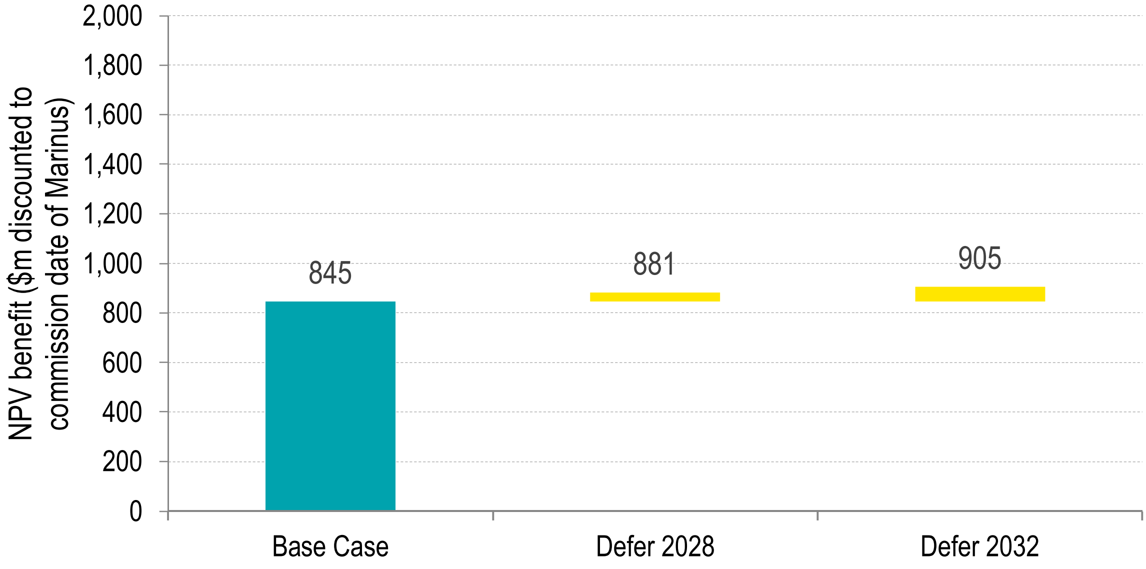
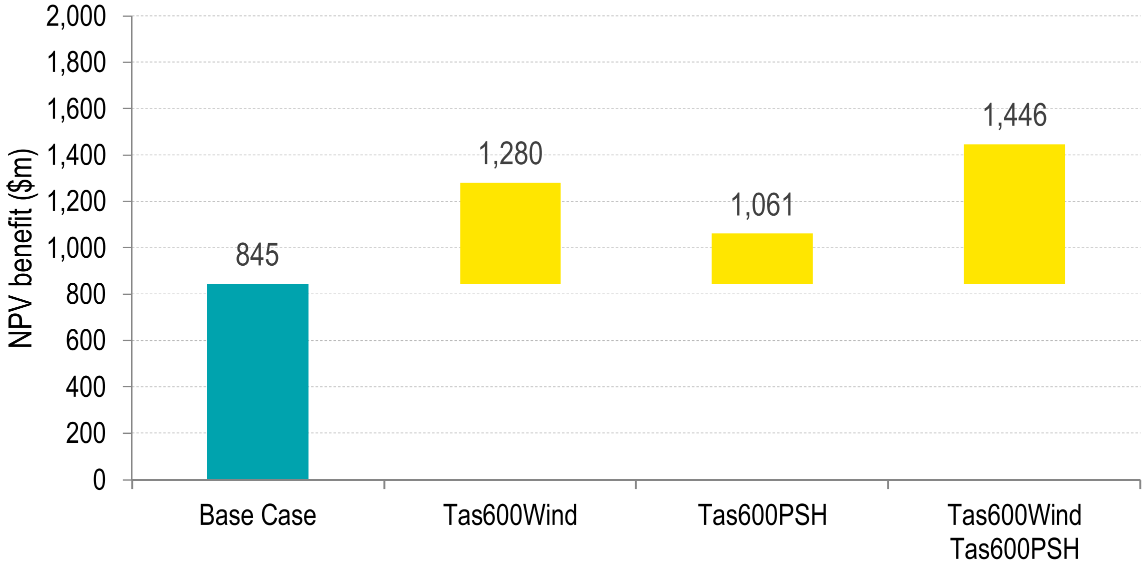


Figure 39 displays a summary of the relative benefits of all sensitivities that assume additional capacity will be installed in Tasmania compared to the Base Case, regardless of Marinus' commissioning.

Figure 39: Waterfall chart of total benefits of Marinus 600 MW in Base Case and sensitivities with additional committed Tasmanian capacity (Tas600Wind, Tas600PSH, Tas600Wind Tas600PSH)



For the Base Case, the primary component of the $845 million benefit of Marinus across the NEM is comprised of a reduction in fuel cost. This is an outcome of Marinus enabling hydro generation in Tasmania to reduce the need to burn gas in Victoria and NSW over peaks, by storing surplus energy from the low demand periods and shifting production to the peak periods when it has a much greater value.

Under the assumption that an additional 600 MW of wind capacity is installed in Tasmania, regardless of the commissioning of Marinus, it is forecast that the expected benefit of Marinus will be $1,280 million. The $435 million in additional benefit for the Tas600Wind Scenario compared to

[44] NPV benefit discounted to the assumed commission date of Marinus 600 MW in each scenario

the Base Case is primarily driven by Marinus' ability to better utilise this 600 MW of Tasmanian capacity so as to reduce capex cost for the mainland.

For the Tas600PSH Scenario, the additional 600 MW of Tasmanian PSH in 2024-25 brings forward the reduction in need to burn gas in Victoria and NSW over peaks. Because of this the benefit of Marinus is increased to $1,061 million, which is $216 million high than the Base Case.

The $1,446 million benefit of Marinus in Tas600Wind Tas600PSH is $601 million more than that of the Base Case. This is only $50 million less than the sum of the increase in benefit in Tas600Wind ($435 million) and Tas600PSH ($216 million), suggesting that increased wind and increased pump storage are complementary to each other.

3.3 Marinus 1,200 MW sensitivities

This section discusses sensitivities in which Marinus has a forward and reverse limit of 1,200 MW. In all sensitivities this is modelled as two 600 MW interconnectors in parallel. The key sensitivities of interest to TasNetworks are presented under three different commissioning schedules:

(1) assuming the full 1,200 MW capacity can be commissioned on 1 July 2025;

(2) a staggered commissioning with the first 600 MW commissioned on 1 July 2025 and the additional 600 MW on 1 July 2027 ;

(3) a staggered commissioning with the first 600 MW commissioned on 1 July 2025 and the additional 600 MW on 1 July 2028.

TasNetworks advises that the two staggered schedules are more likely than a single commissioning date in the event of a 1,200 MW link being built. This became apparent later in the writing of this Report and so the less likely simultaneous schedule is presented first; however, the trends and overall outcomes for the three schedules are not materially different.

3.3.1 Marinus1200

This sensitivity explores the benefits associated with Marinus having forward and reverse limits of 1,200 MW, assuming the total capacity can be commissioned on 1 July 2025. Figure 40 shows the change in NEM capacity for the Marinus 1,200 MW link compared to the Base Case with Marinus at 600 MW. The higher transfer limit of Marinus is forecast provides for a greater level of reliability in the mainland, which allows for the retirement of an additional 150 MW of OCGT capacity in 2023-24 compared to a 600 MW Marinus in the Base Case. Approximately 600 MW less OCGT capacity is required by 2050. The additional transfer limit also brings forward the installation of approximately 150 MW of wind and PSH capacity in the NEM by 5 to 10 years to the mid 2030s. By the end of the study period, the overall wind and PSH capacity in the NEM is forecast to be the same for Marinus 1,200 MW as for the Base Case with Marinus 600 MW.

Figure 40: Change in NEM capacity mix due to increase in Marinus flow limit (with Marinus 1,200 MW minus with Marinus 600 MW; difference relative to sum of Figure 5 and Figure 10)

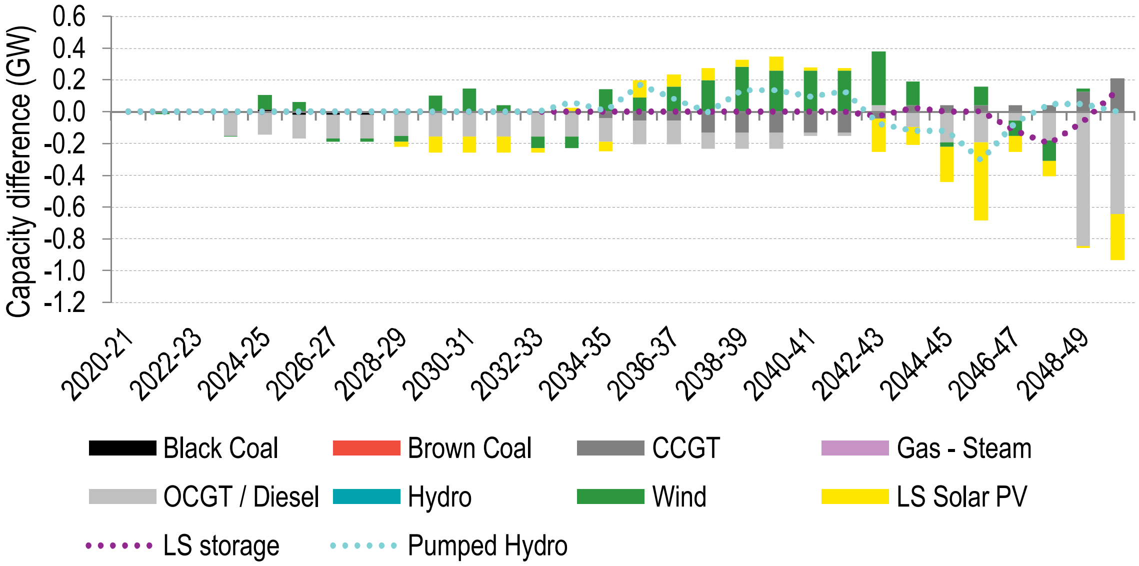


Figure 41 displays the forecast capacity in Tasmania with Marinus 1,200 MW. The difference between the Tasmanian capacities for Marinus 1,200 MW compared to the Base Case with Marinus 600 MW is shown in Figure 42. Marinus 1,200 MW drives forward installation of new entrant wind capacity in Tasmania to 2025-26, with a total of approximately 1,650 MW of wind capacity commissioned in Tasmania from 2032-33 until the end of the study in 2050. This is driven by the reduction in wind spillage associated with an increased transfer limit from Tasmania to Victoria. There is approximately 700 MW of additional wind capacity compared to the Base Case with Marinus 600 MW (Figure 42). The additional transfer limits are also expected to bring forward the installation of 400 MW to 500 MW of PSH capacity to 2034-35. By 2038-39 the 1,000 MW limit for new entrant PSH capacity is reached. Because of this, the amount of pumped hydro capacity in Tasmania is the same for Marinus 1,200 MW and the Base Case with Marinus 600 MW. By bringing forward the benefit of Tasmanian wind capacity, Marinus 1,200 MW reduces the benefit of solar PV from 2035-36 onward, due to the large quantity of renewable capacity already forecast to be installed in Tasmania by this time.

Figure 41: Tasmanian capacity mix forecast for Marinus1200 sensitivity with Marinus 1,200 MW

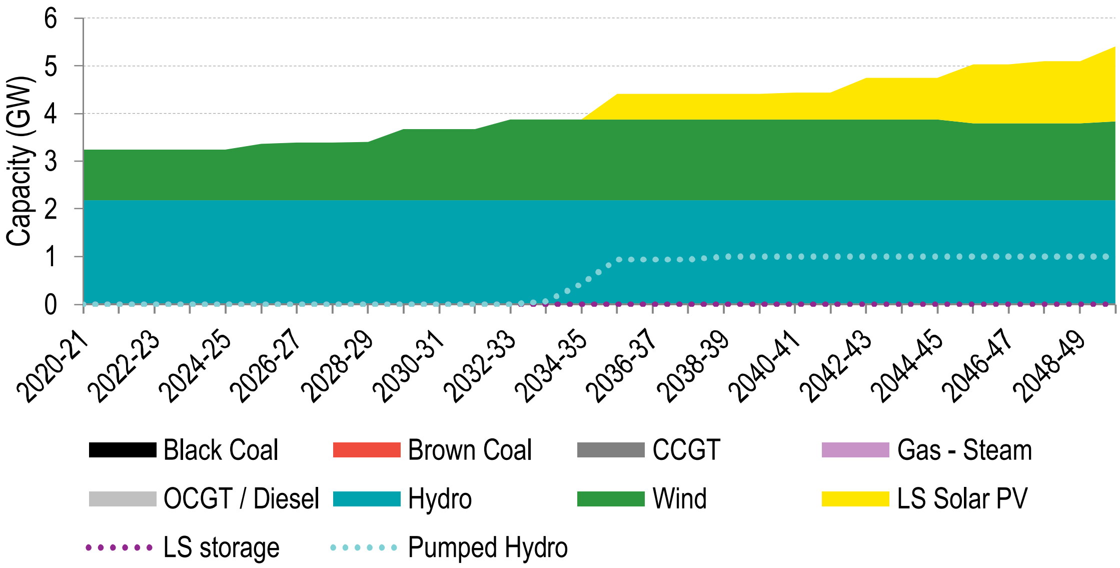
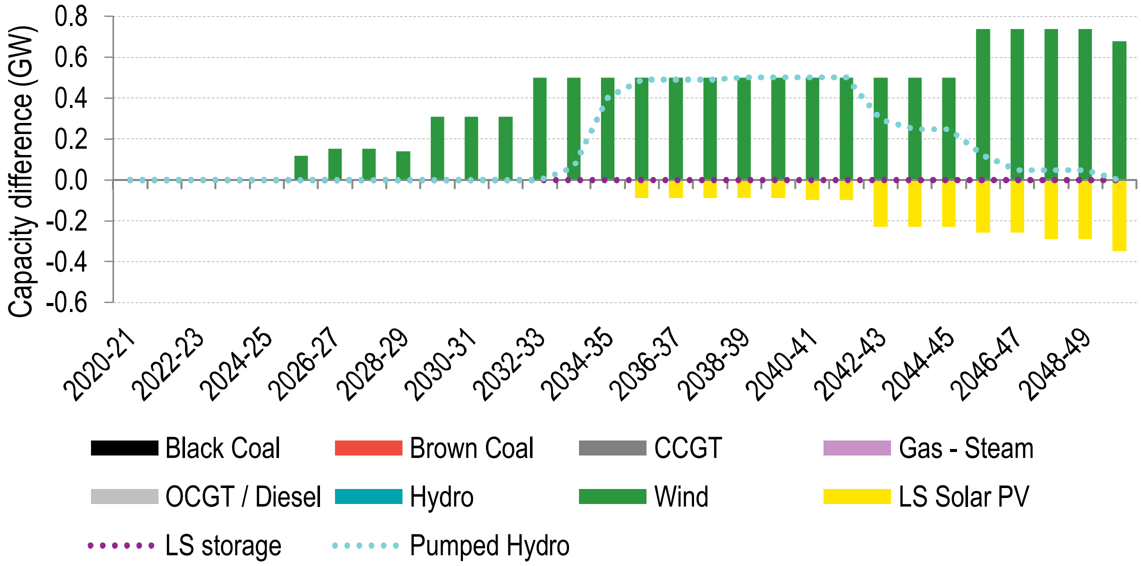


Figure 42: Change in Tasmanian capacity mix due to increase in Marinus flow limit (with Marinus 1,200 MW minus with Marinus 600 MW; difference relative to sum of Figure 8 and Figure 12)



The NPV of the benefits of Marinus 1,200 MW is forecast to be $1,169 million across the NEM (Table 27). The fuel benefit is $942 million, which is a large increase from the fuel benefit of $598 million in the Base Case. The remaining categories of benefits being much lower in magnitude and closer to the Base Case values. As in the Base Case and many sensitivities, the reliability benefit is primarily accrued in Victoria.

Table 27: Marinus1200 sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case
NSW	164	61	333	59	-5	613	314
QLD	159	28	-56	14	-1	144	88
VIC	849	226	527	123	37	1,761	896
SA	299	106	138	40	-	582	340
TAS	-1,433	-339	-	-159	-	-1,931	-794
Total	37	82	942	76	31	1,169	845
Total Base Case	87	59	598	66	35	845	

The $1,169 million in benefit is unevenly spread between the regions (Table 27). The trends occurring in each region are similar to those that occur in the Base Case; however, the additional capacity for Marinus accentuates these trends. The large negative benefit of $-1,931 million for Tasmania is primarily driven by the potential for Marinus 1,200 MW to unlock a large amount of new entrant wind capacity and to bring forward the commissioning of new entrant PSH. Additional capex and earlier spend of capital are both seen as a negative benefit to Tasmania. The Tasmanian renewable and storage capacity that is unlocked by Marinus 1,200 MW results in a reduced need for mainland capacity and generation. Because of this Victoria has a large positive benefit of $1,761 million, up from $896 million with Marinus 600 MW. This is primarily comprised of a capex benefit of $849 million, which is an increase of $542 million compared to Victorian capex benefit of $307 million for the Base Case.

Table 28 indicates that majority of the $942 million fuel benefit associated with Marinus 1,200 MW is predominantly found by reducing the need for peaking plant to operate, made up of $866 million in OCGT and diesel generation fuel cost. The majority of OCGT and diesel fuel benefit occurs in Victoria and NSW, with benefits of $490 million and $318 million, respectively.

Table 28: Marinus1200 sensitivity NPV benefit ($m) by technology

Technology	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case
Black Coal	-	49	-38	-2	-	8	10
Brown Coal	-	14	-2	-	-	12	13
CCGT	27	2	77	8	-	114	-43
Gas - Steam	-	-	39	7	-	46	35
OCGT / Diesel	36	107	866	87	-	1,096	804
Hydro	-	-	-	5	-	5	3
Wind	181	29	-	-36	-	174	393
LS Solar PV	-169	-72	-	-	-	-241	-301
Pumped Hydro	-57	-49	-	9	-	-97	-118
LS storage	20	2	-	-	-	22	15
USE	-	-	-	-	31	31	35
Total	37	82	942	76	31	1,169	845
Total Base Case	87	59	598	66	35	845	

Figure 43 displays the forecast time-of-day profile for the energy flow between Tasmania and Victoria for the Marinus1200 sensitivity with Marinus. For each hour in 2025-26, it is forecast that the average flow from Tasmania to Victoria is approximately 20 MW to 100 MW higher than what is forecast for the Base Case with Marinus 600 MW (Figure 18). By 2025-26 it is forecast that approximately 1,150 MW of wind capacity is installed in Tasmania for both the Base Case with Marinus 600 MW and Marinus1200 with Marinus 1,200 MW. Alternatively, by 2032-33, Marinus1200 with Marinus 1,200 MW is forecast to drive an additional 500 MW of new entrant wind capacity into Tasmania compared to the Base Case with Marinus 600 MW. The additional capacity of both Marinus and wind technology allows for Tasmania to export approximately 190 MW more to Victoria compared to the Base Case with Marinus. This suggests that the greater transfer limits of Marinus 1,200 MW are not able to be fully utilised without additional Tasmanian capacity.

Figure 43: Time-of-day average Basslink and Marinus 1,200 MW flow for Marinus1200 sensitivity with Marinus

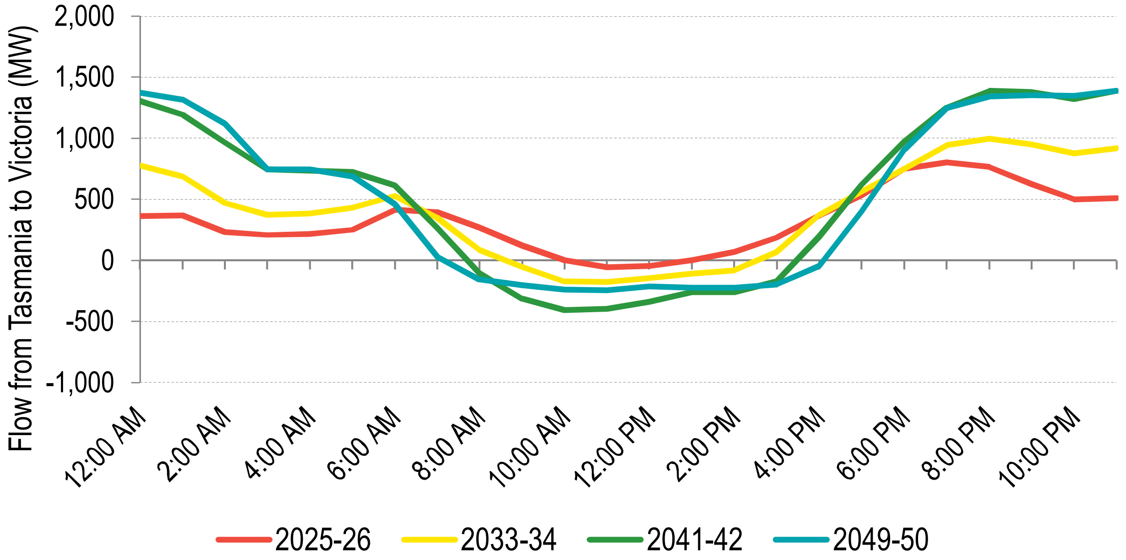
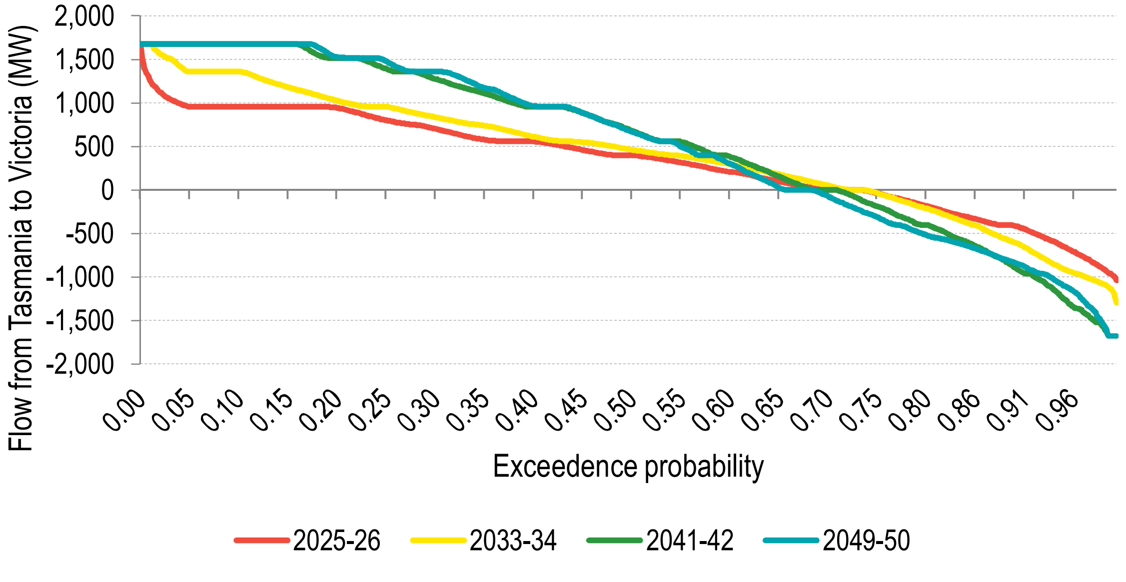


Figure 44 shows an expected duration curve for several different years over the forecast period. It shows that before the installation of approximately 400 MW of new entrant PSH capacity in Tasmania in 2034-35, the combined transfer limit of 1,678 MW from Tasmania to Victoria (478 MW limit for Basslink and 1,200 MW limit for Marinus) is only reached on up to 2 % of time periods. Additionally, the import limit from Victoria to Tasmania is not forecast to bind until 2035-36. By 2040, Tasmania is forecast to have approximately 1,700 MW of wind capacity, 600 MW of large-scale solar PV capacity and 1,000 MW of PSH. This causes the maximum transfer limit of 1,678 MW to be reached for 15 % to 20 % of the time. For all years, energy generally flows from Tasmania to Victoria for 65 % to 75 % of times.

Figure 44: Duration curve for Basslink and Marinus 1,200 MW flow for Marinus1200 sensitivity with Marinus



3.3.2 Marinus1200 Staggered

This sensitivity explores the benefits associated with Marinus 1,200 MW being commissioned in two stages. The first 600 MW capacity of Marinus in commissioned 1 July 2025. Marinus is the assumed to be upgraded to the full 1,200 MW transfer limit on 1 July 2028.

As described for the Marinus1200 sensitivity in Section 3.3.1, the export of energy from Tasmania to Victoria is generally below 1,078 MW and rarely reaches the maximum export limit of 1,678 MW. Because of this, a staggered build of Marinus is forecast to result in few changes to the results identified for Marinus1200, with the majority of differences occurring between 2025-26 and 2028-29.

For Marinus1200 with Marinus, approximately 100 MW of Tasmanian wind capacity is forecast to be installed in 2025-26. For the Marinus1200 Staggered sensitivity, Marinus' lower transfer limit of 600 MW in this year is forecast to result in a deferral of this wind capacity to 2028-29. The reduced export from Tasmania to the mainland until 1 July 2028 brings forward the installation of approximately 100 MW of wind capacity in the mainland from 2028-29 to 2025-26. From the mid 2030s until the end of the study, there are immaterial differences between the capacity mix for the two aforementioned cases of Marinus1200 and Marinus1200 Staggered.

As with Marinus1200, the forecast $1,153 million benefit for Marinus1200 Staggered is unevenly spread between the regions (Table 29). The large negative benefit of $-1,847 million for Tasmania primarily driven by the potential for Marinus to unlock a large amount of new entrant capacity from the 2030s onwards.

Table 29: Marinus1200 Staggered sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Marinus1200
NSW	136	56	316	53	-5	557	613
QLD	168	31	-60	13	-1	150	144
VIC	855	222	527	122	39	1,764	1,761
SA	273	106	121	34	-5	529	582
TAS	-1,368	-329	-	-151	-	-1,847	-1,931
Total	64	87	904	71	28	1,153	1,169
Total Marinus1200	37	82	942	76	31	1,169	

3.3.3 Marinus1200 EC90

This sensitivity explored whether the benefits of a 1,200 MW Marinus materially changed in the presence of a high emissions reduction target. The benefit is $2,402 million which represents a substantial increase relative to the EC90 sensitivity with 600 MW Marinus ($1,605 million).

Figure 45 shows the forecast change in NEM capacity due to the increase in flow limit of Marinus, while Figure 46 shows the equivalent chart for generation. Many of the same trends observable for the EC90 sensitivity (with 600 MW Marinus, Section 3.2.1.2) are also observable here, but are more exaggerated. Specifically, the larger capacity Marinus is forecast to cause:

- A further decrease in generation from brown coal in Victoria, and therefore further advanced retirements;
- A further increase in generation from black coal in Queensland and NSW, and therefore further delayed retirements;
- A further decrease in investment in new peaking capacity on the mainland and use of that capacity from the mid 2030s;
- A further decrease in large-scale battery capacity and energy in the 2040s.

Notably there is also a significant delay in large-scale solar PV installation until the 2040s, and an increase in wind capacity from the 2040s.

Figure 45: Change in NEM capacity mix due to increased Marinus limit for EC90 (Marinus1200 EC90 with Marinus 1,200 MW minus EC90 with Marinus 600 MW; difference relative to sum of Figure 24 and Figure 27)

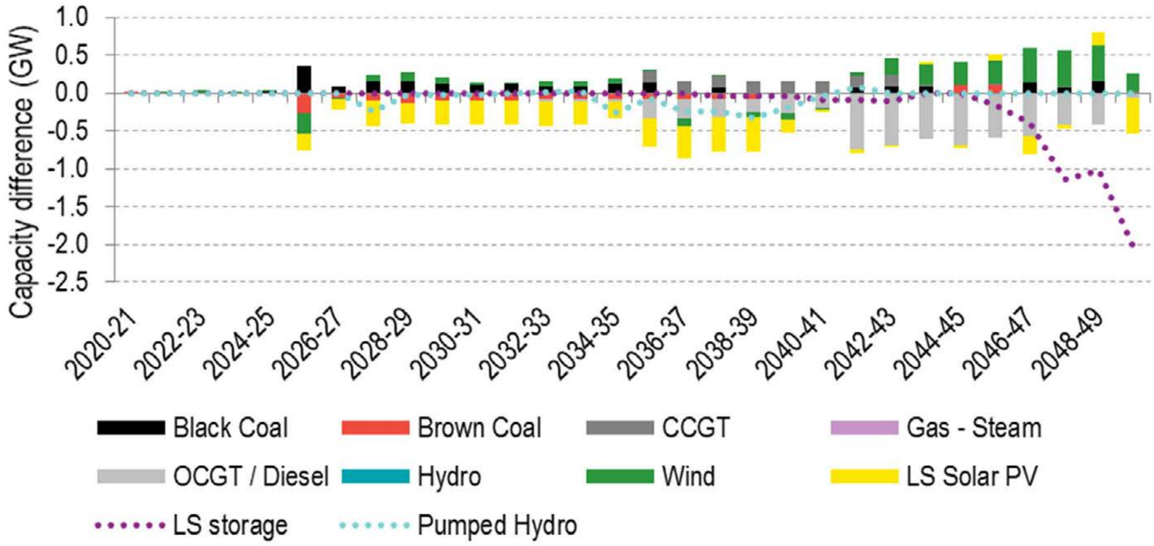
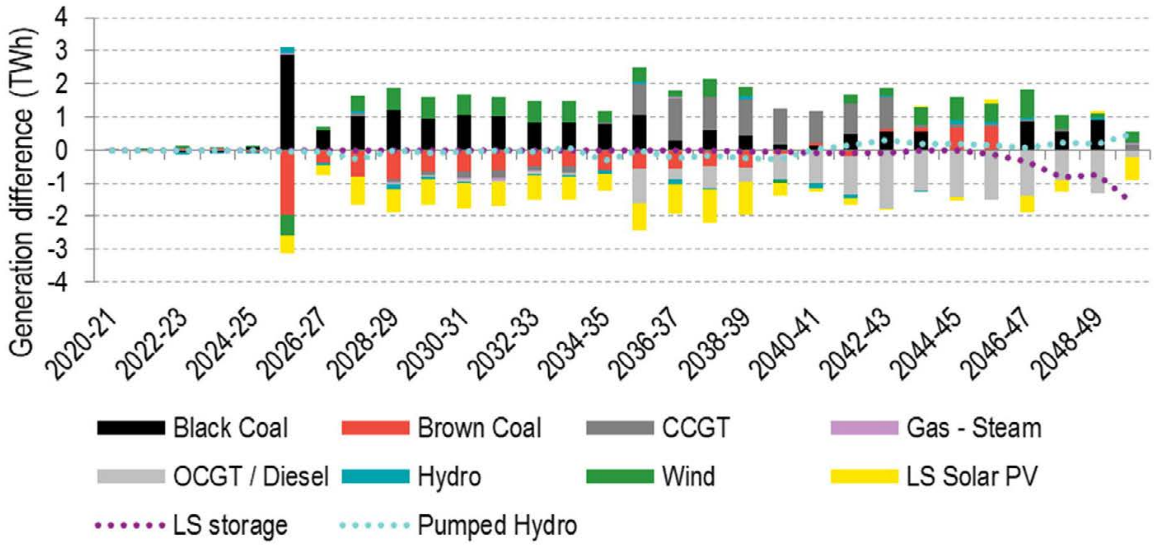


Figure 46: Change in NEM generation mix due to increased Marinus limit for EC90 (Marinus1200 EC90 with Marinus 1,200 MW minus EC90 with Marinus 600 MW; difference relative to sum of Figure 25 and Figure 28)



The forecast capacity mix for Tasmania for this sensitivity with Marinus 1,200 MW is displayed in Figure 47. Figure 48 shows the effect of the Marinus capacity increase of capacity development in Tasmania. By the end of the study, the 1,200 MW Marinus has driven almost an additional 1.2 GW of wind and large-scale solar PV capacity to be installed in Tasmania relative the 600 MW Marinus case. This is an increase of nearly 3 GW relative to no Marinus.

