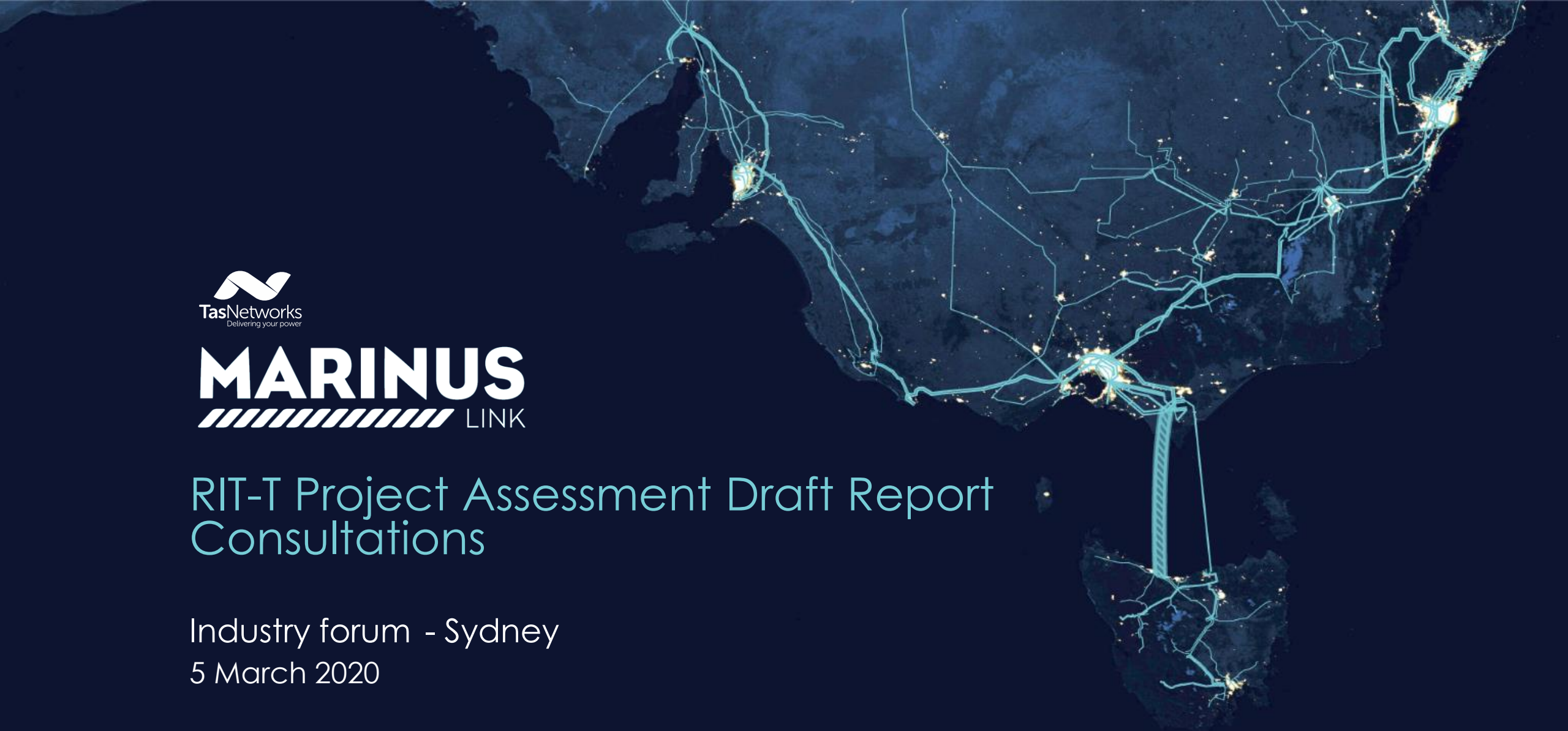