Figure 47: Tasmanian capacity mix forecast for EC90 sensitivity with Marinus 1,200 MW

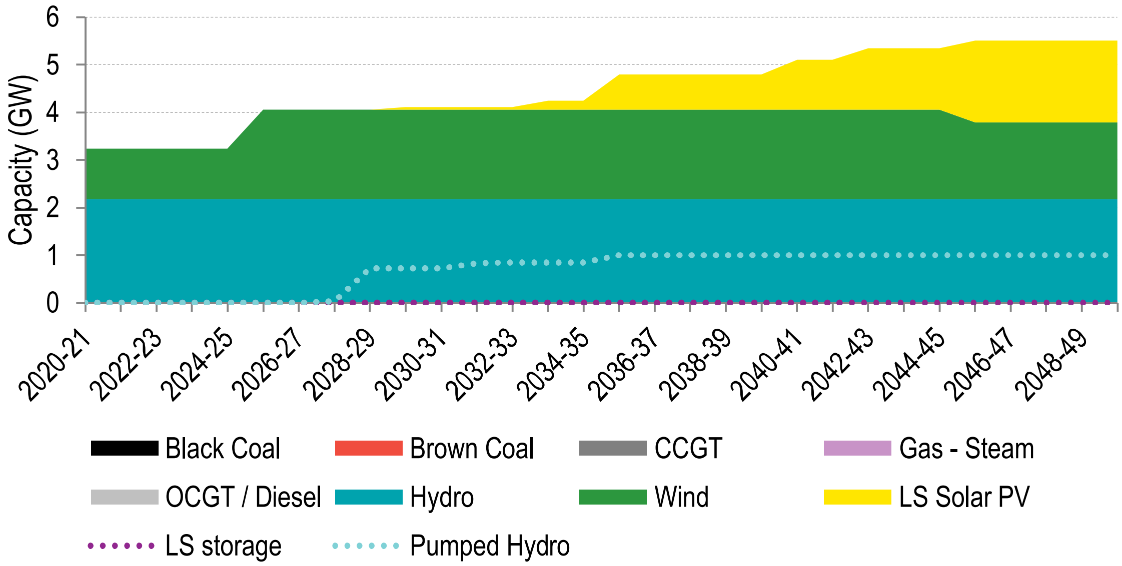
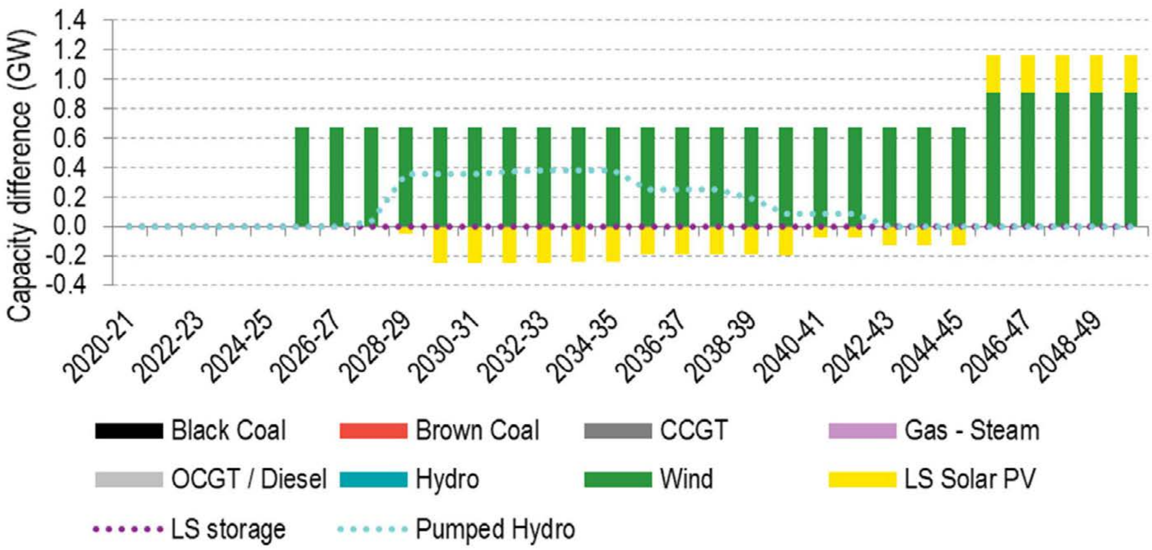


Figure 48: Change in Tasmanian capacity mix due to Marinus 1,200 MW (Marinus1200 EC90 with Marinus 1,200 MW minus EC90 with Marinus 600 MW; difference relative to sum of Figure 26 and Figure 29)



It is expected that there is over 600 MW of additional wind capacity installed in Tasmania relative to the Marinus 600 MW case from 2025-26 when Marinus is installed. From 2045-46 this increases to an additional 815 MW. Without Marinus at this time some wind retires at end of life and is replaced by large-scale solar PV on the grounds of lower cost at that point in time (Figure 26). A 600 MW Marinus drives additional Tasmanian wind capacity but does not change this replacement outcome (Figure 29). Figure 48 shows that a 1,200 MW Marinus allows more of the retiring wind to be replaced with new wind. Therefore, Marinus 1,200 MW is a clear driver of the benefits of Tasmanian wind in providing the lowest cost to the NEM until at least 2045-46.

The expanded development of PSH in Tasmania is advanced in time compared with the Marinus 600 MW capacity EC90 sensitivity from 2028-29 to the early 2040s. During this time large-scale solar PV capacity development in Tasmania is delayed.

The NPV of the benefits of Marinus 1,200 MW with the steeper emissions reduction path is forecast to be $2,402 million across the NEM (Table 30 breakdown by region, Table 31 breakdown by technology). The trends are broadly similar to the EC90 sensitivity, but more exaggerated.

- The capex benefit is $1,223 million across the NEM which represents a significant increase from the Base Case benefits and the EC90 sensitivity (which has 600 MW Marinus capacity). This is driven by increased capex savings in all mainland regions, but particularly Victoria, and offset by increased capital investment in Tasmania. As Tasmania's resources are better unlocked by a larger capacity Marinus, there is reduced need to build in all mainland regions. Overall capital investment across the NEM decreases for large-scale solar PV, peaking, pumped hydro and large-scale storage capacity, and increases for wind and CCGT (Table 31 compared to Table 9).

- The FOM benefit is $287 million, which is a $185 million increase relative to the EC90 sensitivity. This is driven by savings in FOM for brown coal by advancing retirements and for large-scale solar PV by reducing installations.

- The fuel benefit is $794 million, which is also a significant increase relative to the Base Case and EC90 sensitivity. This saving is largely driven by the decrease in usage of peaking gas and to a lesser extent brown coal in Victoria. It is offset by an increase in spending on fuel for black coal and CCGTs.

The remaining categories of benefits are much lower in magnitude. Overall, there is a large increase in the positive benefit to Victoria and a large increase in the magnitude of the negative benefit to Tasmania.

Table 30: Marinus1200 EC90 sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Base Case	Total EC90
NSW	547	121	-145	39	3	565	314	354
QLD	1,100	62	-320	34	-10	867	88	495
VIC	1,606	558	1,131	222	42	3,560	896	1,813
SA	443	140	127	-1	-1	708	340	386
TAS	-2,473	-594	-	-231	-	-3,298	-794	-1,443
Total	1,223	287	794	64	34	2,402	845	1,605
Total Base Case	87	59	598	66	35	845		
Total EC90	734	102	692	71	6	1,605		

Table 31: Marinus1200 EC90 sensitivity NPV benefit ($m) by technology

Technology	Capex	FOM	Fuel	VOM	USE	Total	EC90
Black Coal	-	-166	-692	-61	-	-919	-517
Brown Coal	-	301	106	13	-	419	210
CCGT	-89	-8	-174	-20	-	-291	8
Gas – Steam	-	-	39	6	-	45	40
OCGT / Diesel	272	29	1,516	160	-	1,977	1,230
Hydro	-	-	-	6	-	6	5
Wind	382	62	-	-51	-	392	576
LS Solar PV	285	65	-	-	-	350	-58
Pumped Hydro	90	-31	-	9	-	68	-86

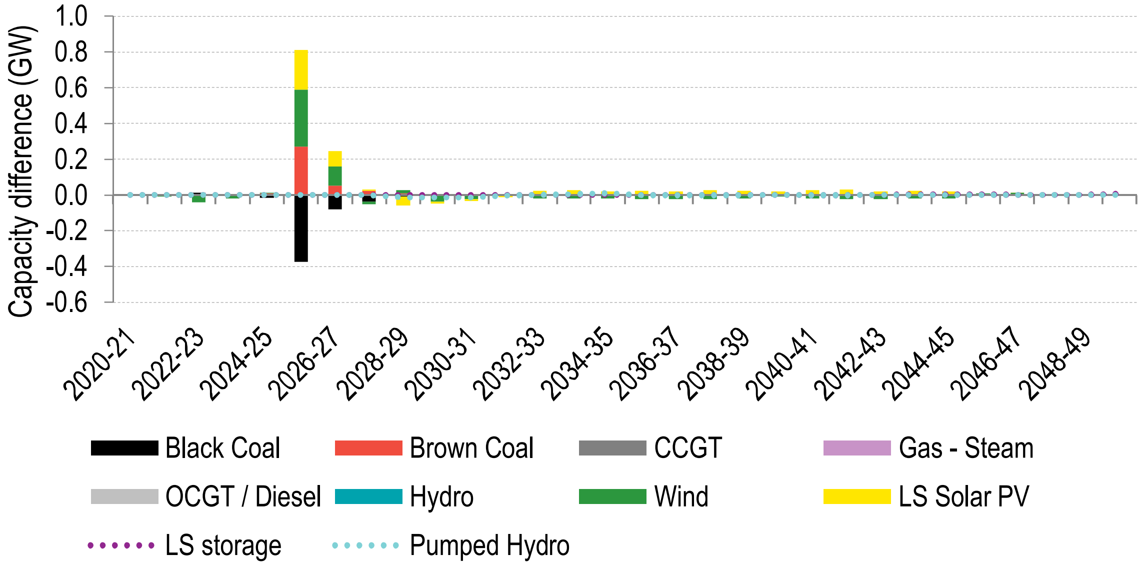
Technology	Capex	FOM	Fuel	VOM	USE	Total	EC90
LS storage	284	34	-	-	-	318	192
USE	-	-	-	-	34	34	6
Total	1,223	287	794	64	34	2,402	1,605
EC90	734	102	692	71	6	1,605	

3.3.4 Marinus1200 Staggered EC90

This sensitivity explores the benefits associated with Marinus 1,200 MW being commissioned in two stages for the EC90 case. The first 600 MW capacity of Marinus in commissioned 1 July 2025. Marinus is assumed to be upgraded to the full 1,200 MW transfer limit on 1 July 2027.

Figure 49 shows the change in NEM capacity due to the staggered build of Marinus, compared to the full 1,200 MW capacity being available from 2025-26.

Figure 49: Change in NEM capacity mix due to staggered Marinus build for EC90 (Marinus1200 Staggered EC90 with Marinus 1,200 MW minus Marinus1200 EC90 with Marinus 1,200 MW)



The primary capacity differences are contained within the two years between the first and second stage of Marinus' commissioning. The reduced transfer limit between Tasmania and Victoria in 2025-26 and 2026-27 results in the deferral of 400 MW of brown coal capacity retirement in Victoria. Subsequently, the retirement of 500 MW of black coal capacity in Queensland and NSW is brought forward from 2027-28 to 2025-26. The lower capacity of Marinus in these two years also results in the deferral of approximately 400 MW of new entrant wind capacity in Tasmania from 2025-26 to 2028-29. Alternatively, on the mainland approximately 700 MW of new entrant wind capacity and 200 MW of solar capacity is brought forward several years to 2025-26. By 2028-29, the NEM capacity mix is essentially identical to that of the non-staggered Marinus1200 EC90 case.

The benefit for Marinus1200 Staggered EC90 is forecast to be $2,366 million (Table 32). This is $36 million less than the benefit for Marinus1200 EC90. The primary differences between the benefits for the two aforementioned cases are associated with fuel cost and capex savings. Because of Marinus' lower transfer limit, it is beneficial for more brown coal capacity to remain operational in Victoria, which has lower fuel cost in comparison to the more expensive black coal options in NSW and Queensland. However, this benefit is offset by the increase in mainland capital expenditure for wind and solar PV capacity due to the weaker connection between Tasmania and Victoria.

Table 32: Marinus1200 Staggered EC90 sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Marinus1200 EC90
NSW	512	125	-102	35	3	575	565
QLD	1,015	64	-276	29	-10	822	867
VIC	1,519	497	1,110	209	42	3,376	3,560
SA	407	132	131	-	-	669	708
TAS	-2,300	-570	-	-207	-	-3,076	-3,298
Total	1,154	248	863	67	34	2,366	2,402
Total Marinus1200 EC90	1,223	287	794	64	34	2,402	

3.3.5 Marinus1200 Snowy 2.0 EC90

This sensitivity explores the effect of Snowy 2.0 and the associated Vic-NSW interconnector upgrades by comparison to the Marinus1200 EC90 sensitivity (Section 3.3.3). It also illustrates the effect of increased Marinus capacity by comparison to the equivalent Marinus 600 MW sensitivity (Snowy 2.0 EC90, Section 3.2.3). The market benefits of Marinus broken down by benefit component and by region, along with the comparative outcomes of other sensitivities, are shown in Table 33.

Table 33: Marinus1200 Snowy 2.0 EC90 sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Snowy 2.0 EC90	Total Marinus1200 EC90
NSW	419	167	130	84	12	813	429	565
QLD	817	64	-233	31	1	679	404	867
VIC	1,496	303	816	236	15	2,867	1,315	3,560
SA	210	65	152	9	-	436	280	708
TAS	-2,269	-465	-	-256	-	-2,989	-1,199	-3,298
Total	673	134	866	105	28	1,805	1,229	2,402
Total Snowy 2.0 EC90	444	38	632	86	29	1,229		
Total Marinus1200 EC90	1,223	287	794	64	34	2,402		

3.3.5.1 Effect of Snowy 2.0 with Marinus 1,200 MW and high emissions reduction target

With a 600 MW Marinus, the development of Snowy 2.0 is forecast to reduce the benefits of Marinus from $1,605 million to $1,229 million (Section 3.2.3). This trend is also true for the 1,200 MW Marinus where overall benefits reduce from $2,402 million to $1,805 million with the development of Snowy 2.0.

Capex and FOM benefits decrease significantly, but these reductions are offset by more modest increases in fuel and VOM benefits. This shift from capex and FOM benefits to fuel and VOM was also a noted effect of Snowy 2.0 with Marinus 600 MW. Moreover, the direction and magnitude of the shift in benefit categories relative to overall benefits is very similar. This shows that against the background of strong emissions abatement, Snowy 2.0 enables existing plant to be used more flexibly to deliver operating cost savings, rather than retiring high emissions plant and building new low emissions plant.

A large decrease in benefits in Victoria, and smaller decreases in Queensland and SA are offset by reduced costs in Tasmania and increased benefits in NSW.

With Snowy 2.0 built, there are reduced capex savings due to Marinus in all mainland regions. This is somewhat offset by less capital cost incurred in Tasmania as the competitive advantage of new wind, solar PV and pumped hydro in Tasmania is eroded by Snowy 2.0.

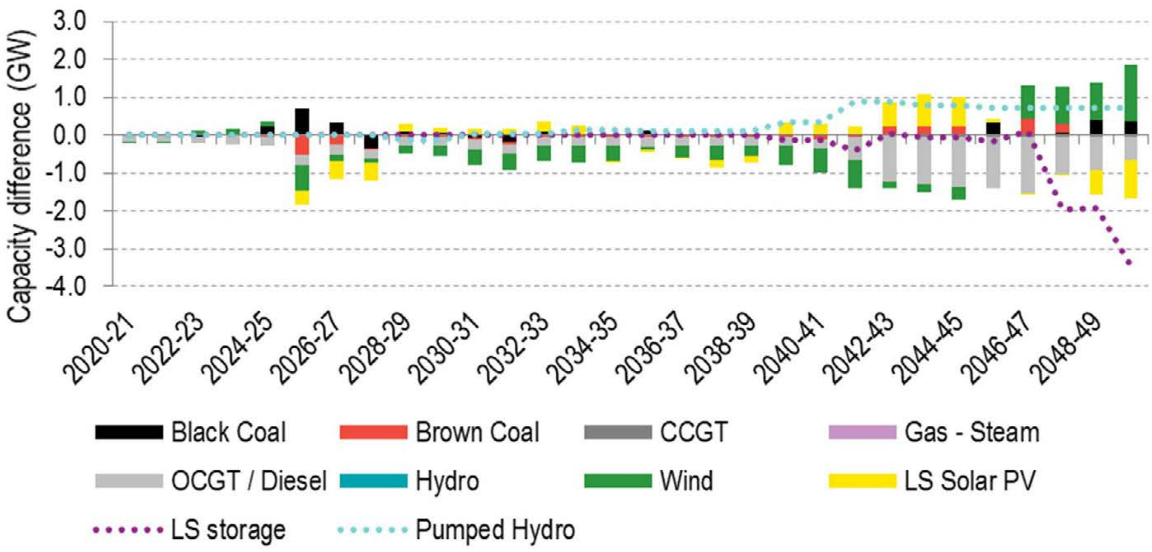
3.3.5.2 Effect of Marinus capacity with Snowy 2.0 and high emissions reduction target

With Snowy 2.0 and the more aggressive emissions reduction target the benefits of Marinus increase when the flow limit is increased from 600 MW to 1,200 MW (Table 33), as occurs in other sensitivities. Relative to the equivalent Marinus 600 MW sensitivity, all benefit categories but USE increase and the relative contribution of benefit categories remains similar. In other words, Marinus 1,200 MW drives larger benefits and changes in benefits are roughly scaled up in proportion to this overall increase.

There is a large increase in benefits in Victoria and to a lesser degree in other mainland regions, but these increases are offset by an increase in costs in Tasmania.

Figure 50 shows the forecast change in NEM capacity mix due to Marinus at 1,200 MW capacity, with Snowy 2.0 developed and a high emissions reduction target. This figure can be directly compared to Figure 30 which showed the effect of Marinus at 600 MW capacity under the same conditions.

Figure 50: Change in NEM capacity mix due to Marinus 1,200 MW for Snowy 2.0 EC90 (Snowy 2.0 EC90 with Marinus minus Snowy 2.0 EC90 without Marinus)



Within the overall forecast market benefit increase relative to the equivalent Marinus 600 MW sensitivity (Table 34 compared to Table 13):

- There is a large decrease in wind capex savings. From the installation of Marinus in 2025-26, there is a shift in wind investment from Victoria to Tasmania. However, the capex savings relative to the Marinus 600 MW sensitivity derive from a large increase in wind capacity in Tasmania from 2045-46. At this time a 1,200 MW Marinus allows more of the retiring

Tasmanian wind to be replaced with new wind, rather than large-scale solar PV as occurred in the 600 MW Marinus sensitivity.

- Black coal fuel costs increase, due to the ability of Marinus to use relatively low emissions, low cost energy from black coal more flexibly. This delays the retirement of black coal.
- There is a proportionally larger increase in OCGT capex and fuel savings as the additional Tasmanian wind energy and more flexible use of energy from Tasmanian hydro and NSW and Queensland black coal decreases investment in new peaking capacity on the mainland and use of that capacity.
- The large-scale solar PV cost becomes a benefit as investment in solar capacity decreases as the capacity of Marinus increases. Solar capital investment shifts from Tasmania to Victoria and the overall capacity built decreases.

Overall, the larger capacity of Marinus unlocks Tasmanian wind capacity and Victorian large-scale solar PV capacity, and allows black coal to run more flexibly. This decreases the need for OCGT generation on the mainland.

Table 34: Marinus1200 Snowy 2.0 EC90 sensitivity NPV benefit ($m) by technology

Technology	Capex	FOM	Fuel	VOM	USE	Total	Total Snowy 2.0 EC90	Total Marinus1200 EC90
Black Coal	-	-68	-374	-41	-	-482	-267	-919
Brown Coal	-	123	38	4	-	165	85	419
CCGT	14	1	217	23	-	255	225	-291
Gas - Steam	-	-	50	8	-	58	40	45
OCGT / Diesel	164	73	935	97	-	1,270	788	1,977
Hydro	-	-	-	5	-	5	2	6
Wind	397	60	-	-39	-	418	517	392
LS Solar PV	43	-2	-	-	-	41	-191	350
Pumped Hydro	-122	-73	-	46	-	-149	-136	68
LS storage	175	21	-	-	-	196	137	318
USE	-	-	-	-	28	28	29	34
Total	673	134	866	105	28	1,805	1,229	2,402
Total Snowy 2.0 EC90	444	38	632	86	29	1,229		
Total Marinus1200 EC90	1,223	287	794	64	34	2,402		

3.3.6 Marinus1200 Snowy 2.0 Vic-NSW 2034 EC90

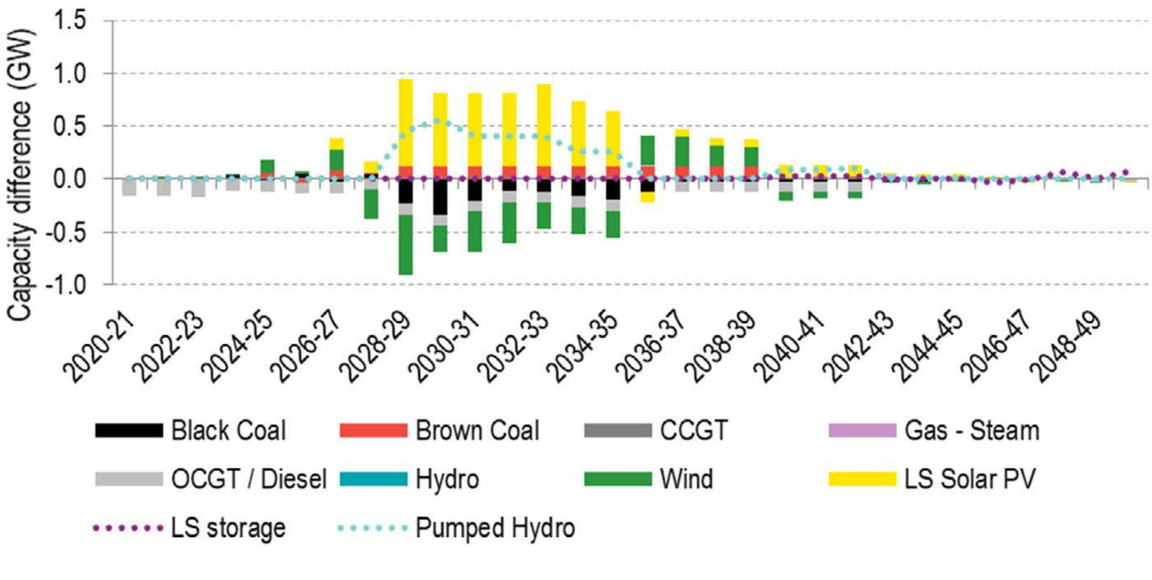
In the previous sensitivities with Snowy 2.0 and the higher emission abatement trajectory (Sections 3.2.3 and 3.3.5), the Vic-NSW interconnector upgrade is commissioned on 1/7/2027 while in the earlier Snowy 2.0 alone sensitivity (Section 3.2.2), it is commissioned on 1/7/2034. This sensitivity defers the Vic-NSW interconnector upgrade to the later date used with the lower emissions reduction trajectory to tease apart the effect Snowy 2.0 and the timing of the Vic-NSW interconnector upgrade.

Delaying the Vic-NSW interconnector upgrade is expected to cause significant changes in the capacity mix (Figure 51). The changes are largest between 2027-28 and 2034-35, but also precede and follow this window. Specifically, a later Vic-NSW interconnector upgrade is forecast to:

- Advance black coal retirements in NSW and Queensland and delays brown coal retirements in Victoria;
- Reduce peaking capacity in NSW and causes a smaller increase in peaking capacity in SA throughout the study;
- Advance large-scale solar PV installations in all regions except SA where effects are mixed;
- Advance pumped hydro installations in Tasmania and later Victoria to a lesser extent;
- Delay wind installation until 2034-35, then advances installation from 2035-36 to 2038-39. There is a reduction in wind installation in Tasmania from Marinus commissioning in 2025-26 until 2044-45.

We discussed in Section 3.3.5 that with Snowy 2.0 and the higher emissions abatement target, Marinus unlocks Tasmanian wind capacity and Victorian large-scale solar PV capacity, and allows black coal to run more flexibly. This decreases the need for OCGT generation on the mainland. This sensitivity shows that a proportion of those changes are reliant on larger interconnection between Victorian and NSW. This capacity must be in place for Snowy 2.0 to be able to time-shift energy from Tasmanian wind and for pumped hydro in Tasmania to be able to time-shift energy from black coal.

Figure 51: Change in NEM capacity mix due to delayed Vic-NSW interconnector upgrade for Marinus 1,200 MW Snowy 2.0 EC90 (Snowy 2.0 Vic-NSW 2034 EC90 with Marinus minus Snowy 2.0 EC90 with Marinus)



With Snowy 2.0 and the higher emissions abatement target, the 1,200 MW Marinus is expected to deliver a larger benefit when the Vic-NSW interconnector upgrade is delayed, as shown in Table 35. When Vic-NSW remains at a lower transfer limit for longer, the effects of Marinus (and Snowy 2.0) are more localised. The overall benefits of Marinus increase because Snowy 2.0 can't compete as effectively with Tasmanian energy enabled by Marinus.

Table 35: Marinus1200 Staggered Snowy 2.0 Vic-NSW 2034 EC90 sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Marinus1200 Snowy 2.0 EC90
NSW	534	146	-91	95	3	688	813
QLD	849	70	-217	39	13	754	679
VIC	1,463	428	866	220	77	3,054	2,867
SA	301	74	178	12	-	565	436
TAS	-2,345	-507	-	-249	-	-3,100	-2,989
Total	803	211	736	117	93	1,961	1,805
Total Marinus1200 Snowy 2.0 EC90	673	134	866	105	28	1,805	

Delaying the Vic-NSW interconnector upgrade causes modest increases in capex benefits, FOM, VOM and USE benefits and a reduction in the fuel benefits of Marinus. The increase in benefits occurs in Victoria, Queensland and SA, while Tasmania sees an increase in costs of Marinus and NSW sees a decreased benefit of Marinus. In other words, the delayed Vic-NSW upgrade shifts the benefits of Marinus away from NSW and increases the cost burden in Tasmania, to the advantage of Victoria, Queensland and SA.

3.3.7 Marinus1200 Staggered Snowy 2.0 Vic-NSW 2034 EC90

The previous sensitivity assumed that the full 1,200 MW capacity of Marinus was available by 1 July 2025 for a scenario incorporating the higher emission abatement trajectory, the commissioning of Snowy 2.0 and the Vic-NSW interconnector upgrade. This sensitivity explores the same scenario; however, it is assumed that Marinus is commissioned in two stages: the first 600 MW capacity being commissioned on 1 July 2025 and an upgrade of an additional 600 MW occurring on 1 July 2027.

Similar to the differences between the non-staggered and staggered Marinus1200 EC90 sensitivities (Sections 3.3.3 and 3.3.4 respectively), the primary difference between the scenario discussed in this section and the previous sensitivity is contained with the two years between the first and second stage of Marinus' commissioning. The reduced transfer limit between Tasmania and Victoria for 2025-26 results in the deferral of the retirement of approximately 400 MW of Victorian brown coal and brings forward the retirement of a total of 500 MW of black coal in NSW and Queensland. The installation of approximately 500 MW of new entrant wind capacity in Tasmania is also deferred in 2025-26 in favour of an additional 1,100 MW of wind capacity in the mainland. By 2027-28, when the full 1,200 MW capacity of Marinus becomes available, the regional capacity mixes for this sensitivity are essentially identical to those discussed in the non-staggered counterpart for this case (Section 3.3.6).

The benefit of a staggered Marinus 1,200 MW in this sensitivity is forecast to be $1,924 million (Table 36). This is $37 million less than the benefit for Marinus1200 Snowy 2.0 Vic-NSW 2034 EC90. The primary differences between the benefits for these two cases are associated with fuel cost and capex savings. Because of the lower transfer limit from Tasmania to Victoria, it is beneficial for more brown coal capacity to remain operational in Victoria, which has lower fuel cost in comparison to the more expensive black coal options in NSW and Queensland. However, this benefit is offset by the increase in mainland capital expenditure for new entrant wind capacity.

Table 36: Marinus1200 Staggered Snowy 2.0 Vic-NSW 2034 EC90 sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Marinus1200 Snowy 2.0 Vic-NSW 2034 EC90
NSW	462	166	2	88	3	722	688
QLD	790	70	-194	33	13	712	754
VIC	1,385	360	842	207	77	2,871	3,054
SA	271	63	185	13	-	532	565
TAS	-2,198	-487	-	-227	-	-2,912	-3,100
Total	710	172	835	114	94	1,924	1,961
Total Marinus1200 Snowy 2.0 Vic-NSW 2034 EC90	803	211	736	117	93	1,961	

3.3.8 Marinus1200 Tas600Wind

As mentioned for the Tas600Wind sensitivity, Tasmania has excellent wind resource in comparison to other NEM regions. The Tas600Wind sensitivity investigated the benefit of an additional 600 MW of wind capacity in Tasmania by the commissioning date of Marinus. For that sensitivity, which had assumed a transfer limit of 600 MW for Marinus, the total flow from Tasmania to Victoria was at the export limit of 1,078 MW for approximately 15 % to 25 % of the time. The Marinus1200 Tas600Wind sensitivity explores the change in market benefits caused by increasing Marinus' capacity to 1,200 MW under the assumption of an additional 600 MW of Tasmanian wind capacity, bringing the total amount of Tasmanian wind capacity to 1,650 MW by the commission date of Marinus. In this analysis, the capital cost of the additional wind is not accounted for.

For the Marinus1200 sensitivity, it was forecast that with a transfer limit of 1,200 MW, Marinus would enable a total of 1,650 MW of wind capacity in Tasmanian by 2032-33. As such, this Marinus1200 Tas600Wind sensitivity can be viewed as bringing forward this capacity, so that Marinus can utilise this additional capacity from installation in 2025-26.

The NPV of the benefits of Marinus 1,200 MW in this scenario with 600 MW additional wind committed from the first year of modelling is forecast to be $1,692 million across the NEM (Table 37). These benefits stand only under the key assumption that the additional wind capacity would be installed in Tasmania regardless of the development of Marinus. As such, the costs of the additional capacity and FOM are not included here since the costs are equivalent with and without Marinus.

Table 37: Marinus1200 Tas600Wind sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Tas600 Wind	Total Marinus 1200
NSW	122	78	302	52	-5	549	319	613
QLD	149	28	-53	15	-	138	93	144
VIC	691	194	569	107	41	1,601	1,082	1,761
SA	265	93	174	48	-	579	456	582

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Tas600 Wind	Total Marinus 1200
TAS	-776	-270	-	-129	-	-1,175	-670	-1,931
Total	451	123	992	91	36	1,692	1,280	1,169
Total Tas600 Wind	409	125	637	66	42	1,280		
Total Marinus 1200	37	82	942	76	31	1,169		

The primary difference for Marinus1200 Tas600Wind in comparison to Marinus1200 relates to the increased capex benefit of $451 million throughout the NEM. The majority of this additional capex benefit derives from not including the capital cost of the 600 MW of additional Tasmanian wind capacity in the calculation. Without Marinus, this additional wind capacity is not as well utilised and so additional mainland wind capacity is required. The additional 600 MW of Tasmanian wind capacity allows for approximately 400 MW of mainland wind capacity to be deferred until 2032-33, which also contributes to the increase in capex benefit in the Marinus1200 Tas600Wind sensitivity.

3.3.9 Marinus1200 Tas600Wind TasPSH600

The NPV of the benefits of Marinus 1,200 MW in the scenario with 600 MW of wind and 600 MW of PSH in Tasmania commissioned prior to Marinus is $1,934 million across the NEM (Table 38). The fuel benefit is forecast to be $1,293 million. The remaining categories of benefits are much less, comprising capex savings, FOM and VOM savings and a slight reliability benefit.

Table 38: Marinus1200 600PSH 600Wind sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total
NSW	68	82	427	72	-7	642
QLD	190	43	-40	22	-	216
VIC	481	198	617	108	58	1,462
SA	121	68	289	55	-	533
TAS	-607	-226	-	-85	-	-919
Total	253	165	1,293	171	51	1,934

The $1,934 million in benefits is unevenly spread between the regions (Table 39), with a large positive benefit of $1,462 million in Victoria and a large negative benefit of $-919 million in Tasmania. Comparing the benefits between the regions, with Marinus, the investment capex in generation in Tasmania increases by $607 million, which is represented as a negative benefit to Tasmania. There are corresponding savings in capex in all the mainland states, due to the reduced need to build in those states, as Tasmania’s resources are able to be unlocked by Marinus, particularly with commissioning of 600 MW of additional wind and 600 MW of PSH prior to Marinus. The introduction of Marinus provides overall capex reductions because wind investment reduces by $736 million across the NEM, but large-scale solar PV increases by $604 million and PSH reduces by $40 million respectively.

Table 39: Marinus1200 600PSH 600Wind sensitivity NPV benefit ($m) by technology

Technology	Capex	FOM	Fuel	VOM	USE	Total
Black Coal	-	101	-65	-3	-	32
Brown Coal	-	42	-1	-	-	41

Technology	Capex	FOM	Fuel	VOM	USE	Total
CCGT	49	4	289	31	-	373
Gas - Steam	-	-	76	13	-	89
OCGT / Diesel	7	153	994	99	-	1,253
Hydro	-	-	-	8	-	8
Wind	736	117	-	4	-	857
LS Solar PV	-604	-250	-	-	-	-854
Pumped Hydro	40	-5	-	19	-	53
LS storage	26	3	-	-	-	30
USE	-	-	-	-	51	51
Total	253	165	1,293	171	51	1,934

The fuel saving of $1,293 million is predominantly in reduced need for peaking plant, made up of $994 million in OCGT and diesel generation fuel cost reductions, but also reduced CCGT operation with fuel savings of $289 million. The combination of wind and PSH is considered to be the cause of reduced CCGT operation and resulting gas consumption. There are small changes to other categories of fuel consumption.

This Marinus 1,200 MW case is similar to the equivalent Marinus 600 MW case, where both have prior additional wind and PSH. However, the larger Marinus is expected to allow for increased arbitrage between periods of export and import to Tasmania. This is seen in Figure 52 which shows that there is importation of power into Tasmania from the mainland during the day due to high volumes of low-cost solar generation at these times, and exports from Tasmania at other times of the day. As mentioned in Section 3.2.11, the lower than average wind generation in 2025-26 for NSW, coupled with the slightly higher than average wind generation for Victoria and Tasmania results in more northerly flow from Tasmania to the mainland for this year.

Figure 52: Time-of-day average Basslink and Marinus 1,200 MW flow for Marinus1200 600PSH 600Wind Scenario with Marinus

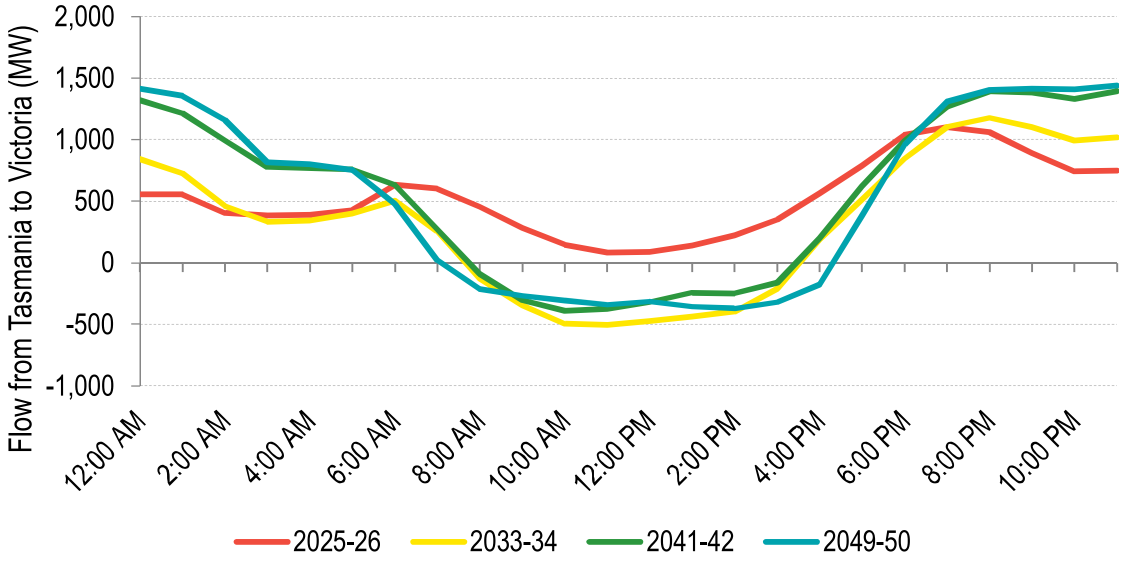
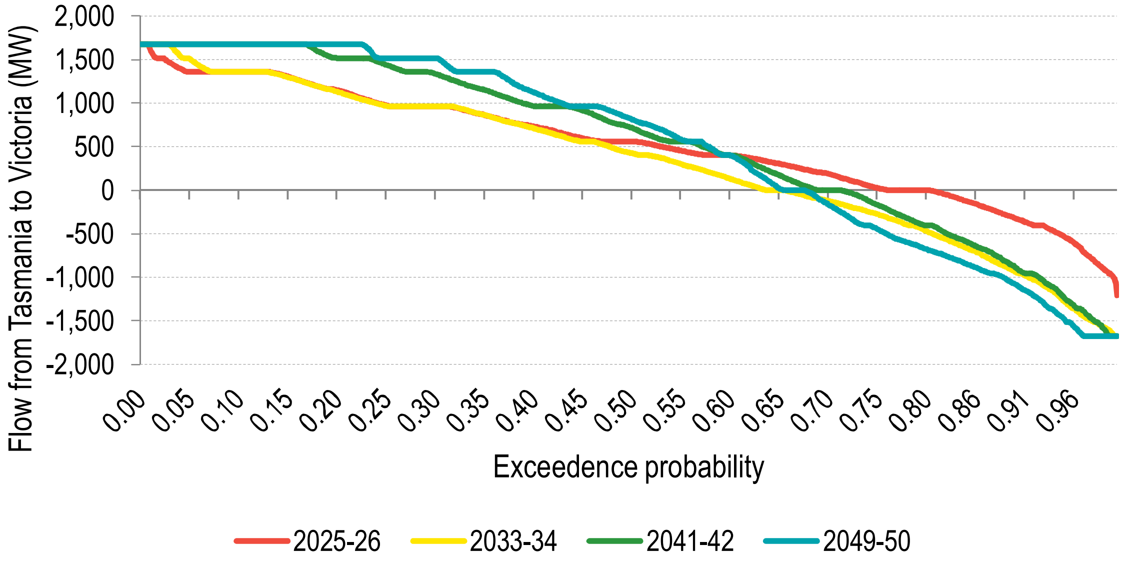


Figure 53 shows an expected duration curve for several different years over the forecast period. It shows that energy generally flows from Tasmania to Victoria for 65 % to 75 % of times. While the maximum transfer limit of 1,678 MW (478 MW limit for Basslink and 1,200 MW limit for Marinus 1,200 MW) is only reached for up to 5 % for 2025-26 and 2033-34, the installation of new large-scale solar PV and pumped hydro capacity from 2034-35 allows the flow from Tasmania to Victoria to reach its maximum limit for 20 % to 25 % of the time for the latter half of the study period.

Figure 53: Duration curve for Basslink and Marinus 1,200 MW flow for Marinus1200 Tas600PSH Tas600Wind Scenario with Marinus



3.3.10 Marinus1200 Tas600Wind EC90

This sensitivity was modelled to explore conditions in which a 1,200 MW Marinus may be economic. The benefit is forecast to be $2,921 million, which represents a substantial increase relative to the Marinus1200 sensitivity ($1,169 million), the Marinus1200 Tas600Wind sensitivity ($1,692 million) and the Marinus1200 EC90 sensitivity ($2,402 million). These benefits all assume that the only difference in the counterfactual is the presence/absence of Marinus (i.e. the 600 MW wind development would occur regardless of whether Marinus proceeds). They also do not account for the cost of the additional wind capacity or the cost of the interconnector.

Figure 54 and Figure 55 show the expected development path in Tasmania for this sensitivity. Marinus 1,200 MW drives an increase in the development of generation capacity in Tasmania, relative to the counterfactual of no Marinus, by nearly 3 GW by the end of the study (Figure 55). The expanded development of wind, large-scale solar PV and PSH in Tasmania is advanced in time compared with the counterfactual. In the case of Marinus 1,200 MW, the 1.6 GW of wind installed prior to the commencement of the Marinus project is augmented to 1.9 GW from 2025-26 for the next 20 years, before some wind is retired at end of life and replaced by solar on the grounds of lower cost at that point in time. Therefore, Marinus 1,200 MW is a clear driver of the benefits of Tasmanian wind in providing the lowest cost to the NEM until almost 2050. Solar and PSH increase by 1 GW and 0.8 GW respectively in Tasmania with Marinus, with PSH economically justified by 2028-29. Without Marinus, about 200 MW of equivalent wind output is wasted, and this drives retirements of some wind after the 25-year wind lifetime is reached.

Figure 54: Tasmanian capacity mix forecast for EC90 Tas600Wind sensitivity with Marinus 1,200 MW

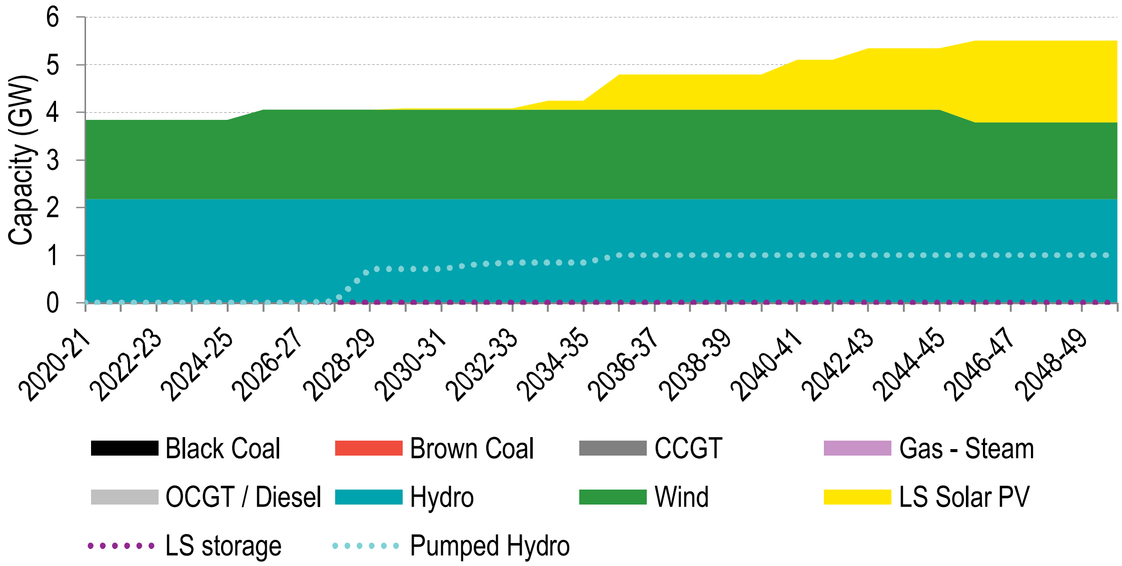


Figure 55: Change in Tasmanian capacity mix due to Marinus 1,200 MW for Tas600Wind EC90 (Tas600Wind EC90 with Marinus minus Tas600Wind EC90 without Marinus)

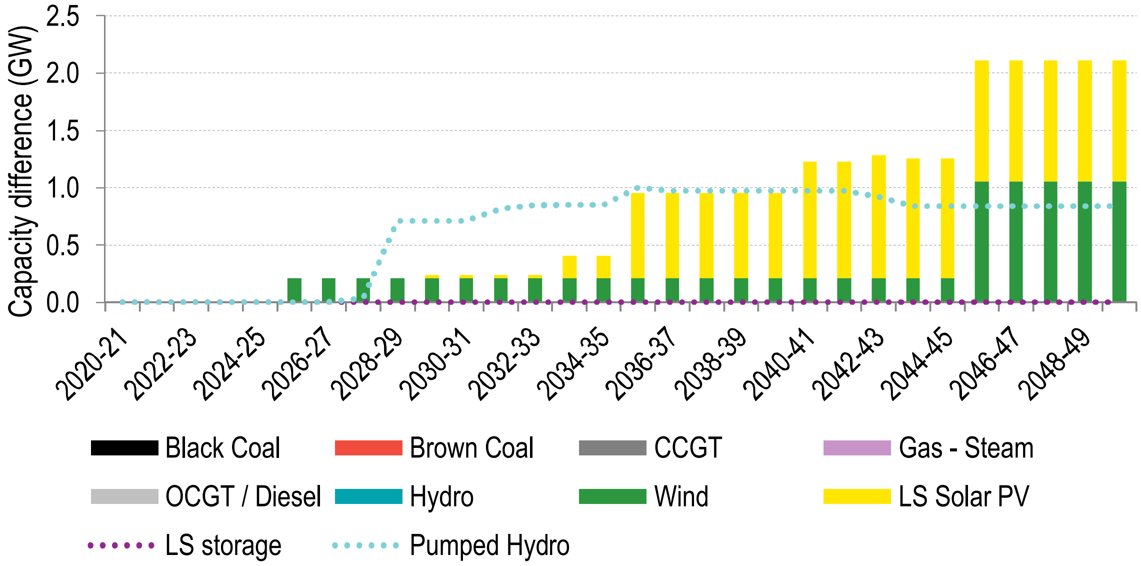
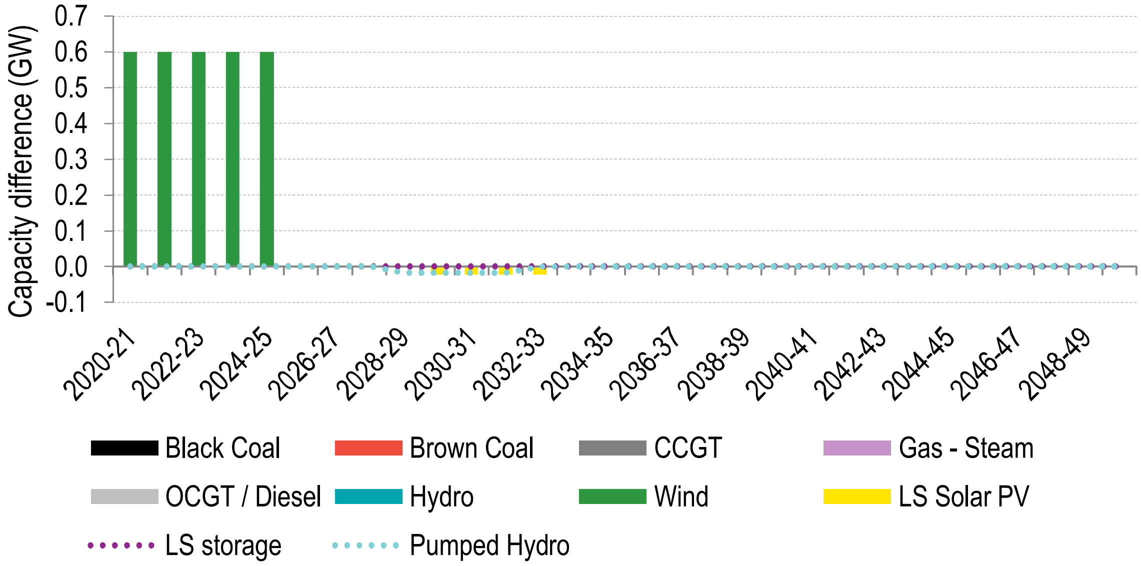


Figure 56 shows the expected development path in Tasmania for this sensitivity relative to the EC90 sensitivity with Marinus 1,200 MW. The figure indicates that if the additional 600 MW of assumed Tasmanian wind capacity had not been installed by 2020-21, it would be installed once Marinus is commissioned in 2025-26. The additional Tasmanian wind capacity also allows for a deferral of approximately 200 MW to 400 MW of wind capacity throughout the mainland prior to 2025-26. After Marinus is commissioned the capacity development in Tasmania is almost identical to the EC90 case with Marinus 1,200 MW. By 2030-31 the capacity development of all NEM regions for Tas600Wind EC90 with Marinus 1,200 MW are almost identical those forecast for EC90 with Marinus 1,200 MW. This suggests that the additional 600 MW of Tasmanian capacity allows for a deferral of mainland capacity, but would not materially alter the capacity development in the NEM from the 2030s onward if Marinus 1,200 MW is commissioned.

Figure 56: Change in Tasmanian capacity mix due to 600 MW of additional Tasmanian wind capacity from the beginning of the study for Tas600Wind EC90 (Tas600Wind EC90 with Marinus 1,200 MW minus EC90 without Marinus 1,200 MW; difference of Figure 54 relative to Figure 48)



The NPV of the benefits of Marinus 1,200 MW in the scenario with 600 MW of additional committed wind in Tasmania prior to Marinus development and the steeper emissions reduction path is forecast to be $2,921 million across the NEM (Table 40). The fuel benefit is $914 million, while the capex benefit is $1,567 million across the NEM. These represent significant increases from the EC90 case with Marinus 1,200 MW. Note though that the capital cost of the additional 600 MW of wind in Tasmania in the Marinus1200 Tas600Wind EC90 case is not accounted for. The remaining categories of benefits are much less, comprising FOM and VOM savings and a slight reliability benefit.

Table 40: Marinus1200 Tas600Wind EC90 sensitivity NPV benefit ($m) by region

Region	Capex	FOM	Fuel	VOM	USE	Total	Total Marinus1200 EC90	Total Marinus1200 Tas600Wind
NSW	469	123	-132	33	-2	492	565	549
QLD	1,058	58	-300	33	-10	839	867	138
VIC	1,205	504	1,165	183	41	3,098	3,560	1,601
SA	387	125	181	4	-1	696	708	579
TAS	-1,552	-498	-	-153	-	-2,204	-3,298	-1,175
Total	1,567	313	914	99	27	2,921	2,402	1,692
Total Marinus1200 EC90	1,223	287	794	64	34	2,402		
Total Marinus1200 Tas600Wind	451	123	992	91	36	1,692		

The $2,921 million in benefits is unevenly spread between the regions (Table 40), with a large positive benefit of $3,098 million in Victoria and a large negative benefit of $-2,204 million in Tasmania. Comparing the benefits between the regions, with Marinus, the investment capex in generation in Tasmania increases by $1,552 million, which is represented as a negative benefit to Tasmania. There are corresponding savings in capex in all the mainland states, due to the reduced need to build in those states, as Tasmania's resources are able to be unlocked by Marinus, particularly due to the investment in wind capacity prior to commissioning of Marinus. The introduction of Marinus provides overall capex reductions because wind and pumped hydro investment reduces by $1,013 million and $104 million across the NEM respectively, and large-scale solar PV investment increases by $25 million (Table 41).

Table 41: Marinus1200 Tas600Wind EC90 sensitivity NPV benefit ($m) by technology

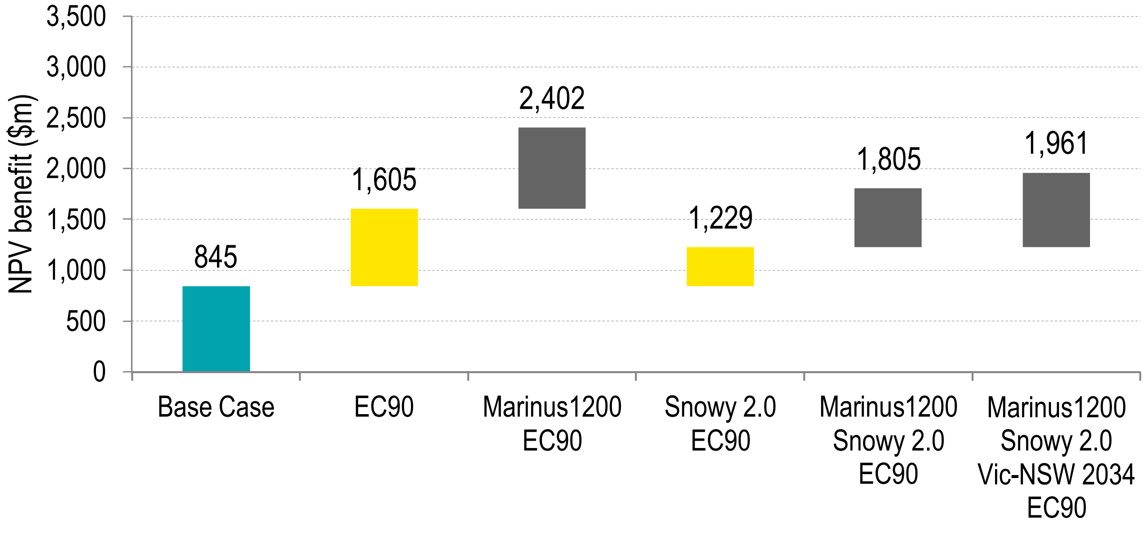
Technology	Capex	FOM	Fuel	VOM	USE	Total
Black Coal	-	-143	-695	-60	-	-899
Brown Coal	-	317	101	12	-	430
CCGT	-91	-8	-123	-15	-	-237
Gas - Steam	-	-	53	9	-	61
OCGT / Diesel	279	27	1,580	167	-	2,053
Hydro	-	-	-	10	-	10
Wind	1,013	157	-	-34	-	1,136
LS Solar PV	-25	-44	-	-	-	-69
Pumped Hydro	104	-28	-	11	-	87
LS storage	287	34	-	-	-	322
USE	-	-	-	-	27	27
Total	1,567	313	914	99	27	2,921

The fuel saving of $914 million (Table 40) is predominantly in reduced need for peaking plant, made up of $1,580 million in OCGT and diesel generation fuel cost reductions, offset by $695 million in additional coal costs (Table 41). There are small changes to other categories of fuel consumption.

3.3.11 Summary of Marinus 1,200 MW sensitivities

Figure 57 shows the benefits for different Marinus 1,200 MW sensitivities with high emissions reduction trajectories. It is forecast that under Base Case assumptions with a high emissions reduction trajectory and a 1,200 MW capacity for Marinus (Marinus1200 EC90) that Marinus' benefit is forecast to be $2,402 million. This is $797 million more than the EC90 sensitivity, which assumed Marinus' import and export limits to be 600 MW.

Figure 57: Waterfall chart of total benefits of Marinus 1,200 MW sensitivities relative to the Base Case (with Marinus 600 MW) and the matched Marinus 600 MW sensitivities, with high emissions constraint



By assuming Marinus 1,200 MW with a high emission trajectory *and* Snowy 2.0 the benefit is $1,805 million. This is $576 million more than the Marinus 600 MW version of this sensitivity. This sensitivity assumed the Vic-NSW Option 7A upgrade to occur in 2027-28. When assuming this upgrade is delayed to 2034-35, the benefit is forecast to increase to $1,961 million. The additional $156 million in benefit for Marinus is primarily driven by the deferral of the Vic-NSW interconnector upgrade, which allows Marinus 1,200 MW to be better utilised from 2027-28 to 2034-35.

Figure 58 displays the benefit for the staggered Marinus 1,200 MW sensitivities relative to their non-staggered counterparts. For all three staggered sensitivities, the first 600 MW stage of Marinus is assumed to be commissioned in 2025-26. For Marinus1200 Staggered it is assumed that the second 600 MW stage is complete by 2028-29. For the two staggered sensitivities with a high emissions constraint, it is assumed that the second stage is complete one year earlier in 2027-28. A reduced benefit of $16 million to $37 million occurs in all staggered sensitivities with respect to their non-staggered counterparts, due to the lesser capacity of Marinus between the first and second stage its construction.

Figure 58: Waterfall chart of total benefits of staggered Marinus 1,200 MW sensitivities relative to their respective non-staggered counterparts

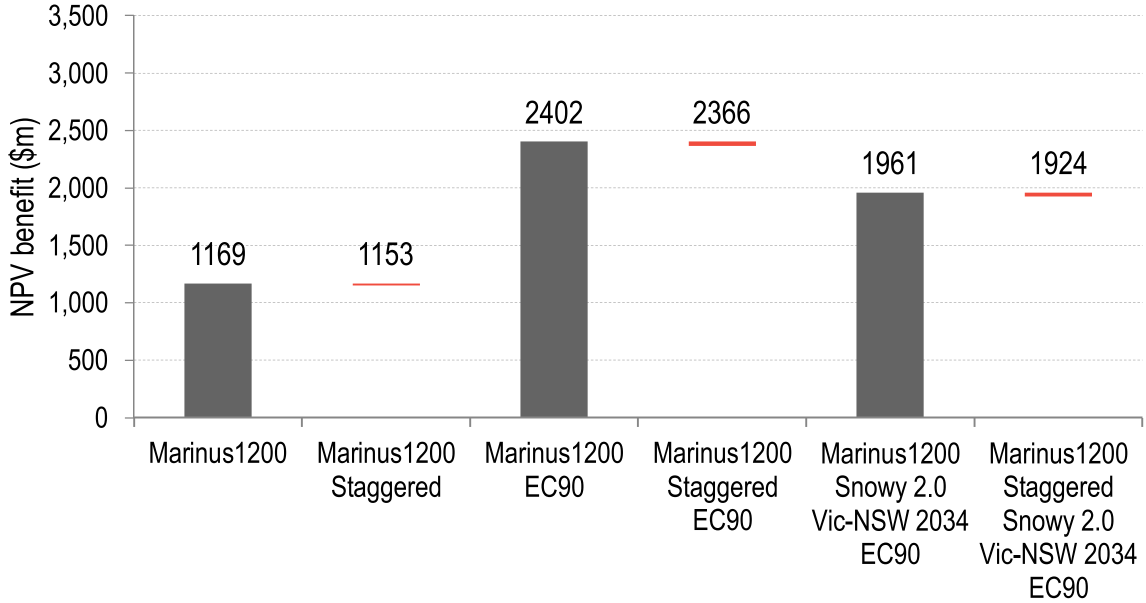
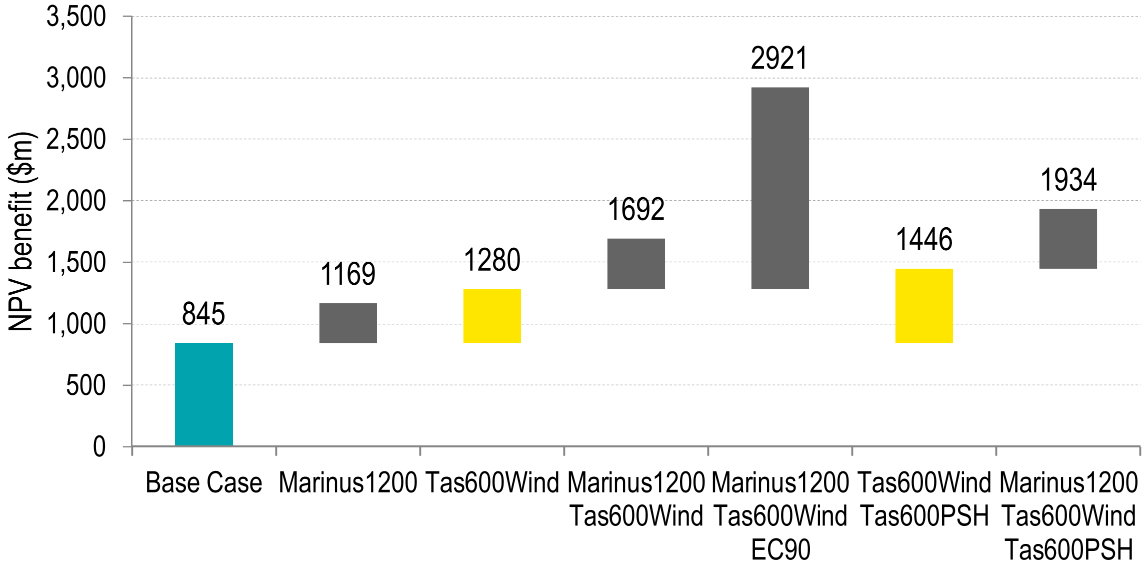


Figure 59 displays a summary of the relative benefits of all Marinus 1,200 MW sensitivities that assume additional capacity will be installed in Tasmania regardless of Marinus' commissioning.

Figure 59: Waterfall chart of total benefits of Marinus 1,200 MW sensitivities relative to the Base Case (with Marinus 600 MW) and the matched Marinus 600 MW sensitivities, with low emissions constraint



The commissioning of Marinus with 1,200 MW capacity in 2025-26 is forecast to result in a $324 million increase in benefit compared to the Base Case, which assumes Marinus' import and export limits to be 600 MW.

For Tas600Wind, which assumed a total of 1,650 MW of Tasmanian wind capacity, the benefit of Marinus 600 MW was forecast to be $1,280 million. For the Marinus 1,200 MW version of this sensitivity, the benefit is increased by an additional $412 million. This suggests that additional Tasmanian wind and additional capacity of Marinus are complementary, since the increase in benefit is more that of Marinus1200 compared to the Base Case. Similarly, by increasing Marinus' capacity to 1,200 MW in the Tas600Wind Tas600PSH case, the benefit rises by $488 million. Again, this indicates additional wind and pump storage capacity is complementary with a larger import and export limit for Marinus. When assuming a high emissions reduction target with 600 MW of additional Tasmanian wind, Marinus' benefit is increased to $2,921 million.

4. Discussion

The benefits of Marinus vary widely depending on the case study. However, there are some common themes in relation to the development path for Tasmania that are apparent. For the Base Case, with and without Marinus 600 MW or 1200 MW links, Table 42 shows the development of capacity in Tasmania in 2050.

Table 42: Forecast development of capacity in Tasmania with and without Marinus

Generation installed in 2050 (MW)	Without Marinus	With Marinus 600 MW	Increase in installed generation with Marinus 600 MW	With Marinus 1200 MW	Increase in installed generation with Marinus 1200 MW
Wind	650	950	300	1,650	1,000
LS Solar PV	1,350	1,950	600	1,600	250
Pumped Storage Hydro	200	1,000	800	1,000	800
Large Scale Storage Battery	0	0	0	0	0
Total (excluding existing conventional hydro)	2,200	3,900	1,700	4,250	2,050

For the Base Case, with or without Marinus, the existing conventional hydro capacity in Tasmania of approximately 2,200 MW is expected to remain operational in 2050. Without Marinus, the installed capacity of other technologies in 2050 is about 2,200 MW. With Marinus, the installed capacity of other technologies is about 3,900 MW. For the Base Case, the increase in long term development in Tasmania associated with Marinus is therefore forecast to be 300 MW of wind, 600 MW of large-scale solar PV and 800 MW of PSH, totalling 1,700 MW of additional capacity.

A wide range of sensitivity studies has been presented in this Report around the 600 MW Marinus Base Case, both with and without Marinus. Most of these sensitivities converge to a very similar development outcome for Tasmania generation installed capacity by 2050 as shown in the table above for the Base Case, i.e. the same outcome as the Base Case installed capacity by type and magnitude. This applies to the Snowy 2.0 sensitivity, (Snowy 2.0), reduced Tasmanian demand of 100 MW (Tas100LossLoad), the high gas price sensitivity (HighGas), reduced Basslink capacity (BL400), deferred Marinus sensitivities (Defer2028 and Defer2032), additional 600 MW of Tasmanian wind (Tas600Wind), additional committed Tasmanian PSH (Tas600PSH), and addition of both 600 MW PSH and 600 MW Tasmanian wind (Tas600Wind Tas600PSH).

The cases with 600 MW Marinus that are forecast to have significantly different generation development in Tasmania are the stronger emissions target cases. In particular the EC90 case has only 700 MW of wind and 1,450 MW of solar, but 1,000 MW of PSH, a total of 3,150 MW. With the EC90 case and both Marinus and Snowy 2.0 (Snowy 2.0 EC90), the development in Tasmania consists of 1,000 MW of wind, 1,700 MW of solar and 1,000 MW of PSH, a total of 3,700 MW new capacity. The stronger emissions cases generally have less generation development in Tasmania, because the additional development of wind and solar on the mainland is able to be transported and stored in the Tasmanian storages more economically than by developing the equivalent storage resources in Tasmania.

With Marinus 1,200 MW development, the installed capacity of new generation projects in Tasmania by the end of the study increases to 4,250 MW, compromising 1,650 MW of wind, 1,600 MW of solar and 1,000 MW of PSH. This is also the case with the additional 600 MW of wind. However, with both 600 MW of wind and 600 MW of PSH introduced by the time Marinus 1,200 MW is built, the outcome by 2050 is for 1,300 MW of wind, 2,100 MW of solar, and 1,600 MW of PSH installed in Tasmania, a total of 5,000 MW of installed capacity in addition to existing hydro. This higher amount of generation in Tasmania in this case is mainly a result of the cap on PSH capacity in Tasmania being lifted by 600 MW for this scenario. The scenarios with Marinus 1,200 MW and stronger emission target have similar development in Tasmania as the Marinus 1,200 MW sensitivities with the Base Case emissions trajectory.

Appendix A List of acronyms and abbreviations

Acronym or abbreviation	Expanded name
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
CCGT	Closed Cycle Gas Turbine
FOM	Fixed Operations and Maintenance
GW	Gigawatt (one thousand MW)
GWh	Gigawatt hour (one thousand MWh)
ISP	Integrated System Plan
LCOE	Levelised Cost of Energy of Generation Technologies ($/MWh)
LS	Large scale Applied to storage and solar PV to differentiate from distributed systems.
MLF	Marginal Loss Factor
MPC	Market Price Cap (as assessed by AEMC)
MW	Megawatt
MWh	Megawatt hour
NEM	National Electricity Market
NPV	Net Present Value
NSW	New South Wales
OCGT	Open Cycle Gas Turbine
O&M	Operations and Maintenance cost
PSH	Pumped Storage Hydro
RIT-T	Regulatory Investment Test for Transmission
RRN	Regional Reference Node
SA	South Australia
Solar PV SAT	Solar Photovoltaic Single Axis Tracking
TI	Trading Interval
TSIRP	Time Sequential Integrated Resource Planner
TWh	Terawatt hour
USE	Unserved Energy (as defined by AEMO)

Acronym or abbreviation	Expanded name
VCR	Value of Customer Reliability (as assessed by AEMO)
VOM	Variable Operations and Maintenance

Appendix 2 - Economic Contribution to Tasmania

Economic Contribution to Tasmania - Project Marinus

TasNetworks

5 December 2018

Building a better working world

The better the question. The better the answer. The better the world works.

Notice

Ernst & Young was engaged on the instructions of Tasmanian Networks Pty Ltd ("TasNetworks") to provide an assessment of the potential economic contribution of Project Marinus (the "Services"), in accordance with the contract dated 31 August 2018.

The results of Ernst & Young's work, including the assumptions and qualifications made in preparing the report, are set out in Ernst & Young's report dated 28 November 2018 ("Report"). The Report should be read in its entirety including the cover letter, the applicable scope of the work and any limitations. A reference to the Report includes any part of the Report. No further work has been undertaken by Ernst & Young since the date of the Report to update it.

Ernst & Young has prepared the Report for the benefit of TasNetworks and has considered only the interests of TasNetworks. Ernst & Young has not been engaged to act, and has not acted, as advisor to any other party. Accordingly, Ernst & Young makes no representations as to the appropriateness, accuracy or completeness of the Report for any other party's purposes.

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Craig Mickle
Partner

Infrastructure Advisory
T +61 2 9248 5196
M +61 411 510 199
E Craig.Mickle@au.ey.com

Bess Clark
General Manager – Project Marinus
Tasmanian Networks Pty Ltd
1/7 Maria Street, Lenah Valley
Moonah Tasmania 7009

5 December 2018

Economic Contribution Report to Tasmania – Project Marinus

Dear Bess,

In accordance with our Engagement Agreement dated 31 August 2018 (“Agreement”), Ernst & Young (“we” or “EY”) has been engaged by Tasmanian Networks Pty Ltd (“you”, “TasNetworks” or the “Client”) to provide an economic contribution analysis (the “Services”) in connection with Project Marinus, proposed second Tasmanian interconnector (the "Project").

The enclosed report (the “Report”) sets out the outcomes of our work. You should read the Report in its entirety. A reference to the report includes any part of the Report.

Purpose of our Report and restrictions on its use

Please refer to a copy of the Agreement for the restrictions relating to the use of our Report. We understand that the deliverable by EY will be used for the purpose of person other than to TasNetworks or to such party to whom we have agreed in writing to accept a duty of care in respect of this Report, and accordingly if assisting TasNetworks in its investigation into market benefits of the proposed second Tasmanian interconnector (the “Purpose”).

This Report was prepared on the specific instructions of TasNetworks solely for the Purpose and should not be used or relied upon for any other purpose.

We accept no responsibility or liability to any such other persons choose to rely upon any of the contents of this Report they do so at their own risk. Third parties seeking a copy of this Report will require permission from EY, and will be required to sign an access letter in the format agreed to between EY and TasNetworks.

Nature and scope of our work

The scope of our work, including the basis and limitations, are detailed in our Agreement and in this Report.

Our work commenced on 12 August 2018 and was completed on 14 November 2018. Therefore, our Report does not take account of events or circumstances arising after 14 November 2018 and we have no responsibility to update the Report for such events or circumstances.

This analysis considers a number of combinations of input assumptions relating to future conditions, which may not necessarily represent actual or most likely future conditions. Additionally, modelling inherently requires assumptions about future behaviours and market interactions, which may result in forecasts that deviate from future conditions. There will usually be differences between estimated and actual results, because events and circumstances frequently do not occur as expected, and those differences may be material. We take no responsibility for the achievement of projected outcomes, if any.

We highlight that our analysis and Report do not constitute investment advice or a recommendation to you on your future course of action. We provide no assurance that the scenario we have modelled will be accepted by any relevant authority or third party.

Our conclusions are based, in part, on the assumptions stated and on information provided by TasNetworks during the course of the engagement. The modelled outcomes are contingent on the collection of assumptions as agreed with the Client and no consideration of other market events, announcements or other changing circumstances are reflected in this Report. Neither Ernst & Young nor any member or employee thereof undertakes responsibility in any way whatsoever to any person in respect of errors in this Report arising from incorrect information provided by TasNetworks.

Craig Mickle
Partner

Infrastructure Advisory
T +61 2 9248 5196
M +61 411 510 199
E Craig.Mickle@au.ey.com

5 December 2018

Bess Clark
General Manager – Project Marinus
Tasmanian Networks Pty Ltd
1/7 Maria Street, Lenah Valley
Moonah Tasmania 7009

In the preparation of this Report we have considered and relied upon information from a range of sources believed after due enquiry to be reliable and accurate. We have no reason to believe that any information supplied to us, or obtained from public sources, was false or that any material information has been withheld from us.

We do not imply and it should not be construed that we have verified any of the information provided to us, or that our enquiries could have identified any matter that a more extensive examination might disclose. However, we have evaluated the information provided to us by TasNetworks as well as other parties through enquiry, analysis and review and nothing has come to our attention to indicate the information provided was materially mis-stated or would not afford reasonable grounds upon which to base our Report.

This letter should be read in conjunction with our Report, which is in the following slides.

Thank you for the opportunity to work on this project for you. Should you wish to discuss any aspect of this Report, please do not hesitate to contact Craig Mickle on 02 9248 5196.

Yours sincerely

Craig Mickle
Partner

Executive summary

Executive Summary

Purpose and scope

TasNetworks has engaged EY to undertake an assessment of the economic contribution of Project Marinus' construction and operating phases to Tasmania.

This report outlines the following:

1. The total direct and indirect economic contribution to Tasmania and Victoria for Project Marinus (600 MW and 1200 MW configurations) – in terms of economic value add and jobs*
2. The total direct and indirect economic contribution of the investment in additional Tasmanian generation that Project Marinus is expected to induce (600 MW, 1200 MW and 1200 MW – with an ambitious emissions reduction target** configurations)
3. The total direct and indirect economic contribution to three regions within Tasmania – in terms of jobs

The analysis provided is intended to assist TasNetworks to quantify the potential wider economic benefits of Project Marinus beyond the electricity market. The electricity market impacts of Project Marinus are set out in a separate EY report.***

Project Marinus

Project Marinus or the Second Tasmania Interconnector ("Project Marinus") is a proposed HVDC (High Voltage Direct Current) electricity transmission connection between mainland Victoria and Tasmania. If built, Project Marinus will complement the existing Basslink interconnector, which began trading energy between Tasmania and Victoria via the National Electricity Market in 2006.

TasNetworks are currently in the process of preparing a preferred Project Marinus configuration.

For this analysis, EY has considered two of these potential configurations:

Option	Size	Type
1	*600 MW*	Symmetrical Monopole
2	*1200 MW*	Twin Symmetrical Monopole

The 600 MW configuration is expected to take between three and four years to construct, with operations expected to commence in July 2025.

The 1,200 MW configuration is expected to be completed in two phases. The first phase is expected to take between three and four years to construct, with operations expected to commence in July 2025. The second phase is expected to take the same time and will begin construction one year before the first phase concludes. Both phases are expected to deliver 600 MW.

The total capital cost of the 600 MW configuration is expected to be $1,360m while the 1,200 MW configuration is expected to cost $2,460m.

Induced renewable investment in Tasmania

Project Marinus is expected to induce further renewable electricity generation in Tasmania. An additional interconnector may over time induce investments which meet the growing demand for cleaner energy from Australia's mainland.

AEMO's Integrated System Plan (ISP) has identified indicative locations for hydro generators, wind and solar farms in the eastern and northern regions of Tasmania. These locations are generally more competitive for renewable energy generation than many sites on the mainland due to their natural characteristics

The induced investments are expected to be incrementally installed after the construction of Project Marinus. The installation magnitude (MW) and timeframe is calculated through EY's "market model", which forecasts costs and likely demand from consumers of electricity. This analysis considers three scenarios for the induced investment:

- **600 MW – EC70 or "600 MW":** A 600 MW Project Marinus configuration with a modest emissions reduction target
- **1200 MW – EC70 or "1200 MW":** A 1,200 MW Project Marinus configuration with a modest emissions reduction target
- **1200 MW – EC90:** A 1,200 MW Project Marinus configuration with an ambitious emissions reduction target

**Please refer to the jobs explanation on page 8*
***Please refer to page 24 for an explanation on the "EC-70" and "EC-90" scenarios*
****Please refer to the EY report titled "Project Marinus economic modelling report"*

Executive Summary

Summary of economic contribution analysis (cont.)

Our approach has involved using economic contributions analysis to capture the direct effects of an industry (i.e. revenues or output) relevant to Tasmania and Victoria. It also applies an economic multiplier to capture the flow-on (or 'indirect') effects of Project Marinus' construction phases and operating phases to when our analysis concludes in 2050. It applies the same process to the additional Tasmanian generation that Project Marinus is expected to induce. The table below summarises the total jobs and value added that Project Marinus and the induced investment is expected to support:

Summary value added ($m) and jobs (job years) expected for Tasmania and Victoria

	Tasmania				Victoria	
	Project Marinus		Induced investment		Project Marinus	
	Value added ($m)	*Jobs (job years)*	*Value added ($m)*	*Jobs (job years)*	*Value added ($m)*	*Jobs (job years)*
600 MW						
Construction	410	2,501	995	6,075	718	4,216
Operations	235	1,224	5367	3,734	279	1,409
1,200 MW						
Construction	689	4,206	1,838	11,225	1,287	7,558
Operations	632	3,366	1,046	7,274	750	3,870
1,200 MW - EC90*						
Construction	689	4,206	2,213	13,513	1,287	7,558
Operations	632	3,366	1,535	10,675	750	3,870

Tasmania

Project Marinus is expected to create value add of approximately $410m and $690m for the Tasmanian economy during construction under the 600 MW and 1,200 MW configurations respectively. Between 2022 and 2025, at the peak of construction for the 600 MW configuration, Project Marinus is expected to support 111 direct and 434 indirect jobs per annum. In 2025, at the peak of construction for the 1200 MW configuration, Project Marinus is expected to support 196 direct and 767 indirect jobs. The induced investment will also create significant employment but those impacts will occur over a longer period of time.

Victoria

Between 2022 and 2025, at the peak of construction for the 600MW configuration, Project Marinus is expected to support 151 direct and 807 indirect jobs per annum. In 2025, at the peak of construction for the 1200 MW configuration, Project Marinus is expected to support 281 direct and 1,501 indirect jobs. The induced investment will also create significant employment but those impacts will occur over a longer period of time. Project Marinus will somewhat reduce the investment in renewables that would otherwise occur in Victoria (see page 29).

**Note that the '1200 MW – EC90' scenario uses the same construction costs and profile as the '1200 MW' option for Project Marinus.*

Regional investment

The report isolates three local economies that are expected to realise the economic contribution of Project Marinus and its induced investment. Specifically: North West Tasmania, North East Tasmania and the Tasmanian Midlands. The direct benefits of Project Marinus are modelled in North West Tasmania but it is likely that some would flow state wide. The table summarises the total jobs that Project Marinus and the induced investment is expected to support:

*Summary jobs (job years) expected for selected local economies**

	North West Tasmania		North East Tasmania		The Tasmanian Midlands	
	Project Marinus	Induced investment	Project Marinus	Induced investment	Project Marinus	Induced investment
600 MW						
Construction	2,002	2,756	0	154	0	1,301
Operations	967	1,677	0	185	0	819
1,200 MW						
Construction	3,368	2,479	0	487	0	1,699
Operations	1,368	2,402	0	759	0	1,794
1,200 MW - EC90						
Construction	3,368	4,285	0	524	0	1,758
Operations	1,368	4,048	0	1,007	0	2,361

North West Tasmania – 600 MW configuration

Between 2022 and 2025, at the peak of construction for the 600 MW configuration, Project Marinus is expected to support a total of 111 actual direct and 326 indirect jobs in each year.

North West Tasmania – 1200 MW configuration

In 2025, at the peak of construction for the 1200 MW configuration, Project Marinus is expected to support 196 direct and 575 indirect jobs. The induced investment will also create significant employment but those impacts will occur over a longer period of time and over a larger geographical area.

Please refer to pages 38 and 43 for the local investment overview.

* The jobs (job years) expected to be attributable to each region do not add up to the total jobs expected for the whole of Tasmania. This is driven by construction and operating jobs flowing to regions not captured in the regional investment analysis – the unshaded areas in the map to the right.

Indicative renewable investment locations in Tasmania

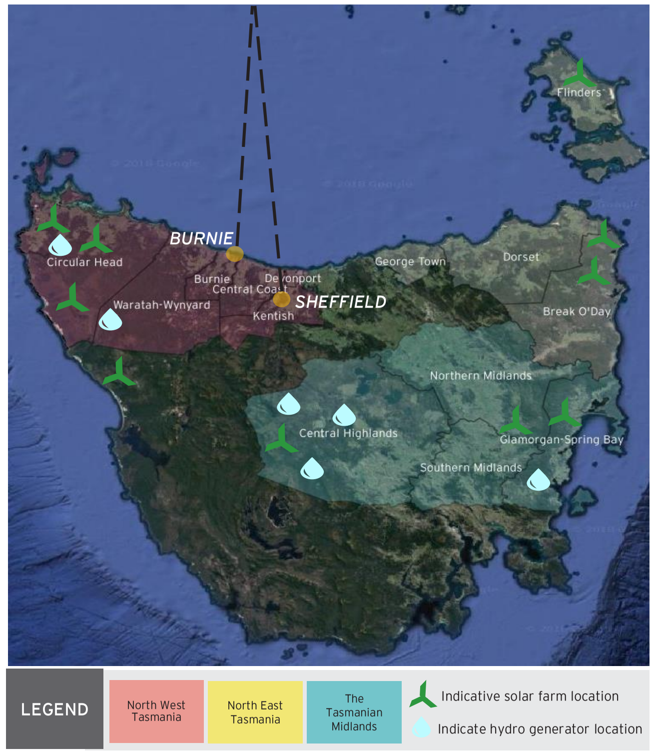


Table of contents

Introduction

Introduction

Purpose of this report: Capturing the broader economic benefits of Project Marinus

TasNetworks has engaged EY to undertake an assessment that captures the total direct and indirect economic contribution of Project Marinus' construction and operating phases to Tasmania and the investments it is expected to induce.

This analysis in this report outlines the following:

1. The total direct and indirect economic contribution to Tasmania and Victoria for Project Marinus (600MW and 1200 MW configuration) – in terms of economic value add and jobs
2. The total direct and indirect economic contribution of the investment in additional Tasmanian generation that Project Marinus is expected to induce (600 MW, 1200 MW and 1200 MW - with an ambitious emissions reduction target - configurations)
3. The total direct and indirect economic contribution to three regions within Tasmania – in terms of jobs

The analysis provided is intended to assist TasNetworks to quantify the potential wider economic benefits of Project Marinus beyond the impacts on the electricity market. The impacts on the electricity market of Project Marinus are the subject of a separate EY report.

What is Project Marinus?

Project Marinus or the Second Tasmania Interconnector ("2IC") is a proposed HVDC (High Voltage Direct Current) electricity transmission connection between mainland Victoria and Tasmania. If built, Project Marinus will complement the existing Basslink interconnector*, which began trading energy between Tasmania and Victoria via the National Electricity Market in 2006.

Based on guidance from TasNetworks, this analysis assumes Project Marinus' currently preferred alignment and configuration, shown in the diagram overleaf.

All years referred to in this report are financial years. Some figures in this report have been rounded for ease of communication. As a result, not all figures will reconcile exactly to totals (e.g. in some tables).

* Basslink is a 400 kV HVDC interconnector between Loy Yang in Gippsland to Bell Bay in Northern Tasmania. capable of transmitting 500 MW of power on a continuous basis in either direction,

Overview of Project Marinus

Possible alignments for the second interconnector

Costs (shown in the tables to the right) are expected to be identical for the two configurations in the diagram above.

TasNetworks is currently in the process of preparing a preferred Project Marinus configuration.

For this analysis, EY has considered two of these potential configurations:

Option	Size	Type
1	*600 MW*	Symmetrical Monopole
2	*1200 MW*	Twin Symmetrical Monopole

600 MW

The 600 MW configuration is assumed to deliver 600 MW of forward and backwards capability, and is expected to take between three and four years to construct, with operations expected to commence in 2026.

1,200 MW

The 1,200 MW configuration is expected to be completed in two phases ('Marinus Link Stage 1' and 'Marinus Link Stage 2' respectively), each assumed to deliver 600 MW of forward and backwards capability. The first phase is expected to take between three and four years to construct, with operations expected to commence in 2026.

Marinus Link Two is expected to take three to four years to construct. However, it is expected to begin construction in 2025, one year before Marinus Link One finishes. Both phases have been modelled with 600 MW of forward and backwards capability, for a total of 1,200 MW when both are operational in 2028.

The total capital cost of the 600 MW configuration is expected to be $1,350m while the 1,200 MW configuration is expected to cost $2,460m.

Cost breakdown – 600 MW configuration

Cost Category	Value ($)
HVDC cable and converter station costs	950
Network integration costs	110
Project costs	290
TOTAL	**1,360**

Cost breakdown – 1,200 MW configuration

Cost Category	Value ($)
HVDC cable and converter station costs	1,890
Network integration costs	140
Project costs	430
TOTAL	**2,460**

Approach – How we have captured the broader economic benefits of Project Marinus

Economic Contribution components

Flow-on (indirect) contribution – captured by economic multiplier

	Direct Economic Contribution +	Industrial Effect +	Consumption Effect =	Total Economic Contribution
General Definition	Total revenue generated by an industry plus value-add taxes	Flow-on contribution generated by an industry purchasing inputs	Flow-on contribution generated by an industry's employees purchasing goods and services with their income	
Example	Industries earn revenue from selling inputs to Project Marinus' construction and operations process	Flow-on (indirect) contribution generated by industries purchasing inputs and generating revenues for other businesses	Flow-on (indirect) contribution generated by industry employees purchasing goods and services with their income	

Economic contribution is a gross measure rather than a net measure of the contribution of an industry or a project to the economy.

Economic contribution studies do not consider substitution impacts, or what would happen if the relevant industry did not exist, or the relevant project did not occur.

Economic contribution analysis measures market related direct and indirect expenditure and economic activity generated by a specific industry and / or activity. Direct contribution analysis involves understanding and mapping the contributions directly attributable to an activity i.e. the construction of Project Marinus. The key direct impacts will come from capital and operating expenditures, employment and tax contributions associated with Project Marinus' construction and operations and the construction and operations of its induced investment. These processes will also directly contribute to value add and jobs.

Indirect economic contribution involves mapping the flow-on impacts from a proposed industry / activity as the direct impacts of the activity trickle through the economy. These flow-on impacts are typically reflected through the supply chain effects as more goods and services are demanded and consumption effects where a proportion of wages and salaries paid to workers are spent on consumptions activities.

Approach (cont.)

REMPLAN and other data sources

Economic contributions analysis has been undertaken using REMPLAN software. REMPLAN is an economic analysis software package designed for use by economic development practitioners to estimate the direct and indirect impacts of infrastructure developments or policy changes. REMPLAN provides detailed economic data for single or combinations of local government areas and also incorporates a dynamic economic modelling capability to allow the analysis of 'what if' scenarios.

Other data sources used to inform calculations in this report include:

- **IRENA Renewable power generation costs in 2017:** Used to obtain capital expenditure cost breakdowns for hydro turbine, wind and solar PV electricity generators;
- **Australian Energy Market Operator (AEMO) 2018 Integrated System Plan appendices** : Used to obtain proposed MW, REZ locations and optimal locations for hydro, wind and solar generation. This data was used to approximate potential investment in the economic regions identified by EY;
- **Project Marinus – Project Specification Consultation Report:** Used to obtain inputs on capital and operating expenditure for Project Marinus;
- **EY's market model:** Used to obtain forecasting data on potential investments induced by Project Marinus. This includes information on:
    - Fixed operating and maintenance costs ($);
    - Variable operating and maintenance costs ($);
    - Capital expenditure costs ($/MW);
    - Planned investments in renewable energy in MW until 2050 for hydro, solar and wind electricity generation investments in Tasmania;
- **TasNetworks internal model:** Used to obtain preliminary cost breakdowns for Project Marinus.

Key approach and assumptions

There are several appendices that the background to our approach. In particular:

- A glossary of key terms
- Appendix A - REMPLAN methodology
- Appendix B – Local investment methodology
- Appendix C – Project Marinus cost apportionment methodology

Jobs explanation

The jobs presented in this report represents the gross employment demand that would arise in Tasmania as a consequence of the construction and operation of Project Marinus. The employment footprint disregards any displacement effects – i.e. it does not make assumptions about whether or not the jobs are net additional. The footprint estimates are suited to understand the overall job opportunities and needs Project Marinus will generate.

Further all jobs in economic contribution analysis represent "job years" - A 'job-year' represents one full time job supported for a full year – for instance, 1,000 job-years may be 500 jobs sustained over 2 years, or 100 jobs sustained over 10 years.

Good practices when reporting these gross employment figures include:

- Always describing the period for which the jobs figure applies; e.g. "for the construction period" or "for ten years", etc.
- Avoiding phrases that assume economic constraints have already been accounted for, e.g. stating that the project "supports 10,000 jobs" or "expects to result in" is more accurate than "supports 10,000 new jobs"; and being clear that the figures are gross jobs, not net.
- Job figures should not be added to other projects undertaken in Tasmania.

Project Marinus - Economic contribution analysis

Overview of Project Marinus' construction profile

Construction

The construction of Project Marinus is expected to take between three and four years. Broadly, the construction phase requires:

- Purchase of intermediate inputs such as metal and metal alloys, cable and converters and construction materials; and
- Construction, financing and project management services.

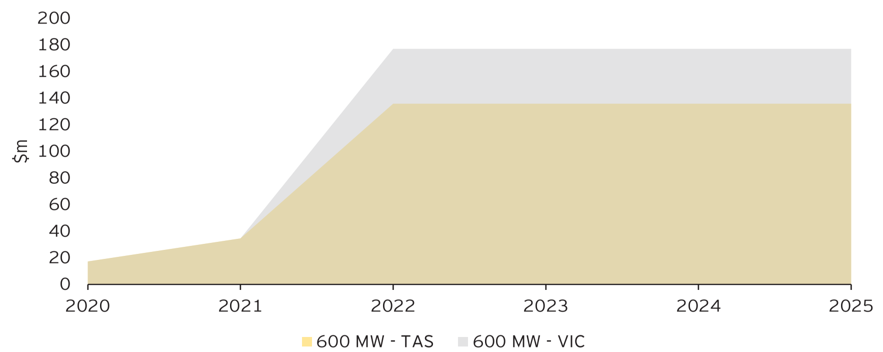
Core physical components of the interconnector include the:

- Undersea cable which carries electricity below the surface of the water;
- Transmission line(s) or cable(s) which carry electricity (to and from the undersea cable) over land to a converter station(s);
- Upgrades to existing transmission lines; and
- Converter station(s) which converts direct current (DC) to alternating current and vice versa.

600 MW configuration

Expenditure is expected to be comparatively lower during the 'definition and approvals phase', in the first half of 2020 and 2021. As the graph below indicates, expenditure is expected to increase as construction, installations and equipment purchases begin in earnest in 2022 through to 2025.

Project Marinus construction profile, Tasmanian and Victoria apportionment - 600 MW (Area graph)



Construction costs for the 1,200 MW option are higher than the 600 MW option, reflecting the larger volumes of equipment, material and manpower required to deliver double the megawatts to and from the mainland.

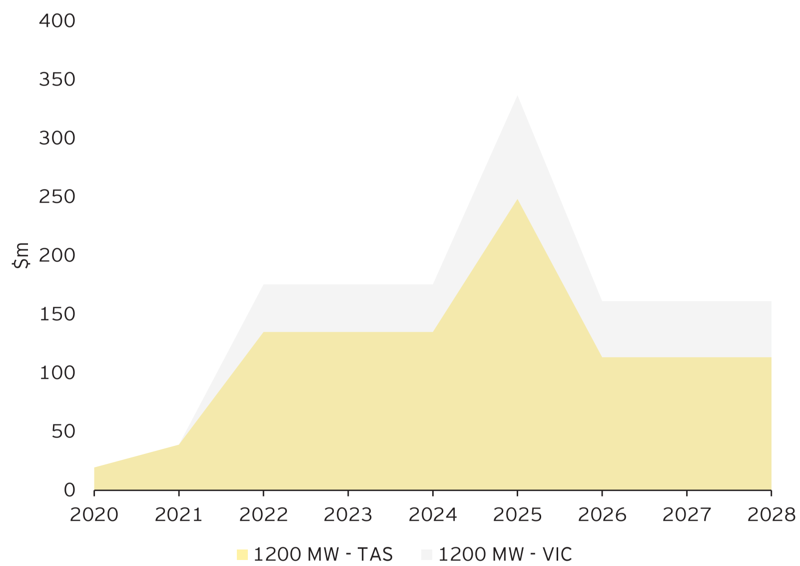
Further, construction costs associated with Victoria are higher than Tasmania's. This difference can be largely attributed to the construction of underground or overhead HVDC transmission line(s).

HVDC cable(s) and larger network integration costs required in Victoria.

1,200 MW configuration

The 1,200 MW configuration consists of two 600 MW interconnectors, both with similar characteristics the previously described configuration. Its timeframe is staggered, with the first phase 'Marinus Link One' sharing the same timing profile as the 600 MW configuration. The second phase 'Marinus Link Two' is expected to begin construction in 2025 and is expected to complete construction in 2028.

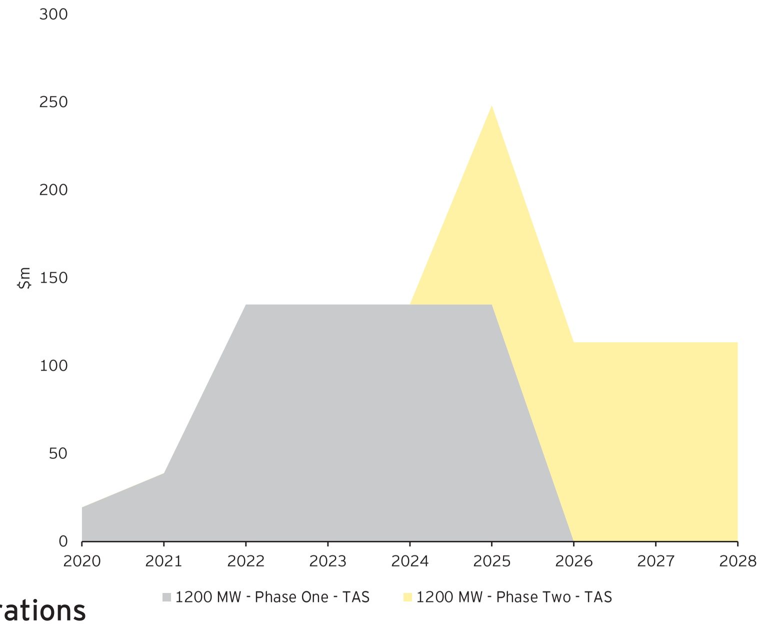
Project Marinus construction profile, Tasmanian and Victoria apportionment – 1,200 MW (Area graph)



Overview of Project Marinus' construction (cont.) and operating profile

The diagram below illustrates the expected construction profile of Marinus Links 1 and 2 of the 1,200 MW configuration. The diagram represents the costs attributed to Tasmania and Victoria combined.

Project Marinus construction profile, Marinus Links One and Two – 1,200 MW (Area graph)



Operations

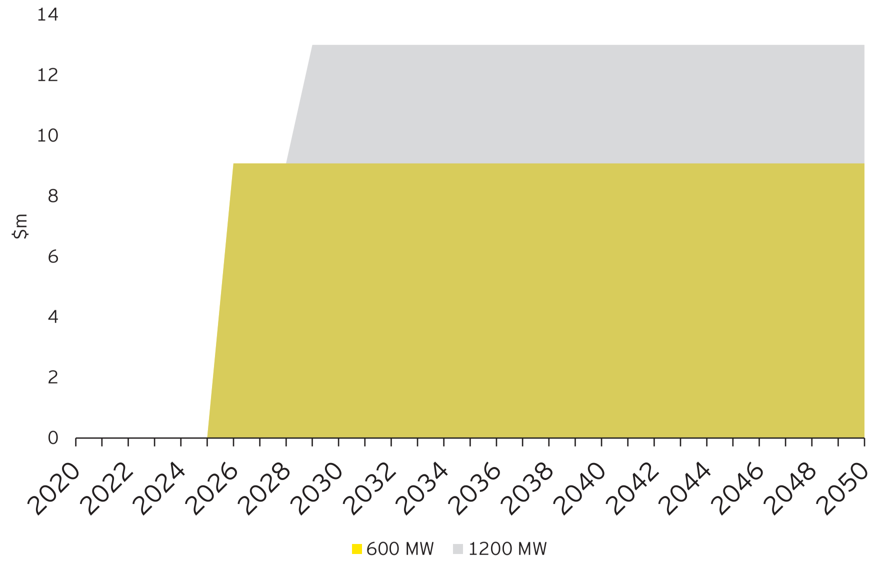
The 600 MW Project Marinus configuration is expected to begin operations in 2026, after the end of its construction phase in 2025. Annual operating costs are expected to be $9.1m per annum in Tasmania and $9.1m per annum in Victoria.

For the 1,200 MW Project Marinus configuration, operations for the first phase 'Marinus Link One' is expected to begin in 2025 with costs identical to the 600 MW option until 2028.

The second phase 'Marinus Link Two' is expected to finish construction in 2028. From 2029 onwards, operating costs are expected to be $13.0m per annum.

Operating costs for the 1,200 MW configuration reflect the expected efficiencies from operating and maintenance staff leveraging their expertise by working across twin monopoles in an efficient manner.

Project Marinus operating profile – 600 MW and 1,200 MW (Area graph)



Types of jobs Project Marinus is expected to support

Types of jobs Project Marinus is expected to support

The construction and operations of Project Marinus and its induced investment is expected to support jobs across a wide range of industries, education levels and occupations.

Construction

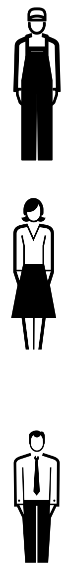
Core jobs in the construction phase include:

- Those physically involved in the building and installation process, such as:

Electricians	Engineers	Builders	Carpenters
Plumbers	Welders	Metal workers	Support workers

- Those indirectly involved in the building and installation process, such as:

Cost estimators	Engineers	Construction managers	Architects
Financial advisors	Technicians	Surveyors	Safety and incident support staff



Operations

Core jobs in the operations phase include:

Safety and incident support staff	Operations and maintenance manager	Plumbers, welders and other maintenance staff	Corporate and financial staff, asset managers

Given Project Marinus' unique status as a maritime project, professionals with experience in dealing in ocean-based environments are required throughout both construction and operating phases:

Maritime safety staff	Marine preservation advisors	Maritime construction and engineering specialists	Maritime logistics and transportation specialists

Types of jobs the induced investment is expected to support

With the exception of maritime related jobs, the induced investment is expected to support jobs similar to those identified above. Specialists with expertise in solar PV, wind and Pumped Hydro generation will also be required.

Tasmania - Project Marinus - 600 MW – construction

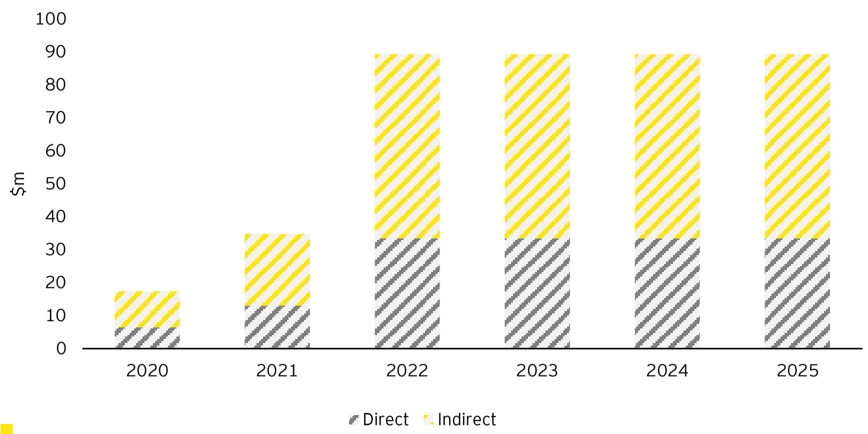
Tasmania	*Victoria*
Project Marinus	*Induced Investment*
600 MW	*1200 MW*
Construction	*Operations*

Over the construction period, the economic contribution analysis indicates that the total direct construction cost of Project Marinus (600 MW option), attributable to Tasmania is expected to be $408m, supporting an economic value added of $4010m and 2,501 job years.

Value added

Over the construction period, Project Marinus' (600 MW) construction is expected to support $154m and $256m in direct and indirect value add. The value added by sector is presented to the right.

Direct and indirect value added profile ($m)



Jobs

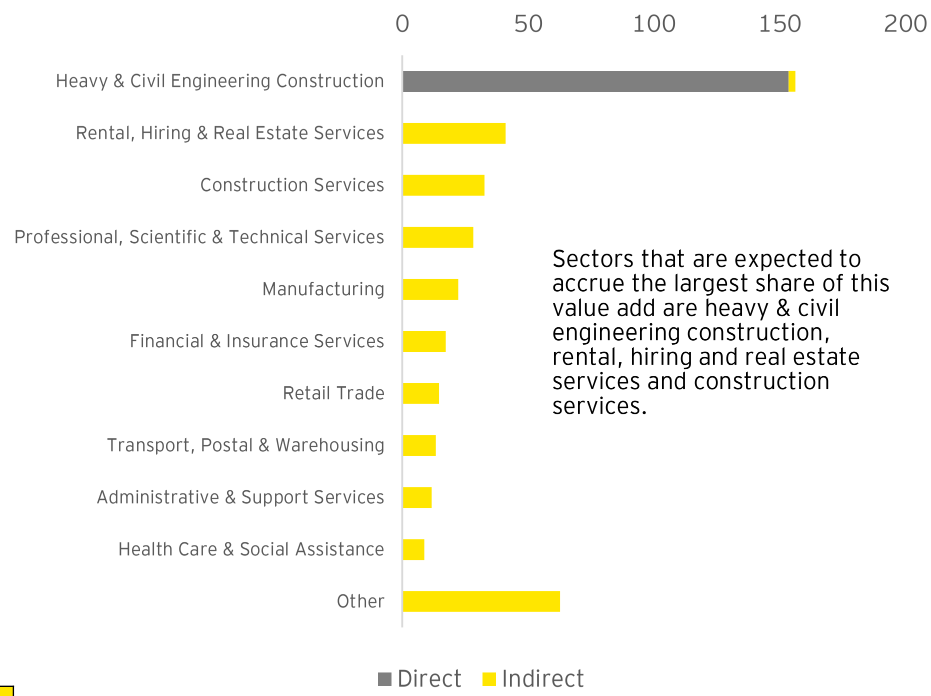
Project Marinus' (600 MW) construction is expected to support 508 in direct and 1,993 in indirect jobs during the construction period. At its peak of construction in 2022, Project Marinus' (600 MW) is expected to support 111 actual direct jobs and 435 indirect jobs.

Direct and indirect value added profile (job years)

	2020	2021	2022	2023	2024	2025	Total
Direct	22	43	111	111	111	111	**508**
Indirect	85	169	435	435	435	435	**1,993**

Value added by sector

Sectors expected to accrue the largest share of value add ($m)



Tasmania - Project Marinus - 600 MW - operations

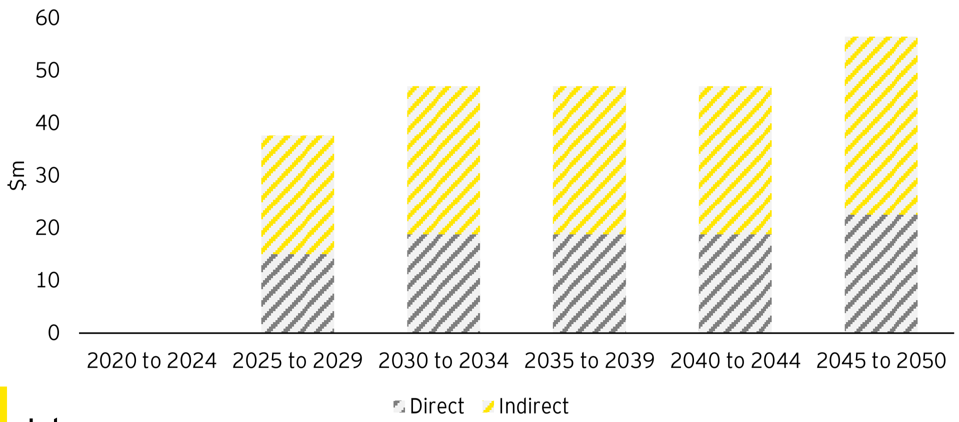
Tasmania	Victoria
Project Marinus	*Induced Investment*
600 MW	*1200 MW*
Construction	**Operations**

Over the operating period, the economic contribution analysis indicates that the total direct operating cost of Project Marinus (600 MW option), attributable to Tasmania is expected to be $227m, supporting an economic value added of $235m and 1,223 job years.

Value added

Project Marinus' (600 MW) operations is expected to support $94m direct and $141m indirect value add during the operations period. The value added by sector is presented to the right.

Direct and indirect value added profile ($m)



Jobs

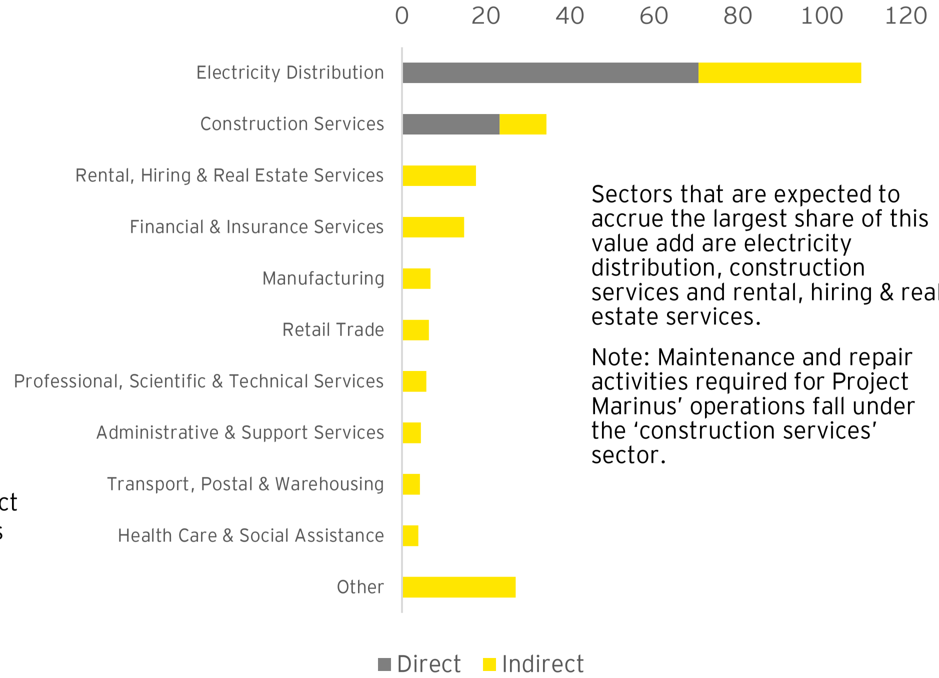
Project Marinus' (600 MW) operations is expected to support 373 direct and 850 indirect job years during the operations period. When operational, Project Marinus' (600 MW) is expected to support 15 actual direct jobs and 34 actual indirect jobs.

Direct and indirect value added profile (job years)

	2020 to 2024	2025 to 2029	2030 to 2034	2035 to 2039	2040 to 2044	2045 to 2050	Total
Direct	-	60	75	75	75	90	**373**
Indirect	-	136	170	170	170	204	**850**

Value added by sector

Sectors expected to accrue the largest share of value add ($m)



Sectors that are expected to accrue the largest share of this value add are electricity distribution, construction services and rental, hiring & real estate services.

Note: Maintenance and repair activities required for Project Marinus' operations fall under the 'construction services' sector.

Tasmania	Victoria
Project Marinus	Induced Investment
600 MW	1200 MW
Construction	Operations

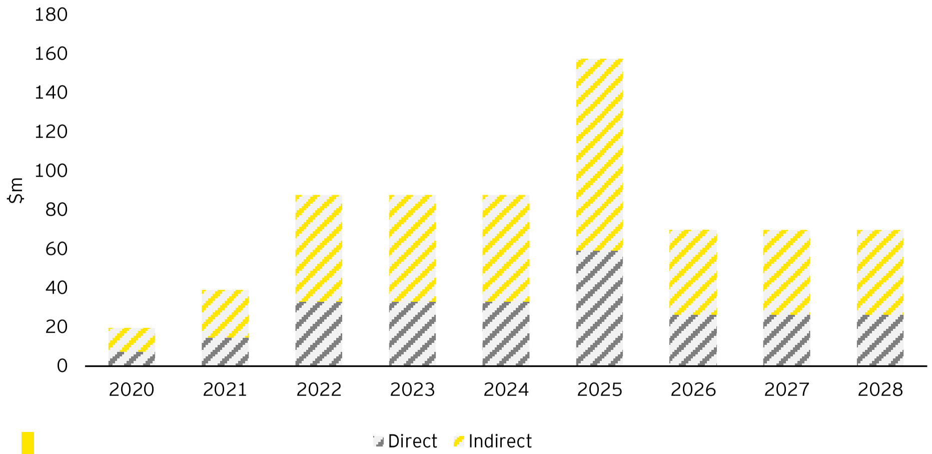
Tasmania - Project Marinus – 1,200 MW - construction

Over the construction period. the economic contribution analysis indicates that the total direct construction cost of Project Marinus (1200 MW option), attributable to Tasmania is expected to be $686m, supporting an economic value added of $688m and 4,206 job years over the construction period.

Value add

Project Marinus' (1200 MW) construction is expected to support $258m in direct and $430m in indirect value add during the construction period. The value added by sector is presented to the right.

Direct and indirect value added profile ($m)



Jobs

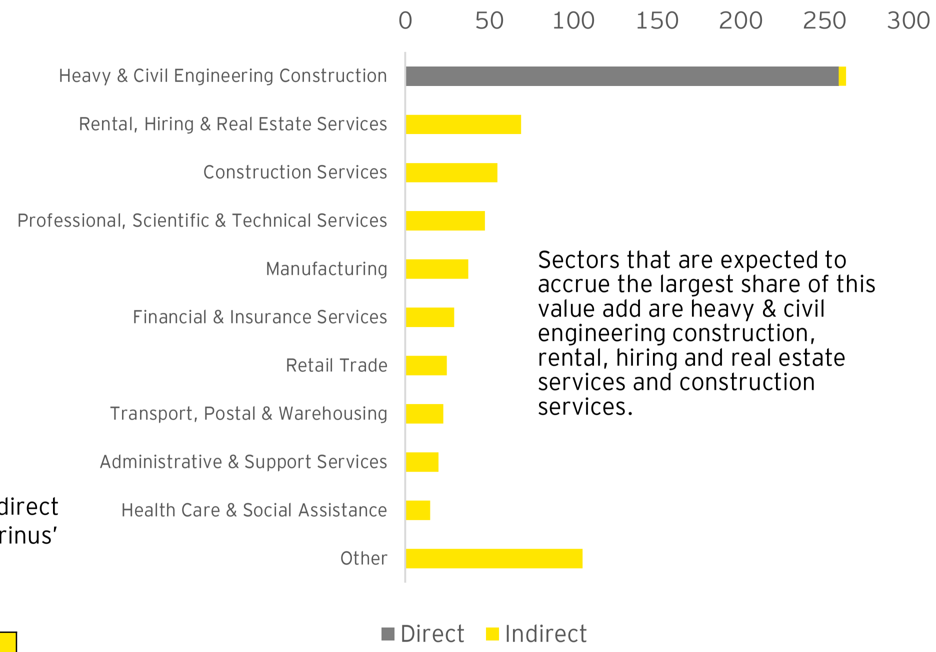
Project Marinus' (1200 MW) construction is expected to support 855 direct and 3,351 indirect job years during the construction period. At its peak of construction in 2025, Project Marinus' (1200 MW) is expected to support 196 actual direct jobs and 767 indirect jobs.

Direct and indirect value added profile (job years)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Direct	24	48	109	109	109	196	87	87	87	855
Indirect	95	190	427	427	427	767	340	340	340	3,351

Value added by sector

Sectors expected to accrue the largest share of value add ($m)



Sectors that are expected to accrue the largest share of this value add are heavy & civil engineering construction, rental, hiring and real estate services and construction services.

Tasmania	Victoria
Project Marinus	Induced Investment
600 MW	1200 MW
Construction	Operations

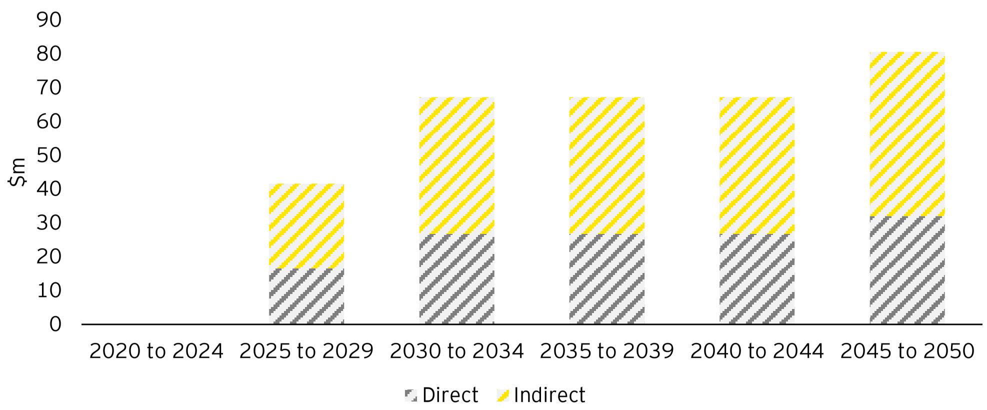
Tasmania - Project Marinus – 1,200 MW - operations

Over the operating period, the economic contribution analysis indicates that the total direct operating cost of Project Marinus (1,200 MW option), attributable to Tasmania is expected to be $314m, supporting an economic value added of $324m and 1,723 job years.

Value added

Over the operational period, Project Marinus' (1200 MW) operations is expected to support $129m and $195m in direct and indirect value add. The value added by sector is presented to the right.

Direct and indirect value added profile ($m)



Jobs

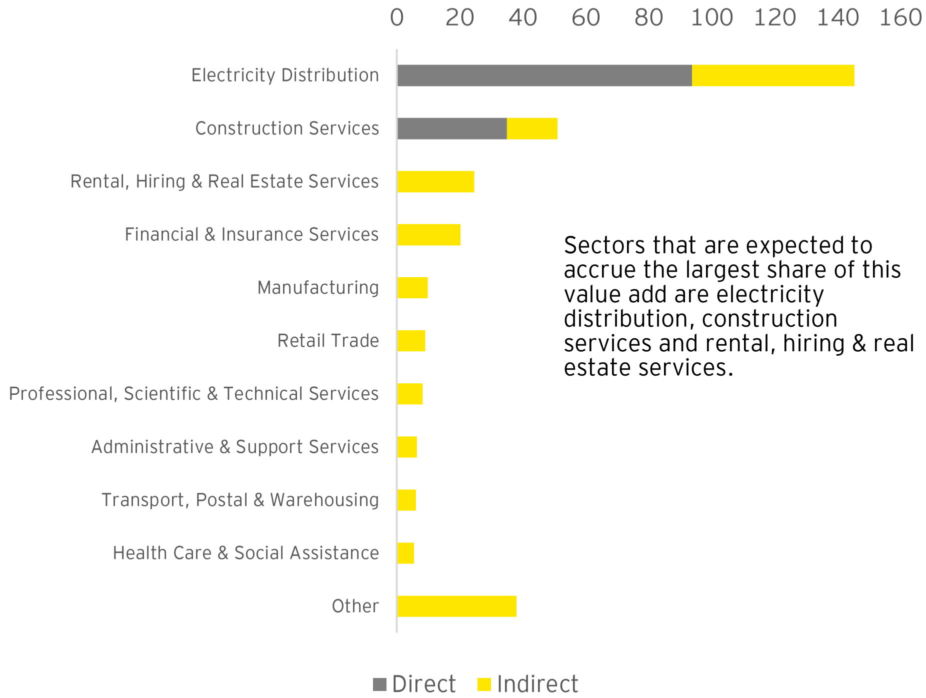
Project Marinus' (1200 MW) operations is expected to support 534 in direct and 1189 indirect job years during the operational period. From 2029, When Marinus Links 1 and 2 are operational, Project Marinus' (1,200 MW) is expected to support 22 actual direct jobs and 50 actual indirect jobs.

Direct and indirect value added profile (job years)

	2020 to 2024	2025 to 2029	2030 to 2034	2035 to 2039	2040 to 2044	2045 to 2050	Total
Direct	-	67	111	111	111	133	**534**
Indirect	-	151	247	247	247	296	**1,189**

Value added by sector

Sectors expected to accrue the largest share of value add ($m)



Sectors that are expected to accrue the largest share of this value add are electricity distribution, construction services and rental, hiring & real estate services.

Tasmania	Victoria
Project Marinus	Induced Investment
600 MW	1200 MW
Construction	Operations

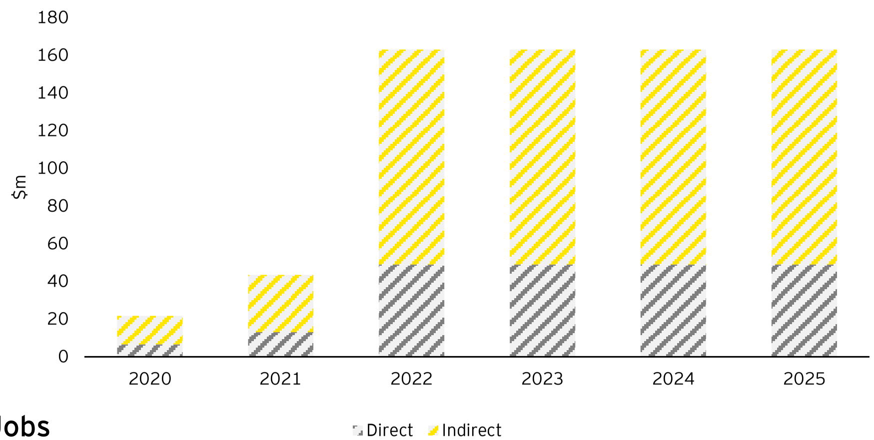
Victoria - Project Marinus - 600 MW – construction

Over the construction period, the economic contribution analysis indicates that the total direct construction cost of Project Marinus (600 MW option), attributable to Victoria is expected to be $573m, supporting an economic value added of $718m and 4,216 job years.

Value add

Project Marinus' (600 MW) construction is expected to support $216m in direct and $502m in indirect value add during the construction period. The value added by sector is presented to the right.

Direct and indirect value added profile ($m)



Jobs

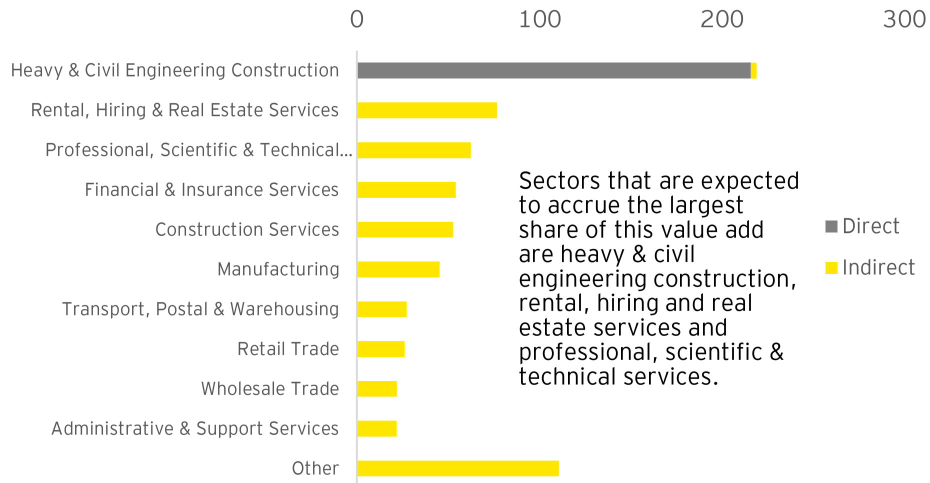
Direct and indirect jobs profile (job years)

Project Marinus' (600 MW) construction is expected to support 665 direct and 3,551 indirect job years.

	2020	2021	2022	2023	2024	2025	Total
Direct	20	40	151	151	151	151	**665**
Indirect	107	215	807	807	807	807	**3,551**

Value added by sector

Sectors expected to accrue the largest share of value add ($m)



Tasmania	Victoria
Project Marinus	Induced Investment
600 MW	1200 MW
Construction	Operations

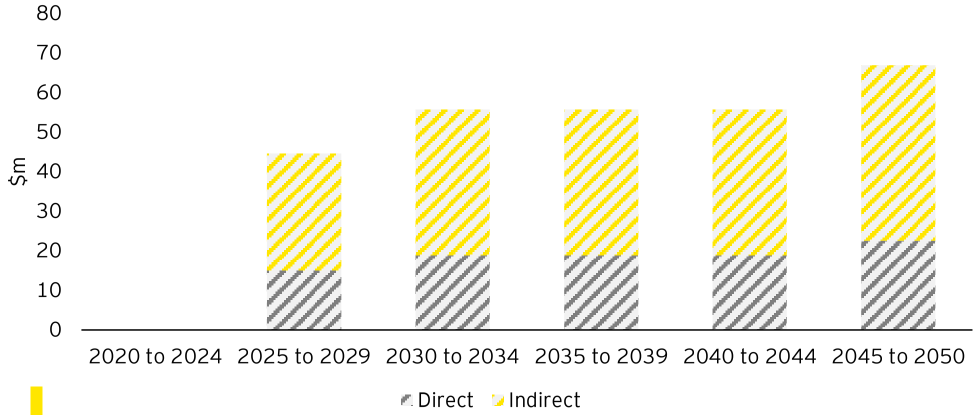
Victoria - Project Marinus - 600 MW – operations

Over the operating period, the economic contribution analysis indicates that the total direct operating cost of Project Marinus (600 MW option), attributable to Victoria is expected to be $227m, supporting an economic value added of $279m and 1,409 job years.

Value add

Project Marinus' (600 MW) operations is expected to support $94m in direct and $185m in indirect value add during the operations period.

Direct and indirect value added profile ($m)



Jobs

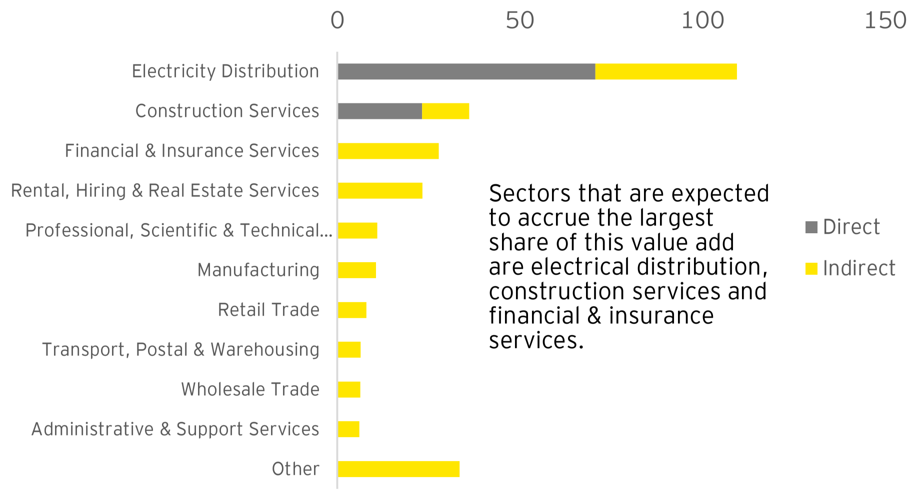
Project Marinus' (600 MW) operations is expected to support 348 direct and 1061 indirect job years over the operational period.

Direct and indirect jobs profile (job years)

	2020 to 2024	2025 to 2029	2030 to 2034	2035 to 2039	2040 to 2044	2045 to 2050	Total
Direct	-	56	70	70	70	84	**348**
Indirect	-	170	212	212	212	255	**1,061**

Value added by sector

Sectors expected to accrue the largest share of value add ($m)



Sectors that are expected to accrue the largest share of this value add are electrical distribution, construction services and financial & insurance services.

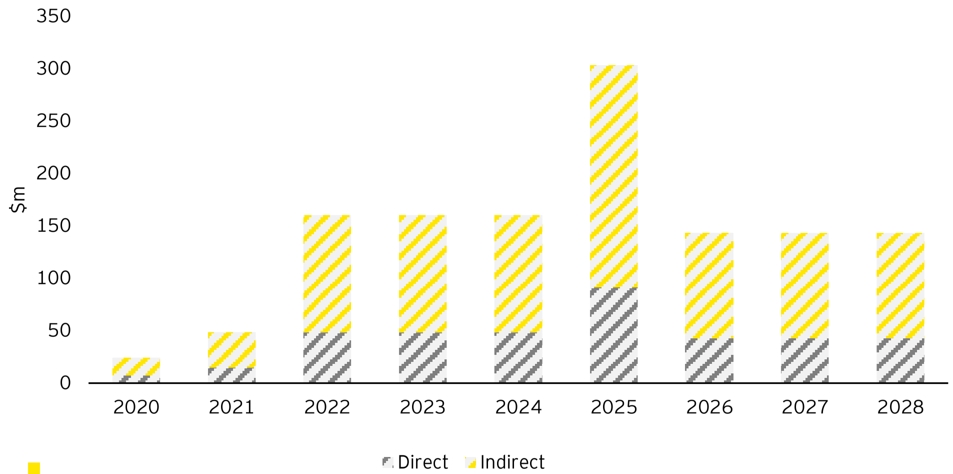
Victoria - Project Marinus – 1,200 MW – construction

Over the construction period, the economic contribution analysis indicates that the total direct construction cost of Project Marinus (1200 MW configuration), attributable to Victoria is expected to be $1,027m, supporting an economic value added of $1,287m and 7,558 job years.

Value add

Project Marinus' (1,200 MW) construction is expected to support $387m direct and $900m indirect value add during the construction period.

Direct and indirect value added profile (job years)



Jobs

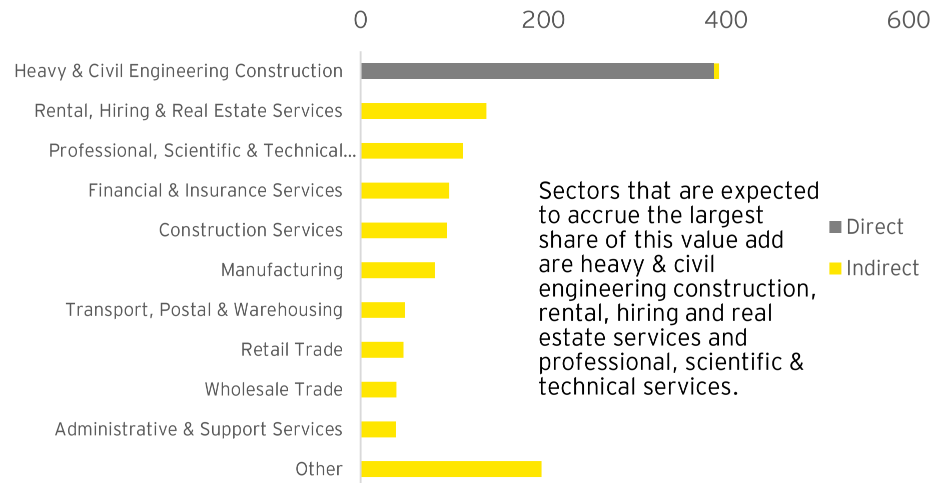
Project Marinus' (1200 MW) construction is expected to support 1,193 direct and 6,366 indirect job years.

Direct and indirect jobs profile (job years)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Direct	23	45	149	149	149	281	133	133	133	**1,193**
Indirect	120	241	793	793	793	1,501	708	708	708	**6,366**

Value added by sector

Sectors expected to accrue the largest share of value add ($m)



Sectors that are expected to accrue the largest share of this value add are heavy & civil engineering construction, rental, hiring and real estate services and professional, scientific & technical services.

Victoria - Project Marinus – 1,200 MW – operations

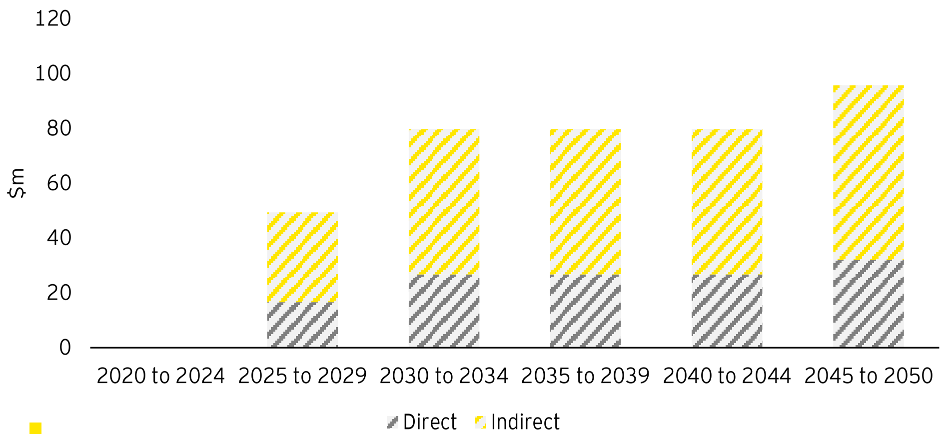
Tasmania	Victoria
Project Marinus	Induced Investment
600 MW	1200 MW
Construction	Operations

Over the operating period, the economic contribution analysis indicates that the total direct operating cost of Project Marinus (1200 MW configuration), attributable to Victoria is expected to be $313m, supporting an economic value added of $384m and 1,980 job years.

Value add

Project Marinus' (1,200 MW) operations is expected to support $129m in direct and $256m in indirect value add during the operations period.

Direct and indirect value added profile (job years)



Jobs

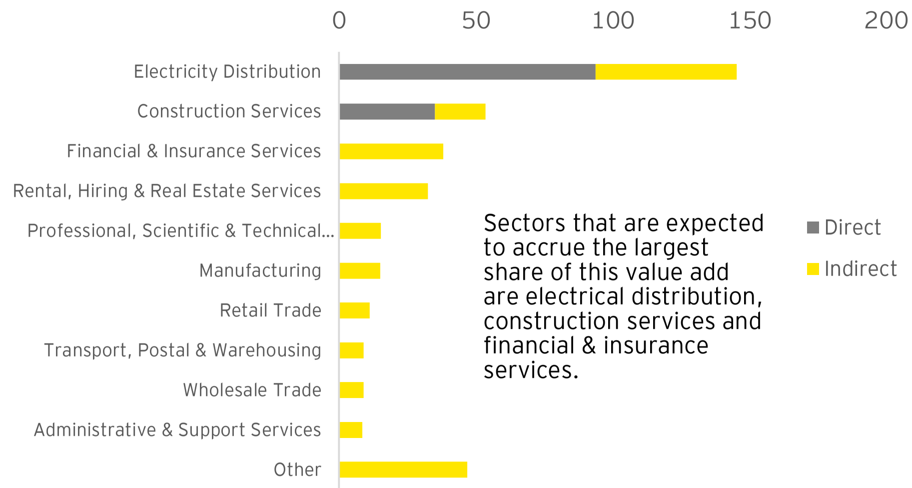
Direct and indirect jobs profile (job years)

Project Marinus' (1,200 MW) operations is expected to support 498 direct and 1,483 indirect job years over the operational period.

	2020 to 2024	2025 to 2029	2030 to 2034	2035 to 2039	2040 to 2044	2045 to 2050	Total
Direct	-	63	104	104	104	124	**498**
Indirect	-	189	308	308	308	370	**1,483**

Value added by sector

Sectors expected to accrue the largest share of value add ($m)



Induced investment

Overview of induced renewable investment in Tasmania

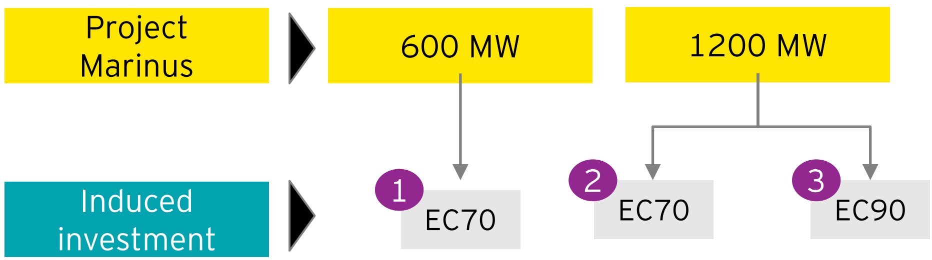
Project Marinus is expected to induce further renewable electricity generation in Tasmania. An additional interconnector may over time induce investments which meet the growing demand for cleaner energy from Australia's mainland.

AEMO's Integrated System Plan (ISP) has identified indicative locations for hydro generators, wind and solar farms in the eastern and northern regions of Tasmania. These locations are generally more competitive for renewable energy generation than many sites on the mainland due to their natural characteristics

The induced investments are expected to be incrementally installed after the construction of Project Marinus. The installation magnitude (MW) and timeframe is calculated through EY's "market model", which forecasts costs and likely demand from consumers of electricity.

MW to dollar conversion rates for capital expenditure have been provided in EY's market model.

Induced investment scenarios



The scenarios specified in the diagram above describe the renewable investments induced by :

- **600 MW – EC70 or "600 MW":** A 600 MW Project Marinus configuration with a "EC70" emissions constraint. This case assumes a 28% emissions reduction from 2005 levels by 2030. Post 2030, the case assumes a linear reduction of emissions to 70% of 2030 levels by 2050. This report will refer to the "600 MW – EC70" scenario simply as "600 MW" throughout.
- **1200 MW – EC70 or "1200 MW":** A 1,200 MW Project Marinus configuration with a "EC70" emissions constraint. This scenario is expected to induce greater investment than the "600 MW – EC70" scenario, by virtue of the larger interconnector capacity. This report will refer to the "1,200 MW – EC70" scenario simply as "1,200 MW" throughout.
- **1200 MW – EC90:** A 1,200 MW Project Marinus configuration with a "EC90" emissions constraint. The "EC90" case assumes a 52% emissions reduction from 2005 levels by 2030. Post 2030, this case assumes an emissions reduction of 90% from 2030 levels by 2050.

Note: This analysis does not include on a "600 MW – EC90" scenario (an ambitious emissions reduction target). This is because under the EC 90 scenario the additional transmission capacity will be necessary to get the additional renewable capacity into the rest of the National Electricity Market.

Induced investment - Overview of induced renewable investment

The table below shows, for each generation type, the difference in generation capacity expected to be delivered between these scenarios. It is important to note that this economic contribution analysis captures the difference between Project Marinus and the investment that is expected to occur under the base case. In other words, the generation investment induced by Project Marinus.

Total installation generation (MW) under Project Marinus compared to base case - Tasmania

	Base Case "No Marinus"	Project Marinus	Induced investment
600 MW			
Solar PV	1,332	1,925	593
Wind	87.0	410	329
Pumped Hydro	214	1,000	786
Total	**1,632**	**3,335**	**1,702**
1,200 MW			
Solar PV	1,332	1,570	238
Wind	87	1,088	1,001
Pumped Hydro	214	1,000	786
Total	**1,632**	**3,658**	**2,025**
1200 MW-EC90			
Solar PV	763	1,715	952
Wind	-	1,054	1,054
Pumped Hydro	204	1,000	797
Total	**967**	**3,768**	**2,802**

Total installation generation (MW) under Project Marinus compared to base case - Victoria

	Base Case "No Marinus"	Project Marinus	Induced investment
600 MW			
Solar PV	4,290	4,587	297
Wind	4,793	4,627	(166)
Pumped Hydro	1,000	1,000	-
Total	**10,083**	**10,214**	**131**
1200 MW			
Solar PV	4,290	4,895	605
Wind	4,793	4,223	(570)
Pumped Hydro	1,000	1,000	-
Total	**10,083**	**10,119**	**36**
1200 MW - EC90			
Solar PV	9,580	8,188	(1,392)
Wind	10,619	9,992	(627)
Pumped Hydro	1,000	1,000	-
Total	**21,198**	**19,180**	**(2,019)**

Overall, Project Marinus is expected to induce somewhat lower generation compared to the base case in Victoria. In the 600 MW and 1,200 MW cases, Project Marinus is expected to induce Solar PV generation, but reduce investment in wind generation.

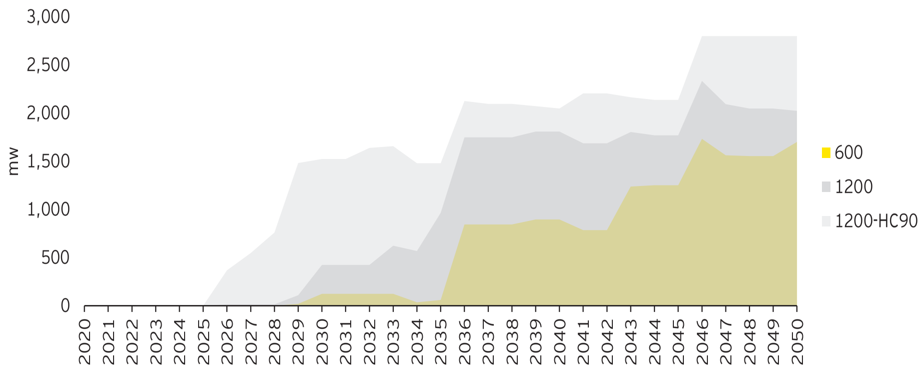
In the 1,200 MW – EC90 case, Project Marinus is expected to deter larger amounts of Solar PV generation in Victoria compared to the cases above.

The analysis on induced renewable generation in the following section focuses on Tasmania only.

Induced investment - Construction and operating profiles in Tasmania

The investment that may be induced in Tasmania will take advantage of the better renewables resources in that State, and the access to market Project Marinus will provide. That investment can be expected to come at the expense of investment (i.e. replace) that might otherwise have occurred elsewhere in the NEM, although the form of that investment both in terms of quantum and type of generation will be different. It will also be different under the different scenarios. Some of that replaced investment would likely have occurred in Victoria under the scenarios outlined. All the investment by quantum, location and type is summarised in EY's market modelling report.

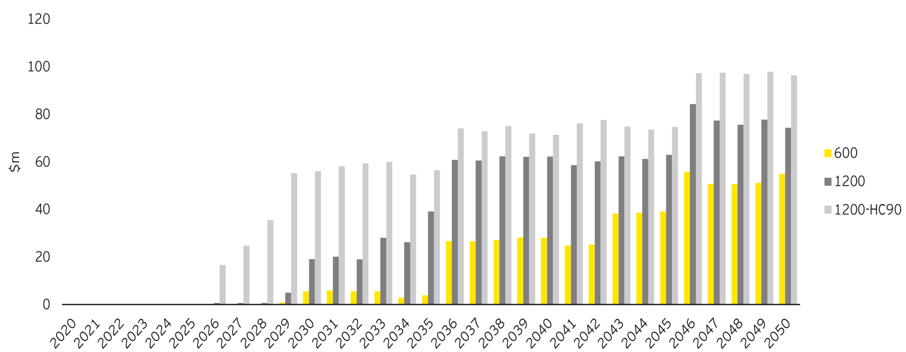
Indicative cumulative induced generation MW delivered to Tasmania, by configuration



The graph above illustrates the cumulative delivery of induced generation in megawatts, by Project Marinus configuration. Highlights include:

- **600 MW configuration:**
  - An expected 274 MW of solar generation, 124 MW of wind generation and 447 MW of pumped hydro generation to be delivered by 2036
  - An expected 593 MW of solar generation, 323 MW of wind generation and 786 MW of pumped hydro generation to be delivered by 2050
- **1,200 MW configuration:**
  - An expected 186 MW of solar generation, 624 MW of wind generation and 940 MW of pumped hydro generation to be delivered by 2036
  - An expected 238 MW of solar generation, 1,001 MW of wind generation and 786 MW of pumped hydro generation to be delivered by 2050
- **1,200 MW - EC90 configuration:**
  - An expected 370 MW of solar generation, 763 MW of wind generation and 995 MW of pumped hydro generation to be delivered by 2036
  - An expected 951 MW of solar generation, 1,054 MW of wind generation and 796 MW of pumped hydro generation to be delivered by 2050

Indicative operating costs ($m), Tasmania, by configuration



Annual operating and maintenance costs are expected to rise in accordance with the installation of new MW.

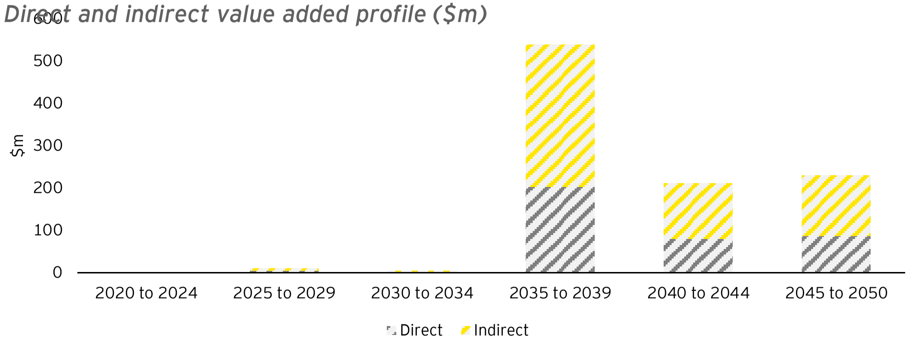
Induced investment - 600 MW - construction

Over the construction period for the induced investment (600 MW), the economic contribution analysis indicates that its total direct construction cost attributable to Tasmania is expected to be $923m. This is expected to support an economic value added of $996m and 6,083 job years.

Value added profile

The construction of the induced investment (600 MW) operations is expected to support $374m and $622m in direct and indirect value add.

Direct and indirect value added profile ($m)



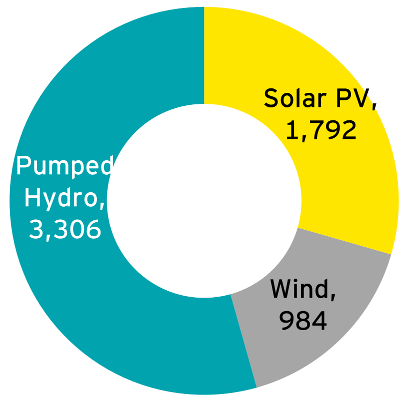
Jobs profile

The construction of the induced investment (600MW) is expected to support 1,236 direct and 4,946 indirect job years.

Direct and indirect jobs profile (job years)

	2020 to 2024	2025 to 2029	2030 to 2034	2035 to 2039	2040 to 2044	2045 to 2050	Total
Direct	-	13	6	669	263	286	**1,236**
Indirect	-	52	22	2,623	1,029	1,120	**4,846**

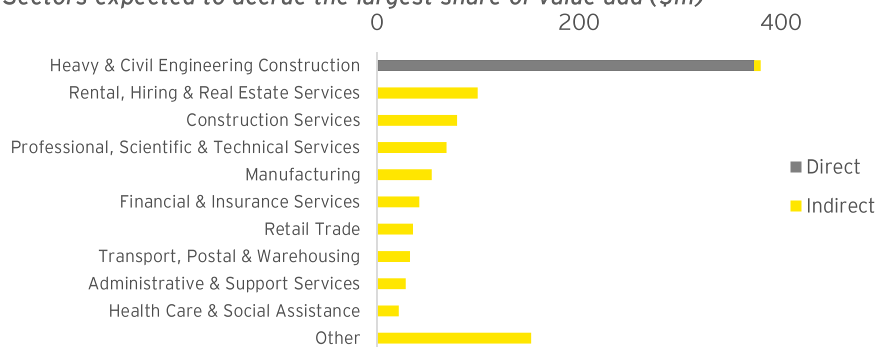
Breakdown of jobs (job years) by type of generation



Value added by sector

Sectors that are expected to accrue the largest share of this value add are heavy & civil engineering construction, rental, hiring and real estate services and construction services.

Sectors expected to accrue the largest share of value add ($m)



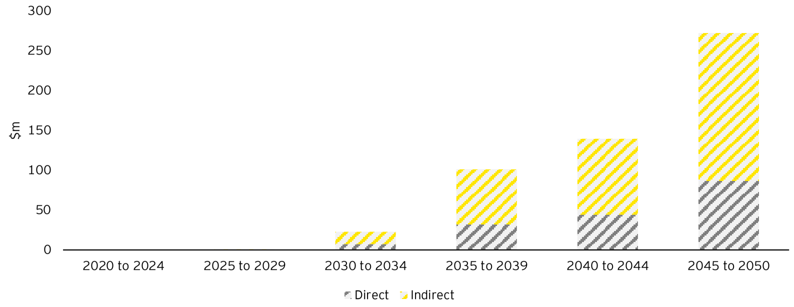
Induced investment - 600 MW - operations

Over the operations period for the induced investment (600 MW), the economic contribution analysis indicates that its total direct operational cost attributable to Tasmania is expected to be $597m. This is expected to support an economic value added of $537m and 3,734 job years.

Value added profile

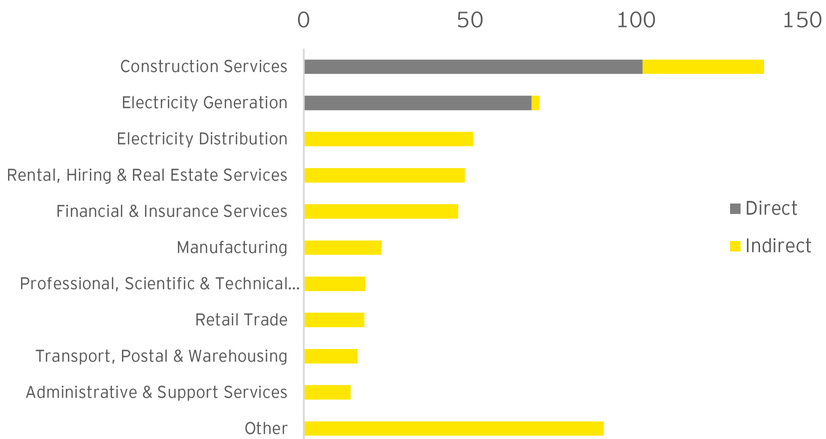
The operations of the induced investment (600 MW) operations is expected to support $171m and $366m direct and indirect value add.

Direct and indirect value added profile ($m)



Value added by sector

Sectors expected to accrue the largest share of value add ($m)



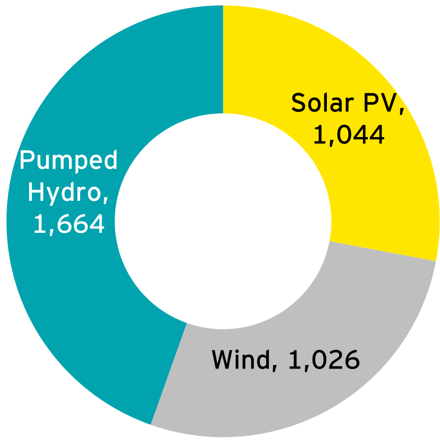
Jobs profile

The operations of the induced investment (600MW) is expected to support 1,271direct and 2,453 indirect job years.

Direct and indirect jobs profile (job years)

	2020 to 2024	2025 to 2029	2030 to 2034	2035 to 2039	2040 to 2044	2045 to 2050	Total
Direct	-	2	54	240	330	645	**1,271**
Indirect	-	4	105	464	640	1,249	**2,463**

Breakdown of jobs (job years) by type of generation



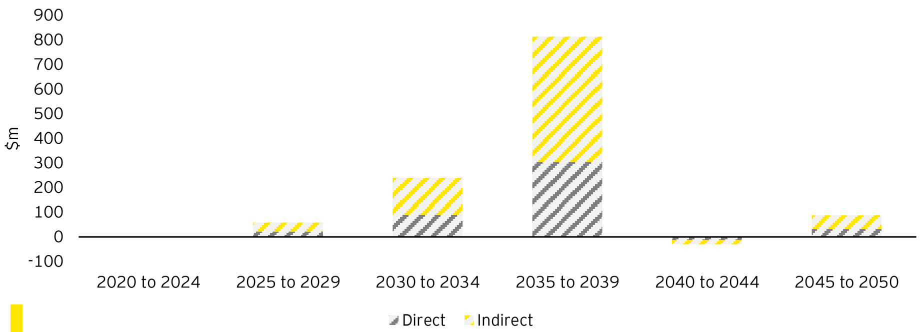
Induced investment - 1200 MW - construction

Over the construction period for the induced investment (1200 MW), the economic contribution analysis indicates that its direct construction cost attributable to Tasmania is expected to be $1,117m. This is expected to support an economic value added of $1,171m and 7,150 job years.

Value added profile

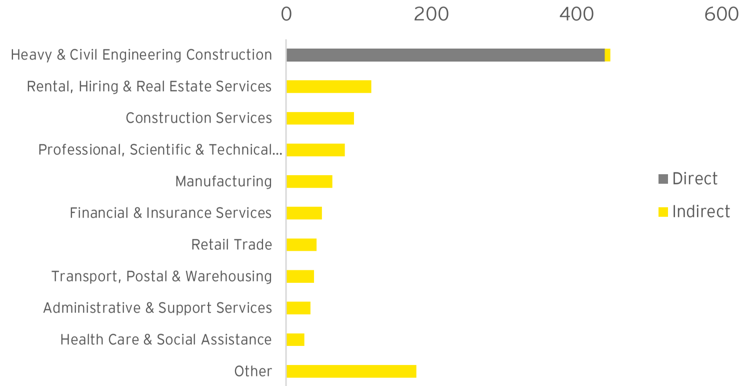
The construction of the induced investment (1,200 MW) operations is expected to support $439m and $732m direct and indirect value add.

Direct and indirect value added profile ($m)



Value added by sector

Sectors expected to accrue the largest share of value add ($m)



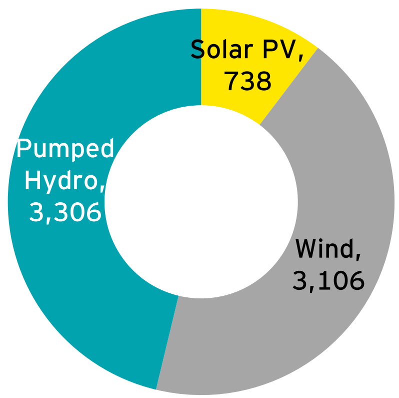
Jobs profile

The construction of the induced investment (1200 MW) is expected to support 1,453 direct and 5,697 indirect job years during the operations period.

Direct and indirect jobs profile (job years)

	2020 to 2024	2025 to 2029	2030 to 2034	2035 to 2039	2040 to 2044	2045 to 2050	Total
Direct	-	73	299	1,010	(39)	109	**1,453**
Indirect	-	285	1,173	3,961	(151)	429	**5,697**

Breakdown of jobs (job years) by type of generation

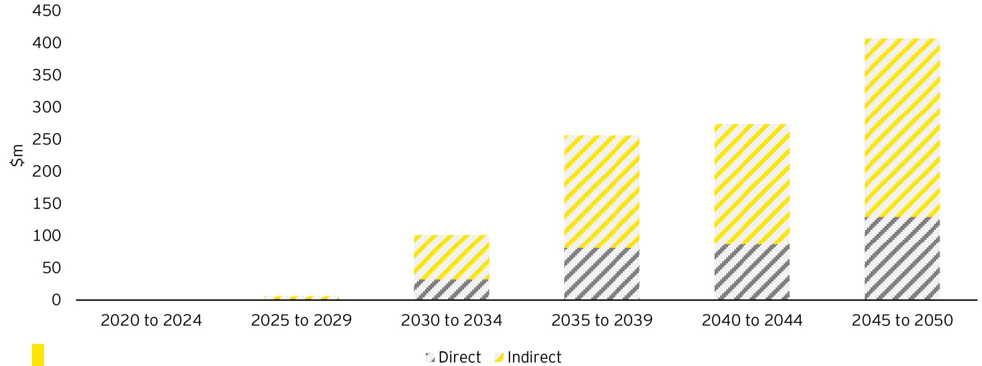


Induced investment - 1200 MW - operations

Over the operations period for the induced investment (1200 MW), the economic contribution analysis indicates that its total direct operational cost attributable to Tasmania is expected to be $1,163m. This is expected to support an economic value added of $1,046m and 7,274 job years.

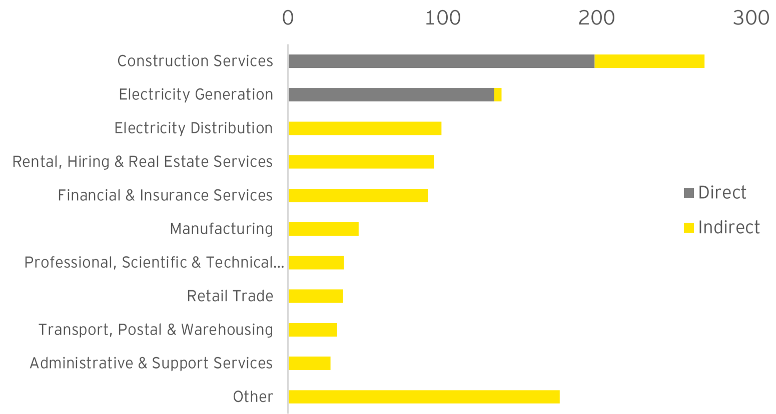
Value added

The operations of the induced investment (1,200 MW) operations is expected to support $332m and $713m direct and indirect value add.



Value added by sector

Sectors expected to accrue the largest share of value add ($m)



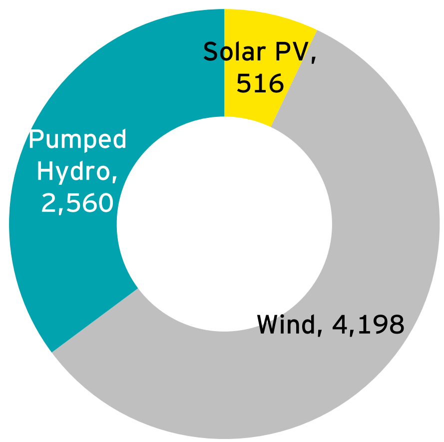
Jobs profile

The operations of the induced investment (1200 MW) is expected to support 2,477 direct and 4,797 indirect job years during the operations period.

Direct and indirect jobs profile (job years)

	2020 to 2024	2025 to 2029	2030 to 2034	2035 to 2039	2040 to 2044	2045 to 2050	Total
Direct	-	15	240	608	649	964	**2,477**
Indirect	-	29	465	1,177	1,258	1,868	**4,797**

Breakdown of jobs (job years) by type of generation



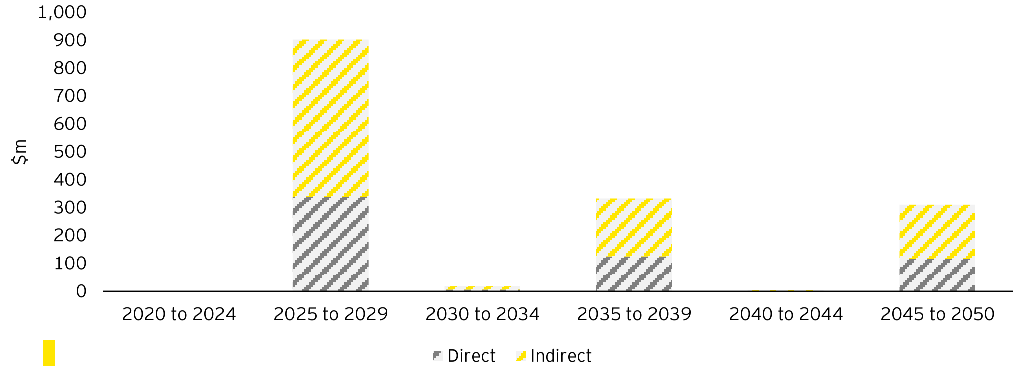
Induced investment - 1200 MW (EC90) - construction

Over the construction period for the induced investment (1200 MW - EC90), the economic contribution analysis indicates that its direct construction cost attributable to Tasmania is expected to be $1,565m. This is expected to support an economic value added of $1,571m and 9,590 job years.

Value added

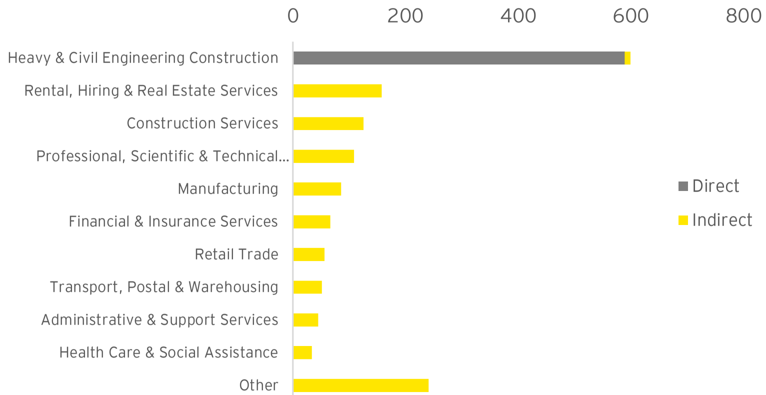
The construction of the induced investment (1200 MW – EC90) is expected to support $488m direct and $1,047m indirect value add.

Direct and indirect value added profile ($m)



Value added by sector

Sectors expected to accrue the largest share of value add ($m)



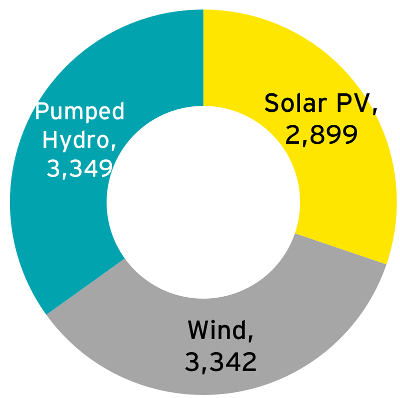
Jobs profile

The construction of the induced investment (1200-EC90 MW) is expected to support 1,949 direct and 7,641 indirect job years during the construction period.

Direct and indirect jobs profile (job years)

	2020 to 2024	2025 to 2029	2030 to 2034	2035 to 2039	2040 to 2044	2045 to 2050	Total
Direct	-	1,121	23	414	5	386	**1,949**
Indirect	-	4,396	89	1,623	19	1,515	**7,641**

Breakdown of jobs (job years) by type of generation

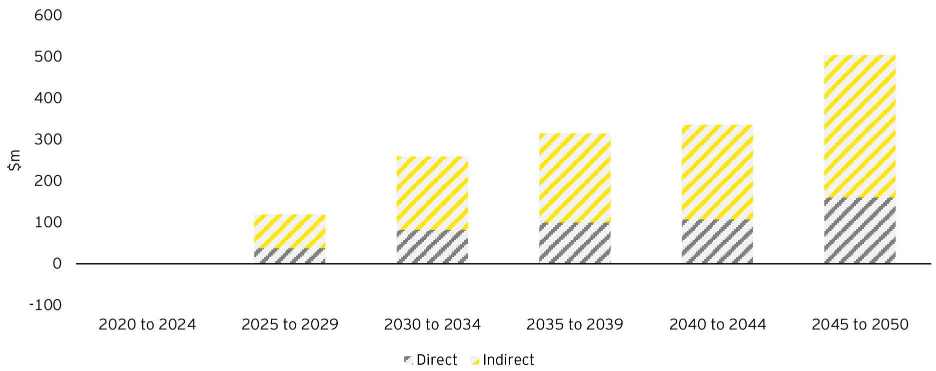


Induced investment - 1200 MW (EC90) - operations

Over the operations period for the induced investment (1200-EC90 MW), the economic contribution analysis indicates that its direct operational cost attributable to Tasmania is expected to be $1,706m. This is expected to support an economic value added of $1,535m and 10,675 job years.

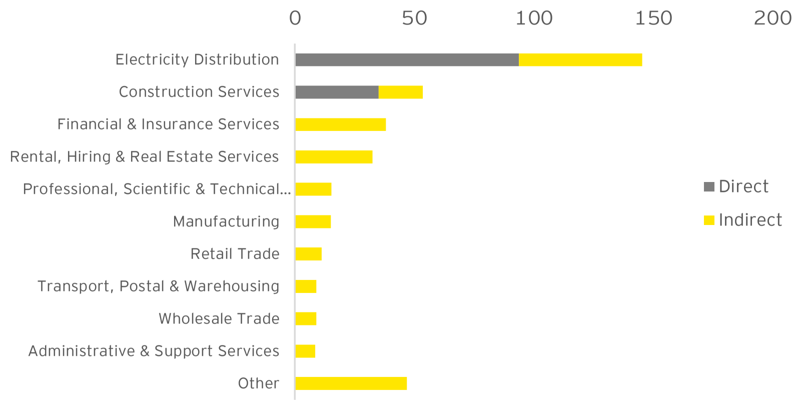
Value added profile

The operations of the induced investment (1200 MW – EC90) is expected to support $488m direct and $1,047m indirect value add.



Value added by sector

Sectors expected to accrue the largest share of value add ($m)



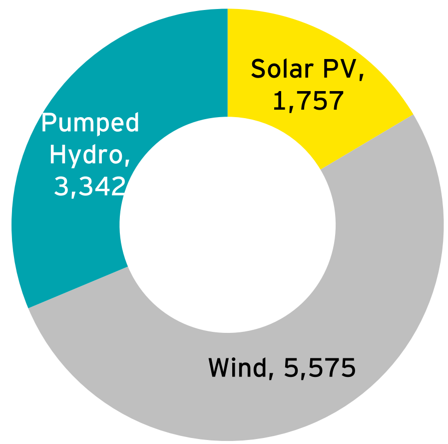
Jobs profile

The operations of the induced investment (1200 MW-EC90) is expected to support 3,635 direct and 7,040 indirect jobyears.

Direct and indirect jobs profile (job years)

	2020 to 2024	2025 to 2029	2030 to 2034	2035 to 2039	2040 to 2044	2045 to 2050	Total
Direct	(0)	282	615	747	796	1,195	**3,635**
Indirect	(0)	546	1,190	1,447	1,543	2,315	**7,040**

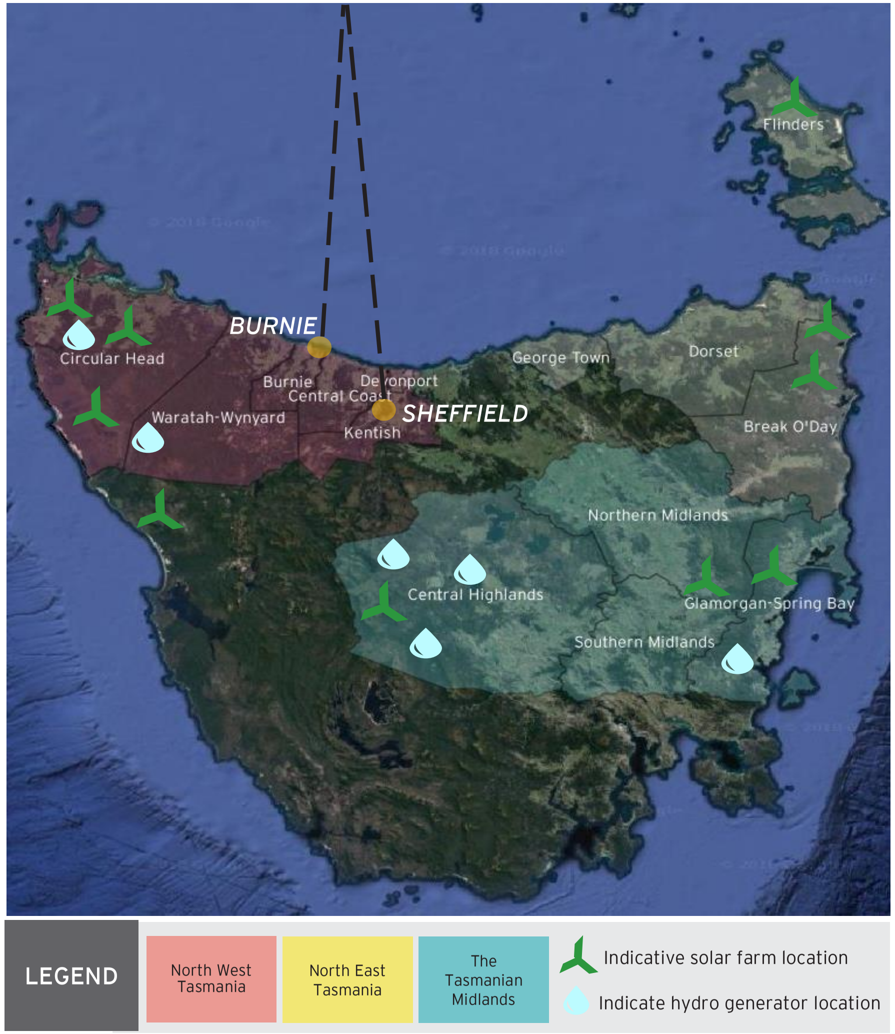
Breakdown of jobs (job years) by type of generation



Local investment

Local investment: overview

Indicative renewable investment locations in Tasmania



Source: AEMO ISP and TasNetworks

The proposed investment is expected to impact local economies within Tasmania. To capture this, the report isolates three distinct regions in Tasmania where:

- Project Marinus' Tasmanian connection point is located; and
- Induced investment in renewable energy is expected to occur.

Local regions and their economies are expected to realise the economic contribution of Project Marinus and its induced investment. These regions used in this analysis are:

- North West Tasmania (NWT)
- North East Tasmania (NET)
- the Tasmanian Midlands (TM).

These regions were also based on AEMO ISP data which specifies the proposed MW and optimal locations for hydro, wind and solar generation (i.e. the Renewable Energy Zones).

In order to capture the total direct and indirect economic contribution of Project Marinus and the induced investment to these regions, the analysis attributes the expected increase in generation capacity to each region. The methodology to calculate this apportion can be found in Appendix C.

Note:

- this analysis only focuses on the expected impact on jobs only.
- The sum of jobs supported in these regions does not equal the total sum of jobs supported in Tasmania. This is because the economic multiplier used in this analysis considers exports to other regions as outflows and therefore, not contributing to the local economy of the region.

North West Tasmania (NWT)

About the region

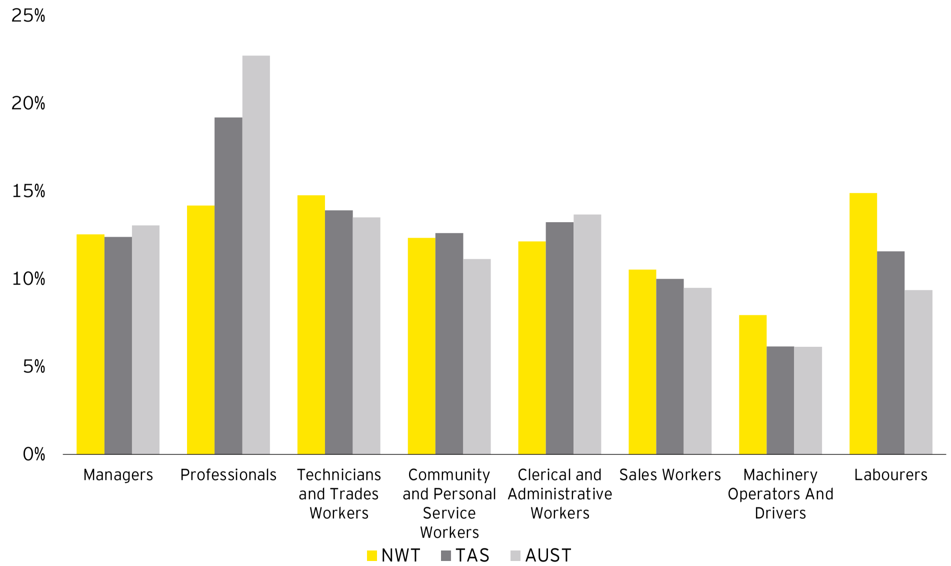
North West Tasmania is renowned for its high quality national parks and nature reserves. The sub-region possesses excellent wind and pumped hydro resources. In terms of generation the sub-region currently supports:

- Multiple hydro generators (867 MW in total); and
- Wind farms (140 MW total).

According to the AEMO ISP, the region also has potential for 600MW in solar generation.

Socioeconomic profile

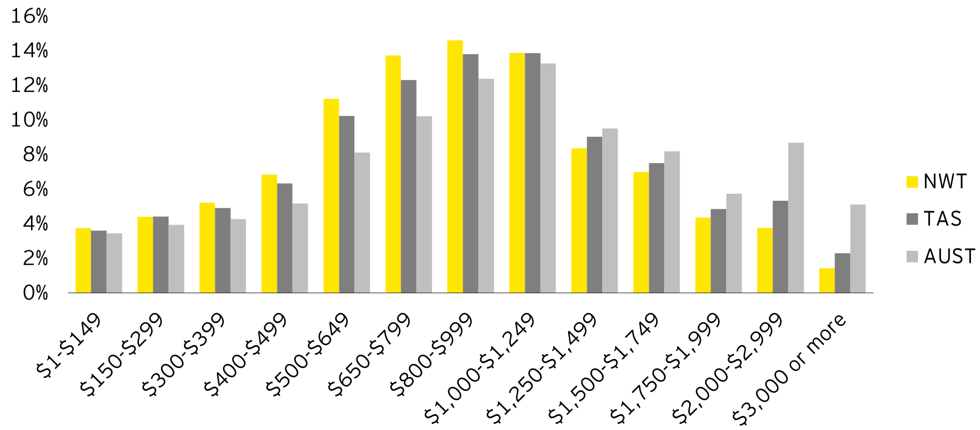
Occupation proportions – NWT, Tasmania and Australia



Source: REMPLAN, ABS Census of Population and Housing (2016) and EY analysis

North West Tasmania's proportion of professionals is 26% and 38% smaller than Australia and Tasmania respectively.

Weekly income proportions – NWT, Tasmania and Australia



Source: REMPLAN, ABS Census of Population and Housing (2016) and EY analysis

North West Tasmania has relatively fewer individuals earning in higher income brackets compared to Tasmania and Australia respectively.

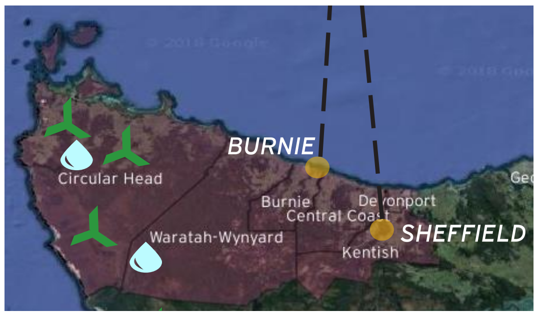
North West Tasmania – cont.

The indicative Tasmanian connection points of Project Marinus are located in the Burnie and Sheffield areas, towns in North-West Tasmania. As such, Project Marinus is expected to support construction and operations jobs in the region.

Jobs (Job years) breakdown by configuration

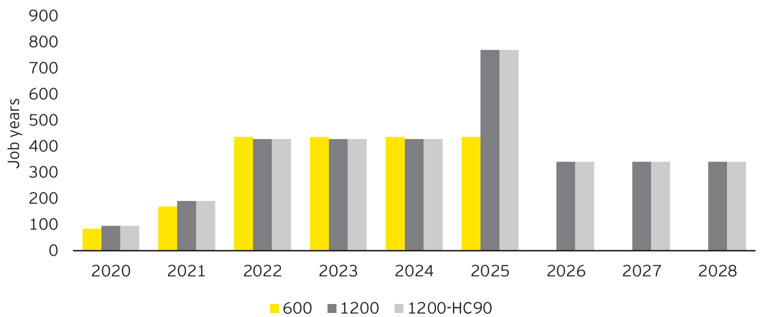
	Project Marinus	Induced investment
600 MW		
Construction	2,002	2,756
Operations	967	1,677
1,200 MW		
Construction	3,368	2,479
Operations	1,368	2,402
1,200-EC90 MW		
Construction	3,368	4,285
Operations	1,368	4,048

Indicative generation locations with Project Marinus' Tasmanian connections

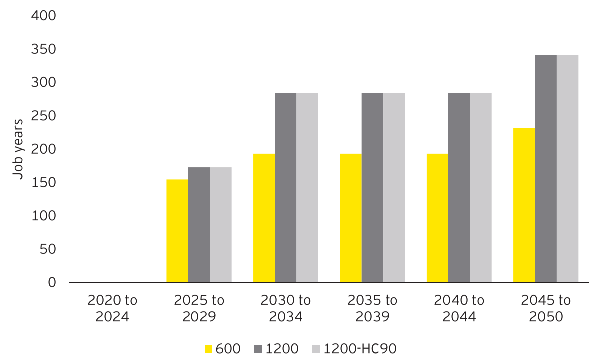


Jobs profile (Project Marinus)

Jobs supported by Project Marinus' construction

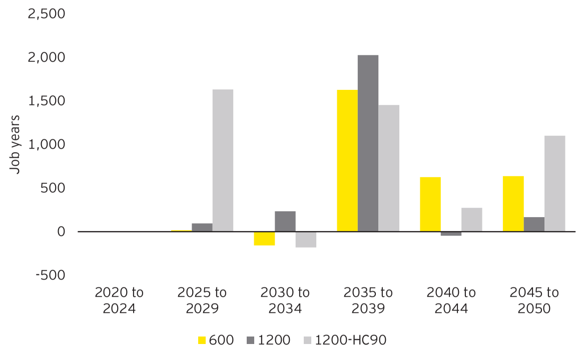


Jobs supported by Project Marinus' operations

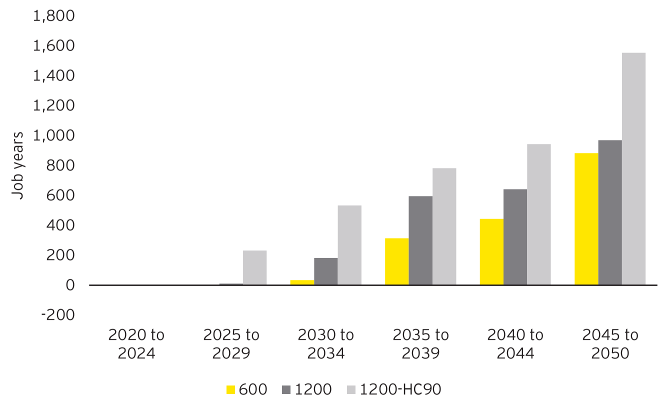


Jobs profile (Induced investment)

Jobs supported by Induced investment' construction



Jobs supported by Induced investment' construction



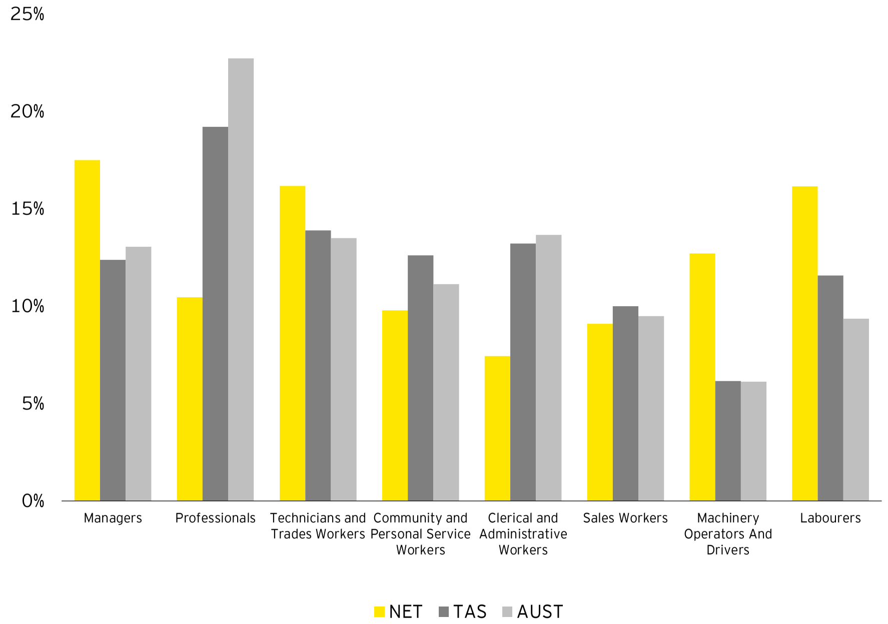
North East Tasmania (NET)

About the region

North East Tasmania is characterised by its rich arts and cultural heritage and diverse natural landscape. Currently, the sub-region possesses one 168 MW wind farm at Musselroe. According to the AEMO ISP, there are three additional locations identified for potential future wind energy investment.

Socioeconomic profile

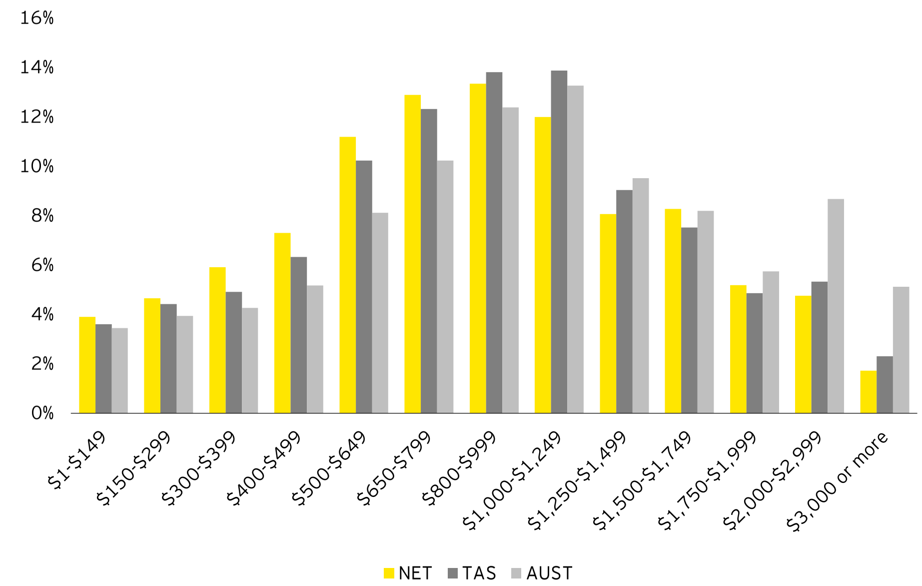
Occupation proportions – NET, Tasmania and Australia



North East Tasmania's proportion of professionals is 46% and 54% smaller than Australia and Tasmania respectively. However, the region's proportion of labourers and machine operators and drivers is higher than both Australia and Tasmania. Also, the region overall

Source: REMPLAN, ABS Census of Population and Housing (2016) and EY analysis

Weekly income proportions – NET, Tasmania and Australia



North East Tasmania has a lower proportion of workers in the middle to high income ranges.

Its proportion of workers in the "$2,000 or more" weekly income range is 65% lower than Australia's, while its proportion in the "$500-$649" range is 58% higher.

Source: REMPLAN, ABS Census of Population and Housing (2016) and EY analysis

North-East Tasmania (NET) – cont.

The expected jobs supported by the induced investment is set out in the table below.

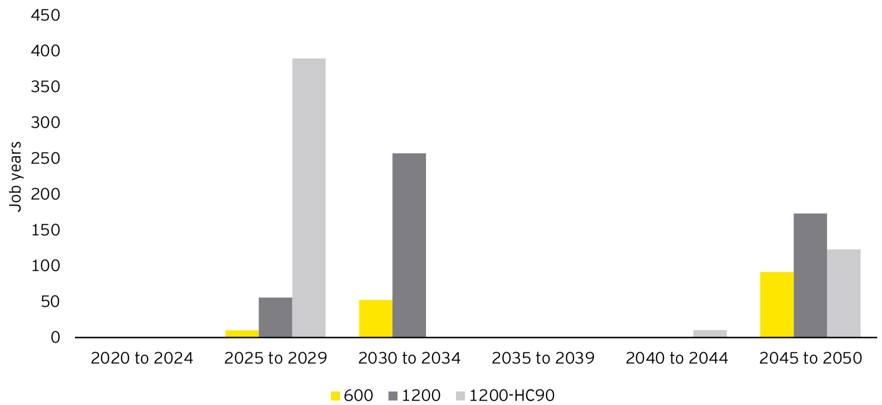
Jobs (Job years) breakdown by configuration

	Project Marinus	Induced investment
600 MW		
Construction	0	154
Operations	0	185
1,200 MW		
Construction	0	487
Operations	0	759
1,200-EC90 MW		
Construction	0	524
Operations	0	1,007

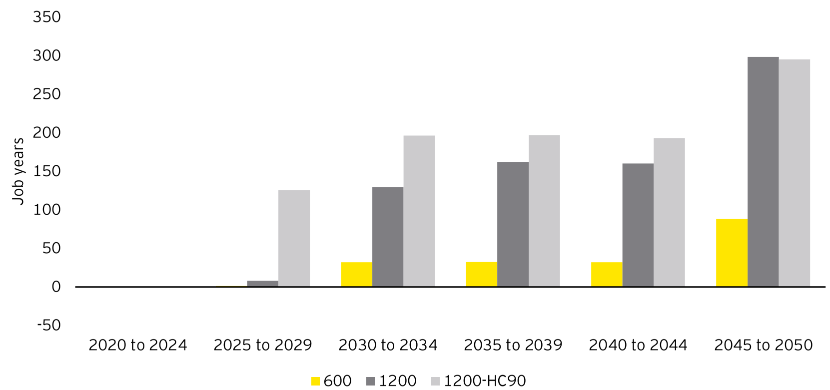
Indicative generation locations

Jobs profile (Induced investment)

Jobs supported by Induced investment' construction



Jobs supported by Induced investment' operations



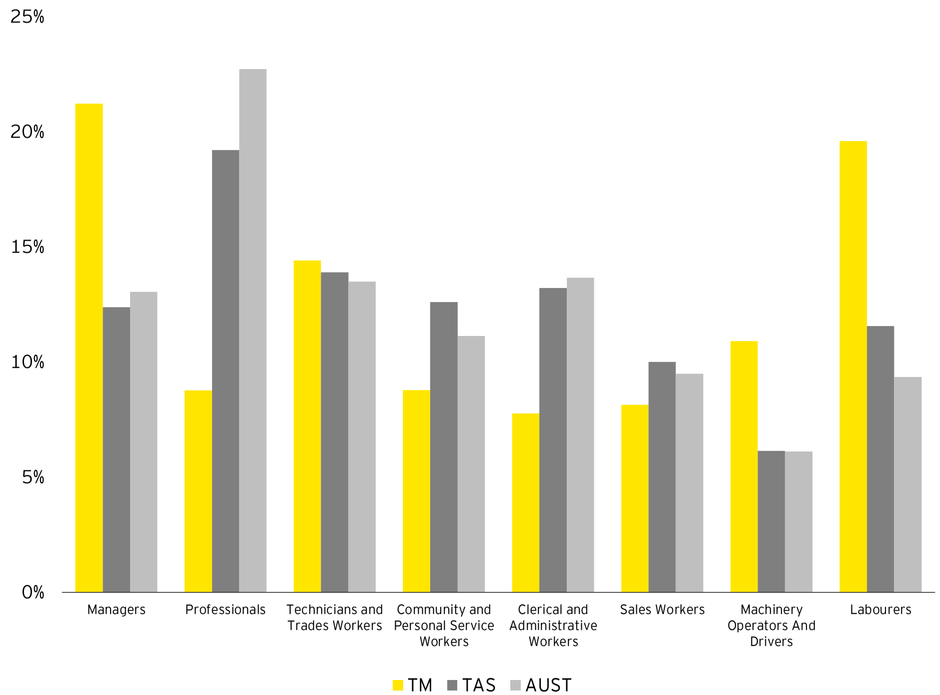
The Tasmanian Midlands (TM)

About the region

The Tasmanian Midlands is replete with prominent national parks and excellent natural resources. Currently there is a total of 1,412 MW in hydro generation throughout the region according to the AEMO ISP. Although the region does not currently possess wind farms*, the AEMO ISP has identified three potential locations for wind investment.

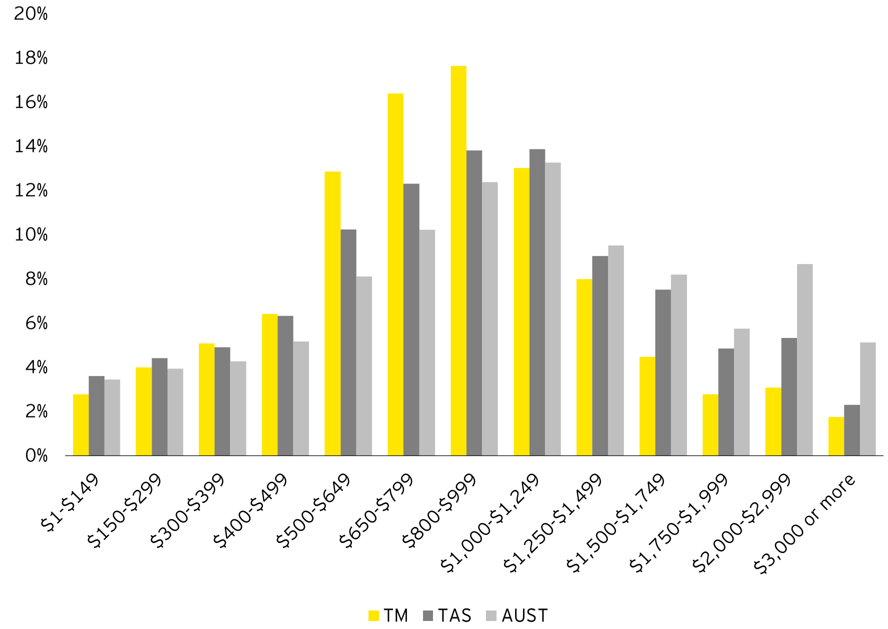
Socioeconomic profile

Occupation proportions – TM, Tasmania and Australia



Source: REMPLAN, ABS Census of Population and Housing (2016) and EY analysis

Weekly income proportions – TM, Tasmania and Australia



Source: REMPLAN, ABS Census of Population and Housing (2016) and EY analysis

TM's occupation and weekly personal income profile largely reflects the two other regions (NWT and NET) presented in this analysis. However, the region's share of managers is significantly higher, 71% and 63% higher than Australia and Tasmania respectively.

**There is one wind farm under construction*

The Tasmanian Midlands – cont.

The expected jobs supported by the induced investment is set out in the table below..

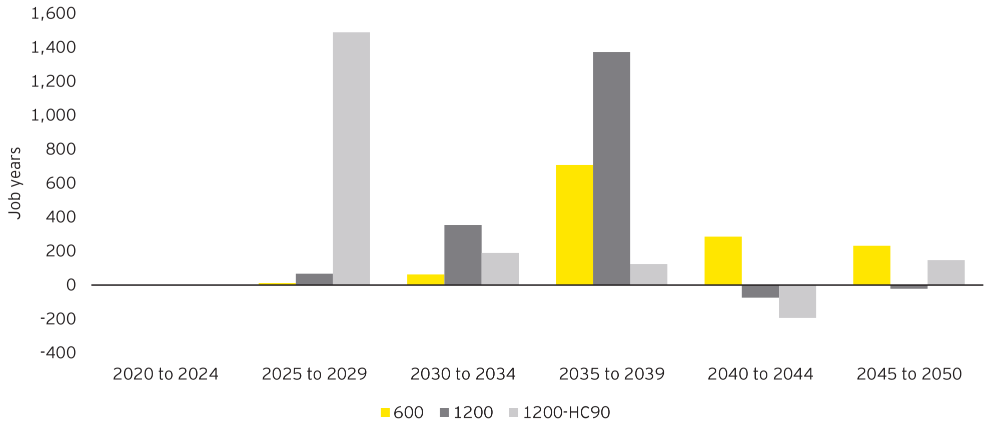
Jobs (job years) breakdown by configuration

	Project Marinus	Induced investment
600 MW		
Construction	0	1,301
Operations	0	819
1,200 MW		
Construction	0	1,699
Operations	0	1,794
1,200-EC90 MW		
Construction	0	1,758
Operations	0	2,361

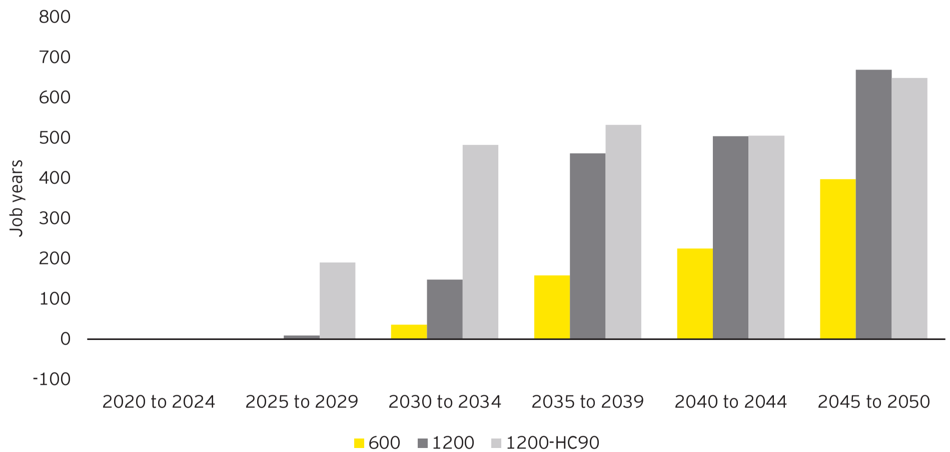
Indicative generation locations

Jobs profile (Induced investment)

Jobs supported by Induced investment' construction



Jobs supported by Induced investment' operations



Appendices

Glossary

Term	Description
Direct economic contribution	Total revenues generated by an industry, plus any applicable value-add taxes
Economic contribution	The total direct effects of an industry (revenue plus any value-add taxes), plus the flow-on (indirect) effects. The flow-on effects are captured by applying an economic multiplier. It is important to note that economic contribution is a gross measure rather than a net measure of the contribution of an industry. Economic contribution studies do not consider substitution impacts, or what would happen if the relevant industry ceased to exist
Gross Output	Market value of goods and services produced
Value Add	Market value of goods and services produced, after deducting the cost of goods and services used. This represents the sum of all wages, income and profits generated
Direct Effect	The direct impact resulting from the construction and operation of Project Marinus
Indirect Effect	The flow-on impact from Project Marinus and increased spending on wages associated with the direct and supply chain impacts
Economic Growth	Increase in total output of a country / region over a period of time
Economic multiplier	Used to estimate the total economic contribution of an industry by multiplying the direct contribution. The economic multiplier incorporates the additional economic contribution generated by the 'Direct' economic contribution (a) which is the industrial effect (b) and the consumption effect (c)
Employment contribution	The total direct employment effects of an industry (total employees), plus the flow-on (indirect) effects. The flow-on effects are captured by applying an employment multiplier
Employment multiplier	Used to estimate the total economic contribution of an industry by multiplying the direct contribution. The employment multiplier incorporates the additional employment contribution generated by the 'Direct' employment contribution
Flow on (Indirect) economic contribution	Additional expenditure as a result of the direct contribution of an industry. It is the sum of the industrial effect and the consumption effect
Flow-on (indirect) employment contribution	Additional employment that results from the direct employment contribution. For example, if an industry employs one additional person, that person can spend their income, and hence require other industries to employ additional people
Industrial effect	Flow-on (Indirect) contribution generated by an industry as it purchases input goods and services generating revenue for other businesses
Consumption effect	Flow-on (Indirect) contribution generated by an industry as its employees spend their wages and salaries on household consumption, providing revenue for other businesses
Job-years	A 'job-year' represents one full time job supported for a full year – for instance, 1,000 job-years may be 500 jobs sustained over 2 years, or 100 jobs sustained over 10 years.
Jobs during the construction phase	Jobs presented during the construction phase should be interpreted in terms of job-years. They are the total number of job-years supported over the four year construction phase.
Jobs during operations	Jobs during operations can be interpreted as permanent ongoing full-time equivalent (FTE) jobs during the relevant year of Project Marinus and induced investment activities.

Appendix A – REMPLAN

The economic analysis has been undertaken using REMPLAN software that estimates direct and indirect impacts of infrastructure developments or policy changes. REMPLAN is an economic analysis software package designed for use by economic development practitioners. REMPLAN provides detailed economic data for single or combinations of local government areas and also incorporates a dynamic economic modelling capability to allow the analysis of 'what if' scenarios. REMPLAN is an input-output model of the Australian economy and regional economies. Input-output models trace the revenue and expenditure flows that link industries and workers within and outside economic regions.

REMPLAN's core data set is based on the latest Australian Bureau of Statistics (ABS) national accounts figures of the Australian economy, coupled with the latest Census data. REMPLAN's key advantage over other input-output models or "off-the shelf multipliers" is that it can be regional specific. For instance, in the past, economic practitioners have used national multipliers produced by the ABS. It should be noted that the ABS has not published national input-output multipliers since 1998-99 and does not plan to compile and reissue this table because of concerns over the abuse of them in economic assessments.

The region chosen to analyse Project Marinus was the state of Tasmania. To assess contribution to local economies, three "sub-regions" were chosen and its data sets created with REMPLAN software. For these smaller regions, multipliers tend to be smaller than national multipliers since their inter–industry linkages are normally relatively shallow. Inter–industry linkages tend to be shallow in small regions since they usually don't have the capacity to produce the wide range of goods used for inputs and consumption, instead importing a large proportion of these goods from other regions. The REMPLAN model accounts for 'leakage' of direct expenditure from the economy in its multipliers. However, it may still be possible for the economic contribution presented to be realised in places other than Tasmania.

Appendix B – Local investment methodology

Methodology to apportion Project Marinus, by local region

The location of the Tasmanian connection point is expected to be located in North West Tasmania. Therefore, the entire direct investment of Project Marinus is expected to be attributable to North West Tasmania.

Methodology to calculate the generation capacity attributable to each region

MW expected of from induced investment, by Project Marinus Scenario × Proportions by generation type from the **AEMO ISP** = Proportion of MW from the induced investment attributable to region, by Project Marinus scenario

Methodology to apportion induced investment, by local region

Induced investment

- **For hydro and wind:** The number of indicative wind farms and hydro generators according to the AEMO ISP; and
- **For solar*:** The resource potential in MW according to the AEMO ISP.

Scenarios	Induced renewable investment (MW) 600 MW	1200 MW	1200 MW (EC90)
Solar PV	593	238	951
Pumped Hydro	786	1,001	796
Wind	323	786	1,054
TOTAL, by scenario	**1,702**	**2,025**	**2,801**

Proportions generation type from AEMO ISP data

North West Tasmania	North-East Tasmania	The Tasmanian Midlands
40%	-	60%
33%	33%	33%
100%	-	-

Proportions generation type from AEMO ISP

	North West Tasmania	North-East Tasmania	The Tasmanian Midlands
Pumped Hydro (locations)	2	0	3
Wind (locations)*	3	3	3
Solar PV (MW)**	600	-	-

The figure to the right illustrates the process to calculate the generation capacity attributable to each region (in MW).

After calculating the generation capacity attributable to each location, the direct investment and subsequently, the economic contribution in terms of jobs and value added is calculated. MW to dollar conversion rates for capital expenditure were sourced from EY's market model.

The economic multipliers unique to each region used in the economic contribution analysis were obtained from this analysis.

**An indicative wind farm in West Coast LGA was excluded from this analysis. Although this indicative wind farm was included in the North West Tasmania REZ, the inclusion of West Coast LGA in this economic analysis (as part of the NWT region) would skew the economic profile of the NWT region towards the entire west coast.*

***Indicative solar farm locations were not identified in Tasmania.*

Appendix C - Project Marinus cost apportionment methodology

Locational attribution to Tasmania (or Victoria)

Step 1

TasNetworks provided EY with a construction cost breakdown for the 600 MW and 1,200 MW options. The cost breakdown included items split within the following broad cost categories:

- HVDC cable costs;
- Converter station costs;
- Network integration costs; and
- Project costs.

Although TasNetworks identified cost items occurring in Tasmania or Victoria, some cost items did not refer to a specific geographic location. For these items, EY has split them 50/50 between Tasmania and Victoria. The tables below summarise this approach.

Indicative high-level construction costs ($m) – Project Marinus (600 MW)

	600 MW	
Cost Category	TAS	VIC
HVDC cable and converter station costs	426	527
Network integration costs	25	89
Project costs	145	145
TOTAL	596	761
		1,360

Indicative high-level construction costs ($m) – Project Marinus (1,200 MW)

	1200 MW	
Cost Category	TAS	VIC
HVDC cable and converter station costs	828	1,059
Network integration costs	7	129
Project costs	217	217
TOTAL	1,052	1,405
		2,460

Economic attribution to Tasmania (or Victoria)

Step 2

The construction costs (set out to the left) for both Project Marinus and its induced investments are split equally between:

- Equipment and material costs; and
- Project management, installation and construction costs.

This analysis assumes that all equipment costs are sourced from interstate and overseas, owing to the small electrical equipment manufacturing industry in Tasmania. Therefore, equipment costs have not been included in the economic contribution calculation (see table directly below).

This analysis assumes that operational costs for both Project Marinus and its induced investments are equally split between:

- Operations and maintenance costs (material inputs only); and
- Wages and salaries.

Separate economic multipliers were applied to these broad categories to reflect the unique nature of transactions occurring in these broad industries.

Construction cost ($m) attribution

	600 MW		1200 MW	
	TAS	VIC	TAS	VIC
Total cost apportioned to each region	596	761	1,052	1,405
Material and equipment costs	-188	-188	-365	-378
Total cost of Project Marinus directly attributable to the Tasmanian economy	408	573	686	1,027

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Appendix 3 - Tasmanian Electricity Market Simulation Model

1494-05 TEMSIM Modelling of Second Interconnector Scenarios

Current approval and revision history:

Rev	Description	Prepared	Reviewed	Approved
1	Initial version	Stuart Allie 11/10/2018	James Pirie 7/11/2018	James Pirie 7/11/2018

Contents

1 TEMSIM – High-Level Description

1.1 Overview

TEMSIM is a *simulation* model of the Tasmanian electricity generation and transmission system, including a single interconnector between Tasmanian and Victoria.

- TEMSIM models the key physical elements of the system (hydro, wind, and thermal generators, hydro storages and water conveyances) as well as the market-based dispatch process.
- TEMSIM is flexible in the way it operates the electricity system, with the generation offers (bids) determined by operating rules that can be changed by the user.
- The resulting operations of the system – the generation outcomes and water flows through the hydro system – are the outcomes of the dispatch process.
- One key outcome is the energy flows across the interconnector linking Tasmania with Victoria.

1.2 Monte-Carlo Simulation

TEMSIM operates as a discrete-time simulation (currently with an hourly time step) of the electricity system, focussed on the supply side dispatch of Tasmanian generation (particularly the hydro system) and interconnection, with a simplified representation of the transmission system and electricity demand. One key feature of TEMSIM is the ability to perform multiple (“Monte-Carlo”) simulations from the same initial conditions with a *range* of (possibly random) inputs producing a *distribution* of outcomes.

The most common random input is water inflows to the hydro system, as this hydrological variability is the largest single driver of variability in the operation and dispatch of the hydro generation system. Managing the hydro system in the face of highly variable inflows is a significant challenge and a large part of the benefit of TEMSIM as a model comes from the insight gained from the spread of outcomes driven by the simulated hydrological variability.

1.3 Objects Modelled

The key physical objects modelled in TEMSIM include:

- Hydro power stations with multiple machines;
- Hydro storages;
- Water conveyances (spillways, canals, tunnels, pipelines, etc.);
- Pumps;
- Radial transmission network (centred on the Basslink node at Georgetown);
- Basslink;
- Wind farms;
- Other non-hydro generation (gas, solar, etc.).

1.4 External Drivers

The main external drivers of the generation system include:

- Inflows to the hydro system;

- Tasmanian electricity demand;
- Victorian spot market prices;
- Wind speed (drives wind farm generation).

1.5 Operating Rules

- The operation of the hydro system is determined by a (simplified) representation of the Storage Operating Rules (SOR) used by Hydro Tasmania to manage the water levels and flows in the hydro system.
- The SOR includes requirements for minimum flows and minimum/maximum storage levels.
- The operating rules determine the generation offers from the hydro power stations, and the dispatch process determines the actual generation output from each station.
- The generation from the hydro stations determines the rate at which water is drawn from the hydro storages.
- For those storages that do not directly feed a power station, the water releases are determined by rules that set the flows in various water conveyances such as canals, tunnels, etc.

1.6 Dispatch

TEMSIM simulates a simplified version of the NEM dispatch process. The dispatch process determines the output from each generator and the flow across the Tas-Vic interconnector on a least-cost basis so that total cost of meeting Tasmanian and Victorian demand is minimised. In practice, this means that when the Vic spot price is low, some of Tasmania's demand will be met by imports from Vic via the interconnector. Conversely, when the Vic spot price is high (*relative* to the price of available Tasmanian generation) some Tasmanian generation will be dispatched to export power across the interconnector to meet Vic demand.

Note that TEMSIM does not implement the *full* NEM dispatch process. In particular, TEMSIM does *not* model the transmission and system stability constraints that form a major part of the dispatch process in the real world. TEMSIM models a simple energy-only dispatch process.

TEMSIM models a very simplified view of the Victorian end of the interconnector. TEMSIM makes a range of generation offers for the Vic end of the interconnector that ensures that there is sufficient available generation, and sufficient demand, so that the interconnector can operate at either maximum import (to Tas) or maximum export (to Vic) at every time-step.

1.7 Transmission System and Losses

TEMSIM models transmission losses in a very simplified way, assuming (radial) losses between each generator and the single interconnector node. TEMSIM does model the Marginal Loss Factors (MLFs) determined by the market operator and applied to each generator for revenue purposes. The actual *and* marginal losses across the interconnector are modelled in TEMSIM.

1.8 Simulation Process

At a very high level, at each time-step in the simulation, TEMSIM performs the following steps:

- Apply rules to determine:
    - Water releases from storages that do not directly feed a power station;
    - Generation offers from hydro power stations.
- Make generation offers for non-hydro generators (thermal, wind, solar, etc.).

- Calculate dispatched generation and resulting interconnector flow.
- Apply generation outcomes to hydro system (water flows resulting from hydro station generation).
- Update water levels in storages and flows in water conveyances.

1.9 Outputs

Key outputs from TEMSIM include:

- Storage levels;
- Spill from storages;
- Generation volumes;
- Interconnector flows;
- Tasmanian spot price;
- LGC[1] production.

Almost any aspect of the modelled system can be output by TEMSIM, and the outputs can be aggregated in various ways; e.g. the monthly total generation for a single power station.

[1] Large-Scale Generation Certificates – produced by renewable energy generators under the national Renewable Energy Target (RET) scheme.

2 Modelling of Second Interconnector

The methodology was to use TEMSIM to run scenarios that matched as closely as possible the second interconnector scenarios modelled by EY on behalf of TasNetworks. We then compared the outputs from TEMSIM to the outputs from the EY modelling both qualitatively and quantitatively.

The key changes to TEMSIM standard assumptions in order to match the EY scenarios are summarised in Table 1.

Table 1: Summary of non-standard TEMSIM assumptions.

Assumption	Standard Assumption	Assumption for this work
Tas Demand	Annual demand – HT view based on AEMO NEFR outputs Detailed hourly trace based on recent historical data	Tas demand reconstructed from EY hourly generation and interconnector flow data. Method: • Total generation “sent out” (all sources) • Less interconnector flows (at Tas end) • Include storage load (i.e. battery and pumped storage “charging”) • Deduct 3.5% transmission losses to get "to node" (required for input to TEMSIM)
Interconnectors	Basslink: • 500 MW capacity at sending end (478 MW received) • MLFs as per AEMO’s annual determination	Basslink: • 500 MW capacity at sending end (478 MW received) Second interconnector (2IC) scenarios: • 600 MW or 1200 MW capacity at receiving end Modelled in TEMSIM as a single combined interconnector MLFs from Interconnector connection point to Regional Reference Nodes in both Tas and Vic set to 1.0
Outages	Current future outage schedule	No station or machine outages
Wind Generation (Tas)	Existing wind farms (Woolnorth and Musselroe)	Existing wind farms (Woolnorth and Musselroe) Cattle Hill and Granville Harbour included

	Cattle Hill and Granville Harbour commissioned by late 2019 Wind generation determined by historical reconstructed wind speed data	Additional wind generation as per EY scenarios *All* wind (including existing wind farms) operated to match EY generation
Solar, battery, and pumped storage	None at present	Single solar, battery, and pumped storage generators operated to match EY generation Load from battery and pumped storage included in Tas demand
Prices	Vic contract prices from market forward curve and HT Long-Term Price Benchmark Price Duration Curves (PDCs) derived from forward prices and historical spot price data	Vic Price data directly from EY modelling outputs Vic price elasticity of +/-10% at full import or export
Gas generation	Tamar Valley Power Station (TVPS) modelled Operation as per current operational plans	No gas generation in Tas
Inflows to hydro system	Historical data (combination of modelled and measured) for 1997-2017 sampled monthly (multiple random inflow sequences)	Single inflow sequence: historical FYE 2011 to FYE 2017 inflows repeated starting from FYE 2018 (So first modelled year of FYE 2021 uses FYE 2014 inflows)
Major storages (Lake Gordon and Great Lake)	Major storage targets as per current operational plans	Storage trajectories reconstructed from the EY modelling outputs Trajectories used as storage *targets* in TEMSIM
Modelling period	Varies	30 years: FYE 2021 to FYE 2050 (I.e. 1 July 2020 to 30 Jun 2050)

Notes:

- Apart from the specific items listed in Table 1, no changes were made to TEMSIM representation or simulated operation of the Tas generation system.
- Specifically, *no* changes were made to the operating rules for storages or power stations.
- It is likely that there would be *some* changes to the way the hydro system would be operated with additional interconnection, but the details, extent, and significance of those changes are not yet known.

- Future work on modelling the impacts of additional interconnection is expected to include some exploration of possible changes to system operations and their impact on storage levels, river flows, and other aspects of the hydro system.

3 Modelling Results

3.1 Spill

With greater interconnection capacity, the hydro system is able to generate more energy from the hydro stations during periods of high inflows, reducing the amount of energy lost from the system due to water spilling from the storages. TEMSIM is able to estimate the energy value of this spill. The total system spill results for the base case and the 600 MW and 1200 MW second interconnector scenarios are summarised in Table 2 below.

Table 2: Total hydro spill (GWh) from TEMSIM for base case and 2IC scenarios.

FYE	Base	2IC 600 MW	2IC 1200 MW	Difference (2IC 600 MW – base)	Difference (2IC 1200 MW – base)
2021	1812	1813	1814	1	2
2022	292	291	293	-1	1
2023	979	980	978	1	-1
2024	2106	2106	2106	0	0
2025	598	594	591	-4	-7
2026	590	496	495	-94	-95
2027	170	89	94	-80	-75
2028	1629	1377	1356	-252	-273
2029	316	265	282	-51	-34
2030	980	763	719	-217	-261
2031	2026	1622	1579	-403	-446
2032	554	448	459	-106	-96
2033	555	447	456	-108	-99
2034	137	89	88	-48	-49
2035	1577	1380	1370	-197	-207
2036	320	254	267	-66	-53
2037	926	749	741	-176	-185
2038	1988	1620	1587	-368	-401
2039	542	455	457	-87	-85
2040	531	447	447	-85	-84
2041	136	89	89	-46	-46
2042	1535	1379	1374	-155	-161
2043	298	265	273	-32	-25
2044	893	754	741	-139	-152
2045	1913	1618	1585	-295	-328

2046	480	464	466	-16	-14
2047	446	455	448	9	2
2048	94	87	91	-7	-3
2049	1478	1393	1382	-85	-96
2050	263	274	283	11	21
Total	**26162**	**23066**	**22912**	**-3095**	**-3250**

Comments:

1. The addition of the second interconnector results in a reduction in total hydro system spill.
2. Over the 30 years modelled, the total spill reduction is estimated to be 3095 GWh for a 600 MW interconnector and 3250 GWh for a 1200 MW interconnector.
3. For the 25 years for which the second interconnector is in operation this gives an average of 124 GWh p.a. (600 MW interconnector) and 130 GWh p.a. (1200 MW).

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Appendix 4 - Project Specification Consultation Report related feedback from stakeholders

Appendix 4: Project Specification Consultation Report related feedback from stakeholders

The following table summarises the feedback raised by stakeholders in response to questions posed in TasNetworks' Project Marinus Project Specification Consultation Report, which was released for public comment in July 2018. To summarise the feedback received, TasNetworks has captured common themes from different submissions in one or two sentences. It should be noted that individual stakeholders have expressed their feedback somewhat differently to the outlined summary sentences. TasNetworks received 15 submissions from the following companies and organisations:

- AusNet Services
- Clean Energy Council
- COTA Tasmania
- Energy Australia
- Energy Consumers Australia (ECA)
- Energy Users Association of Australia (EUAA)
- Hydro Tasmania
- Meridian Energy Australia
- Northern Tasmanian Development Corporation
- Origin Energy
- Roger Martin
- Snowy Hydro
- Tasmanian Small Business Council
- Tasmanian Renewable Energy Alliance
- UPC Renewables

The following table does not include the stakeholder feedback provided in meetings and workshops, although the key issues raised are consistent with those raised in written submissions. Stakeholders will have further opportunities to engage with TasNetworks as the further analysis is undertaken, as explained in Chapter 10 of the Initial Feasibility Report.

Theme	Stakeholder feedback	TasNetworks response
Consultation process	TasNetworks should be commended on its transparent and consultative approach to Project Marinus. (Clean Energy Council, COTA Tasmania, Energy Consumers Australia, Hydro Tasmania)	Customers are central to everything we do at TasNetworks and our success is anchored to the prosperity and well-being of our customers. Our process for considering the feasibility of Marinus Link has involved engaging with end-use customers and stakeholders to gather feedback and discuss key project issues. The Project Marinus Feasibility and Business Case Report is supported by a Stakeholder and Community Engagement Plan. All of the planned engagement activities are coordinated, complementary and tailored to key stakeholder groups. Following the release of the Initial Feasibility Report, stakeholder and community engagement activities will continue throughout 2019. More information on our Stakeholder and Community Engagement strategy is provided in chapter 10 of the Initial Feasibility Report.
Integration with AEMO's Integrated System Plan (ISP)	Stakeholders will want to understand the reason for any difference in its assumptions and conclusions compared to the 2018 ISP, such as proposed timing of the second interconnector. (AusNet Services, Energy Australia, Origin Energy, Tasmanian Small Business Council) Future ISPs should undertake additional consultation to capture the unique jurisdictional opportunities and knowledge relevant to Tasmanian-based ISP projects. (Clean Energy Council) The 2018 ISP did not fully reflect the unique Tasmanian storage opportunities identified through the Battery of the Nation project. (Clean Energy Council, Hydro Tasmania) The 2018 ISP incorrectly assumed that wind or solar have the same cost and capacity factors across all regions. The ISP also assumed that pumped storage costs are the same across the NEM. In both instances, Tasmania has a comparative advantage compared to the mainland. (UPC Renewables)	TasNetworks recognises that the benefits of the proposed timing of the second interconnector is dependent on assumptions made about the future NEM. The benefits across the NEM provided by Marinus Link would outweigh its construction and operating costs if the commissioning and operation of Marinus Link coincides with a period of large-scale retirement of coalfired generation in the NEM for either emission reduction or economic reasons. The detailed work undertaken by TasNetworks as part of the Initial Feasibility Report will be shared with AEMO to help inform its approach to its national planning work, including development of the next ISP. TasNetworks will also progress the RIT-T process for Marinus Link. Submissions received on the PSCR and those made to this Report will inform the approach and analysis to produce the Project Assessment Draft Report (PADR) for Marinus Link. TasNetworks acknowledges the comments made by UPC regarding assumptions made in the ISP in relation to cost and capacity factors being consistent across the NEM. TasNetworks has recognised the relevant generation and storage differences to other regions and this has been reflected in the Initial Feasibility Report. AEMO signaled its intention to engage more closely with stakeholders to understand the potential to leverage the existing Tasmanian hydro-power system, understand the cost differences in storage between NEM regions and the optimal timing of investment in supporting transmission interconnection. Information regarding the key differences in assumptions this Report and the ISP is detailed in section 6.2.1 of the Initial Feasibility Report.

Theme	Stakeholder feedback	TasNetworks response
Performance of Basslink **Performance of Basslink**	There should be a full analysis of Basslink's operation to gauge whether a second interconnector is justified. (COTA Tasmania) Basslink has created energy security issues in peak periods. A mix of new generation technologies and redundancy across the regions is part of the solution for the system of the future. (Meridian)	TasNetworks notes the views expressed by COTA in relation to analysis of the performance of Basslink and linkages to the feasibility assessment of a second Bass Strait interconnector. A range of learnings from the Basslink project were outlined in the 2012 Electricity Supply Industry Expert Panel review, commissioned by the Tasmanian Parliament. Other industry experts have developed reports and undertaken studies relating to security issues which have been outlined in section 1.7 of the Initial Feasibility Report. The lessons learned from Basslink are already influencing the technical scope consideration, and in the longer term will inform our project management and risk assessment approach.
Potential benefits of Project Marinus (or alternatives) **Potential benefits of Project Marinus (or alternatives)**	Project Marinus offers unique interconnection benefits as a result of different demand patterns, generation assets and potential storage solutions across regions. (Clean Energy Council, Hydro Tasmania, Meridian, UPC Renewables) The benefits sought for Tasmania (reduced costs and increased energy security) could potentially be met through non-network solutions, or less ambitious augmentations. (Tasmanian Renewable Energy Alliance, Origin Energy, Tasmanian Small Business Council) The PSCR identifies energy security for Victoria as a potential benefit, but it is questionable whether a project of this magnitude is the best way of addressing this requirement. (Energy Australia) Network resilience is a potential benefit from the second interconnector that may be worth considering, although it is difficult to quantify. (AusNet Services) Tasmania has a combination of excellent wind resources and large-scale storage. (Clean Energy Council, Hydro Tasmania, Tasmanian Small Business Council, UPC Renewables) Tasmania is not unique in being able to provide storage, with Snowy 2.0 and utility scale batteries, for example, also in a position to do so. Moreover, Tasmania's hydro assets and transmission will require significant investment to offer expanded services. (Roger Martin, Tasmanian Small Business Council) Export of Tasmanian renewable energy to the mainland NEM could contribute to emissions reductions in the NEM. This could be a significant benefit, providing that exported Tasmanian energy would displace fossil fuels. (Tasmanian Renewable Energy Alliance) Thermal generation sources are becoming increasingly unreliable. A more interconnected NEM can offer system resilience. (Clean Energy Council) Increased interconnection would facilitate competition benefits. (Clean Energy Council, Hydro Tasmania) Marinus Link will prove to be a highly cost-efficient option to address Victoria's forecast supply adequacy concerns and provide fast-ramping capacity in response to the rapid decline in solar output in the evening. (Hydro Tasmania) HVDC can provide fast frequency response and black start capability, as well as independent active & reactive power control. (Hydro Tasmania)	TasNetworks welcomes the identification of benefits by stakeholders and recognises that, at this stage, a number are still to be quantified. TasNetworks also recognises that there are other solutions that can provide customer benefits. Chapter 6 of the Initial Feasibility Report outlines the benefits considered as part of the economic modelling undertaken to assess the economic feasibility of Marinus Link, compared to a base case without Marinus Link. The Initial Feasibility Report demonstrates the benefits across the NEM provided by Marinus Link outweigh its construction and operating costs where Marinus Link supports the NEM as large-scale retirement of coalfired generation occurs, whether that is in the 2020s or 2030s. TasNetworks modelling has considered both Snowy 2.0 and Marinus Link and found that, whilst the benefits of Marinus Link are reduced if Snowy 2.0 is constructed, in the event that coal fired power stations are retired ahead of their design lives then Marinus Link's benefits still outweigh its costs assuming Snowy 2.0 is progressed. The modelling outcomes suggest the NEM requires both Snowy 2.0 and Marinus Link to support a rapid transition to renewable energy. TasNetworks will continue to refine and update the economic modelling with the latest assumptions and forecasts and will consider whether different analytical methods should be utilised to assist in quantifying additional benefits, including those identified by stakeholders. TasNetworks will undertake more detailed calculations of additional benefits for which preliminary values were used, notably the reduction in ancillary services costs, energy security benefits, and the avoided costs of future network expansion. TasNetworks will continue to engage with our customers, policy makers, regulators and market bodies as they refine the regulatory and investment frameworks in a transforming NEM. Any consequential changes to the modelling approach will be addressed in further RIT-T consultations and the Final Feasibility Report.

Theme	Stakeholder feedback	TasNetworks response
Project costs	The new cost estimates are between \$300 million-\$800 million higher than the Tamblyn report. An unrealistically high estimate of cost will undermine the cost/benefit analysis. A more detailed reconciliation of costs compared to the Tamblyn report is required. (UPC Renewables) The Project Assessment Draft Report (PADR) should clearly outline any expected capital costs across regions and the likely impact and/or benefit to consumers in each region. (Energy Australia)	The cost estimate released in the PSCR (July 2018) for Marinus Link reflected a revision in the project scope when compared to the initial estimate produced in June 2016 as part of the Tamblyn study. This revision was due to the inclusion of some electricity network upgrades in Victoria and Tasmania to support increased electricity flows as well as reconsideration of base cable costs. The cost estimate included in the Initial Feasibility Report has been further refined with estimates provided by equipment suppliers and considered favourable routes. Chapter 7 of the Initial Feasibility Report provides an overview of the cost estimate as well as a description of the development methodology utilised.
Modelling assumptions **Modelling assumptions (continued)**	TasNetworks examination of two options is too narrow for such a large project. There are other credible options that should be more thoroughly examined, such as a smaller link (perhaps with option value), use of the Basslink corridor and use of alternative converter technology. (Tasmanian Small Business Council) The rapid deployment of new technologies such as grid and decentralised battery storage and demand management could meet the need to match energy supply and demand faster than can large scale projects such as pumped hydro. This undercuts the business case for investments such as Marinus and may result in the cost to consumers of a regulated asset exceeding the benefits. (Tasmanian Renewable Energy Alliance, Roger Martin) TasNetworks should rely on the central assumptions and scenarios developed by AEMO for the ISP where possible. (Snowy Hydro, Tasmanian Small Business Council) A "hydrogen scenario" should be modelled to determine whether Tasmania's hydrogen options should be pursued in parallel with the Battery of the Nation project. (Northern Tasmanian Development Corporation) TasNetworks should provide clear and transparent information around any assumptions of new generation capacity. (Energy Australia) TasNetworks should provide sufficient robust, transparent and realistic modelling of market benefits, capturing all potential sensitivities and future scenarios. (Energy Australia) Modelling should clearly address assumptions and methodology around how the lifting of water level restrictions is modelled. The treatment of high impact, low probability events should also be modelled transparently. (Energy Australia) Modelling should consider the economics of all resources across regions, noting that Victoria has interconnection with SA and NSW, and the ISP recommends immediate upgrades between Victoria and NSW. The estimated length of time to complete this project could potentially see several other ISP projects initiated and completed in that time (Meridian, Energy Consumers Australia, Tasmanian Small Business Council) Modelling should test assumptions around coal closure, noting that the United States has assumed a much shorter lifespan for coal generation (up to 10 years). (UPC Renewables) 'Round trip' network losses and 'round-trip' efficiency of storage need to be modelled carefully in assessing the potential benefit of energy arbitrage activities where Tasmania stores excess energy from the mainland. (Energy Australia, Roger Martin)	Chapter 6 of the Initial Feasibility Report outlines the economic assessment undertaken to analyse the potential benefits to the NEM from the construction and operation of Marinus Link. The assessment also considers the broader economic benefits of Marinus Link to the Victorian and Tasmanian economies. The analysis undertaken considers a range of options and sensitivities and has utilised, where possible, assumptions consistent with AEMO's ISP. However, in some cases the assumptions differ; this is particularly the case in relation to forecast renewable generation. Chapter 6 provides information about the evolving power system including AEMO's ISP considerations. Section 6.2.1 of the Initial Feasibility Report provides a justification for these differences. AEMO's analysis did not consider the full range of benefits suggested in the recent Hydro Tasmania Battery of the Nation analysist. To this end, AEMO will undertake further work to better understand the inter-relationship between Marinus Link and the Battery of the Nation project and how this may be best incorporated into the next ISP. TasNetworks agrees with the feedback that the modelling assumptions and analysis should be transparent. The Initial Feasibility Report should provide stakeholders with confidence that we intend to provide comprehensive information to explain and support the analysis. At this stage, TasNetworks' acknowledges that some of the modelling issues raised by stakeholders have not been examined in detail. These observations will be considered further, as work continues towards the finalisation of the RIT-T and feasibility study.

Theme	Stakeholder feedback	TasNetworks response
Project design – particularly relating to connection point considerations	The full benefits of the second interconnector will depend on augmenting the connection points in Victoria and Tasmania (AusNet Services). The connection point options are credible. (AusNet Services).	Network upgrades in both Tasmania and Victoria will be required to support Marinus Link. The extent of the upgrades is dependent on the route selected and the capacity of Marinus Link (i.e. a 600 MW option or a 1200 MW option). Chapter 3 of the Initial Feasibility Report details the technical elements of Marinus Link and provides an overview of the supporting transmission network upgrades that may be required as well as the connection point considerations. TasNetworks will continue to engage with AusNet Services and AEMO in connection point considerations.
Project funding **Project funding (continued)**	TasNetworks should detail the costs and benefits to Tasmanian customers in the short-and long-term showing the impact on electricity bills. (COTA Tasmania, Energy Consumers Australia, Tasmanian Small Business Council) The project should not proceed unless it delivers lower electricity prices for consumers. Affordability must be a constraint on investments decisions. (COTA Tasmania, Energy Consumers Australia) It is vital to maintain important consumer safeguards such as a robust RIT-T and independent regulatory oversight to ensure that the project only proceeds if it delivers a net economic benefit (EUAA, Origin Energy) Tasmanian electricity consumers should not carry the cost and risk of development that benefits a range of parties, including wind farm developers. (EUAA, Tasmanian Renewable Energy Alliance, Energy Consumers Australia, Tasmanian Small Business Council) There is little comment in the PSCR on who would pay the network charges for Project Marinus. In our view, they should be allocated according to who benefits, including renewable energy owners, consumers in Tasmania and consumers in Victoria. (Tasmanian Small Business Council) The costs of funding Project Marinus may fall to Tasmanian customers, which would not be fair. (COTA Tasmania, EUAA Tasmanian Renewable Energy Alliance, Energy Consumers Australia) The following parties would benefit from Project Marinus: Hydro Tasmania, TasNetworks, Tasmanian Wind Developers, Tasmanian Government, Victorian Government, Federal Government and Energy Consumers. (EUAA) TasNetworks should also consider alternative funding models that reflect the important strategic drivers for this project, including Government funding (Energy Consumers Australia, EUAA) If additional interconnection was to be funded outside the RIT-T framework we would be concerned that this may have a negative distortionary impact on the market. (Energy Australia) It is possible that the Battery of the Nation Project could fund the costs of a new interconnector, avoiding cost recovery through a RIT-T process. (Meridian)	Customers and stakeholders have expressed their concern about affordability, and in particular, the impact on electricity prices as a result of the development of a second Bass Strait interconnector. Tasmanian customers want TasNetworks to continue to deliver on the strategy of lowest sustainable network prices. Chapter 8 of the Initial Feasibility Report provides a description of developer and financing options for Marinus Link. There are a number of matters that will be addressed in future work, including the service and funding model for Marinus Link. Where the project is forecast to deliver a positive net economic benefit, the question of 'who pays' will be highly relevant to the investment decision. Contributions from Government(s) and/or modifications to the present pricing framework would support fair pricing outcomes for Tasmanians from a regulated Marinus Link, recognising that energy market benefits are principally to mainland NEM customers. TasNetworks will actively work with policy makers, regulators and market bodies to seek this outcome (for more information refer to Chapter 9 of the Initial Feasibility report).

Appendix 5 - Letter of review Dr John Tamblyn 23 November 2018

JC TAMBLYN &ASSOCIATES PTY LTD

Dr John Tamblyn

Managing Director

PO Box 4249

Castlecrag NSW 2068

John.c.tamblyn@gmail.com

Ms Bess Clark

General Manager Project Marinus

TasNetworks Pty Ltd

PO Box 606 Moonah Tasmania 7009

Dear Ms Clark

PROJECT MARINUS – INITIAL FEASIBILITY REPORT

This letter responds to your request that I conduct an independent review of this report on an Initial Feasibility Assessment of a proposed second Bass Strait interconnector, Marinus Link(ML). The specific aspects of the report that I have been asked to review are:

- The feasibility assessment approach, assumptions and methodology adopted for the study
- the supporting analysis and the conclusions reached regarding the prospective economic feasibility of Marinus Link
- The Initial feasibility Report as a whole.

As we agreed, in conducting the review I have focused principally on aspects of the report that deal with or are relevant to the economic feasibility of ML.

INTRODUCTION AND CONTEXT

This initial assessment of ML has been conducted by TasNetworks as a preliminary evaluation of the relevant issues, prior to conducting a Final Feasibility and Business Case Assessment forecast to be completed by December 2019. This initial assessment process has provided valuable insights that will inform the final assessment process, including identification of areas where the assessment methodology, modelling framework and quantification of potential benefits and costs can be improved.

Since the completion of the study, 'Feasibility of a Second Tasmanian Interconnector' that I presented to the Tasmanian and Commonwealth Governments in April 2017, there have been further developments in the National Electricity Market (NEM) that are relevant to this proposal to increase interconnection between Tasmania and the mainland, including:

- The Tasmanian Government's response to the 'Willis Review' on security risk mitigation measures for Tasmania
- Publication of AEMO's inaugural Integrated System Plan (ISP) and continuing work under the auspices of the Energy Security Board on converting the ISP into an actionable strategy
- Ongoing planning for the development of two large-scale pumped hydro storage projects, Snowy Hydro's Snowy 2.0 project and Hydro Tasmania's Battery of the Nation (BOTN) project
- Commencement of this further more detailed assessment of the feasibility of ML by TasNetworks in conjunction with ARENA.

AEMO's ISP is of particular relevance to the ML interconnection proposal because it provides detailed analysis of the major transformation that is underway in the NEM and projections of the changes to the generation mix and the transmission network that will be required to maintain secure and reliable electricity supply at least cost in the medium and longer term. In particular, the ISP predicts a strong future role for energy storage, including pumped hydro storage, to provide capacity firming support at times of peak demand, and a need for strengthened interconnection between NEM regions to take advantage of the geographic diversity of renewable energy generation across the power system.

While AEMO acknowledged a potentially valuable future role for ML and BOTN in the ISP, it also recognised that large scale, long term generation and transmission proposals of that kind must be subject to rigorous economic and technical feasibility assessments to inform future decisions on whether they should proceed.

This initial report by TasNetworks on the feasibility of ML provides an important preliminary contribution to the more comprehensive assessment of ML's economic and technical feasibility forecast to be completed in December 2019. In conducting this independent review of the initial feasibility report I have been mindful of the preliminary status of this assessment process and also of the NEM-wide context in which the assessment is being conducted.

ASSESSMENT METHODOLOGY AND APPROACH

The analytical framework and methodology applied for this economic feasibility assessment of ML was based largely on the requirements of the Regulatory Investment Test for Transmission (RITT) in the National Electricity Rules, although a number of variations to that methodology were adopted in recognition that this study is a precursor to a more comprehensive assessment in 2019. The RITT is used to assess the economic efficiency of network and non-network 'credible options' in the electricity market required to meet an 'identified need' from the perspective of participants and consumers in the (NEM).

The need identified for ML is to generate net economic benefits across the NEM by capitalising on the diversity of energy resources and supply and demand conditions between Tasmania and mainland Australia. Two credible options for delivering that outcome were identified: a 600MW HVDC link and a 1200MW HVDC link between Tasmania and Victoria. For this initial assessment, provisional estimates of the capital and operating costs of the alternative ML options were used with the expectation that more detailed probability weighted cost estimates will be developed in subsequent phases of the evaluation process.

The central element of the assessment methodology was the use of economic modelling, specified on a least cost, central planning basis, to quantify and compare changes in the transmission system and the generation mix and the resulting changes in electricity market supply and demand conditions, with and without ML in operation over the modelling period of 30 years. The modelling approach adopted a single scenario to specify longer term conditions in the

NEM and the wider economy, largely based on the ‘neutral scenario’ used in the ISP. It then compared the modelled market outcomes from this ‘base case’ scenario with modelled outcomes with ML in operation over the period to 2050, with the change in NEM-wide resource costs between the with and without ML modelling results providing a measure of the net benefits to the NEM from ML. The net benefit outcome was then compared to the capital and operating costs of ML to provide an assessment of the net economic worth of ML under neutral scenario conditions.

The modelling approach for this initial study did not assess the economic feasibility of the two ML options under different scenarios of plausible future market conditions (eg high, medium and low demand conditions) as a basis for deriving a probability weighted estimate of net economic benefits, as would be required for a full RITT assessment. Instead, the modelling analysis tested the sensitivity of the neutral scenario with/without ML modelled outcomes to the outcomes resulting from specified changes in key parameters and assumptions about future energy market supply and demand conditions, energy market policy settings and other potentially competitive or complementary electricity market investment options.

The majority of sensitivities assumed a state of the world where ML would be commissioned in 2025 in comparing sensitivity outcomes with the neutral scenario outcomes. Two sensitivities assumed states of the world where ML commissioning was deferred to 2028 and 2032 respectively and compared those modelling outcomes to the neutral scenario outcomes.

The modelling analysis valued an important sub-set of the potential economic benefits from ML; namely resource cost savings from avoided capital costs, reduced operating and maintenance costs and reduced unserved energy. Provisional estimates of some other potential benefits (eg avoided energy spill, ancillary service cost savings, avoided network investment costs) were obtained from other sources. It was not possible to quantify other potential benefit classes (eg power system security, competition and options value benefits) at this initial stage of the assessment process.

As noted above, an important outcome of this study has been identification of areas for further development of the assessment methodology, including with respect to the specification of modelling scenarios and sensitivities and the capacity to value all of the economic benefits of potential relevance to the economic feasibility of ML.

In my view, the methodology that has been applied in conducting this study was specified appropriately and was fit for the purpose of the study which was to conduct an initial assessment of the relevant economic feasibility issues and outcomes as a precursor to more detailed analysis during the final feasibility assessment process in 2019.

ANALYSIS AND CONCLUSIONS ON ECONOMIC FEASIBILITY

The analysis and preliminary findings on the economic feasibility of ML are set out in Chapter 6 of the report, supported by the modelling report at Appendix 1. The initial findings from the analysis indicate that ML could generate a wide range of potential net economic worth outcomes, depending on the scenarios and sensitivities adopted about likely future market developments in the NEM and policy settings that have implications for behaviour and outcomes in the NEM.

The initial finding from the analysis in Chapter 6 is that ML would be a strategic interconnection investment that could provide NEM-wide net economic benefits under all of the sensitivities analysed. It would do this by facilitating substitution of lower cost, renewable Tasmanian generation resources for higher cost thermal and renewable generation in mainland NEM regions. An important contributing factor to delivery of economic benefits by ML was the scale and timing of the retirement of coal generation on the mainland, with the assumption that large scale retirements commence in the 2020s rather than the 2030s (for emission reduction or economic reasons) having a significant positive impact on net benefit delivery.

However, the extent of the resulting benefits varied significantly across the sensitivities and when compared to ML's capital and operating costs both positive and negative net economic worth outcomes were obtained (as summarised in Table 10). Positive net economic worth outcomes resulted from sensitivities assuming a higher emission reduction target (with and without Snowy 2.0 in operation), a significant loss of Tasmanian load and deferment of ML commissioning to 2032. Negative net economic worth outcomes resulted from other sensitivities, including those assuming operation of Snowy 2.0 (under the neutral scenario emission target) and full achievement of VRET and QRET targets.

As noted above, this initial study has identified a number of areas where the modelling framework and benefits assessment approach used for this study could be further improved during the next phase of the assessment process. These preliminary findings should therefore be interpreted with these initial analytical constraints in mind.

For example, a number of the potential benefit categories were either not valued or undervalued in this initial assessment process when improved quantification of those benefits may well have improved the net economic worth outcomes under some sensitivities.

The modelling approach used for the scenario and sensitivities analysis also incorporated certain design constraints that could be relaxed in future. For example, each of the sensitivities was modelled as an individual variation to the neutral scenario assumptions and outcomes. That approach did not permit more nuanced analysis, involving different plausible economic scenarios and the testing of potential interactions between relevant sensitivities. Adoption of a more comprehensive modelling framework would have the potential to provided additional useful insights into the net economic worth of ML under other plausible assumptions about future developments in the NEM.

For example, while analysis of the sensitivity assuming deferment of ML to 2032 produced a marginally positive net economic worth result compared to the neutral scenario base case, the remaining sensitivities were not modelled under the assumption of ML deferment to 2032. More detailed future sensitivity modelling with respect to different ML commencement dates would therefore have the potential to provided a more comprehensive understanding of the likely impact of deferment on the net economic worth of ML.

Identification of these and other areas where the analytical methodology could be further developed has been a valuable incidental outcome of this initial study.

Having reviewed the feasibility assessment presented in Chapter 6 and the supporting evidence presented in the modelling report, I am of the view that the analysis and findings from this study have been appropriate and effective for the purposes of an initial assessment of ML's economic feasibility.

THE INITIAL FEASIBILITY REPORT AS A WHOLE

While the initial study has addressed a number of issues going beyond the economic feasibility of ML, this review has been focused on matters involving or related to the economic feasibility assessment.

Overall, the initial report provides a reasonably clear and balanced description and explanation of the economic feasibility analysis and findings. Judgement was necessarily involved in summarising the principal findings in the Executive Summary and relevant Key Messages sections and I have deferred to the judgement of report's authors in that respect.

For the reasons outlined above, I consider that this initial study has performed a valuable role in scoping the issues relevant to the feasibility assessment of ML, in specifying and testing an appropriate modelling and analytical framework and in presenting relevant preliminary findings, as a basis for developing a more rigorous and nuanced analytical framework and approach for implementation in 2019.

In my opinion, this initial study has performed that role effectively and in doing so has a established a sufficiently persuasive case for taking the feasibility assessment of ML to the more detailed final stage in 2019

CONCLUDING OBSERVATIONS

My overall conclusion is that this initial study on the potential for ML to operate on an economically viable basis in future has been fit for purpose and effective in terms of the methodology adopted, the analysis and findings presented and the general clarity and balance of the reported outcomes.

This letter reflects my independent review and views on the methodology, analysis and preliminary findings presented in this Initial Feasibility Report.

Yours sincerely

JTamblyn

John Tamblyn

Managing Director

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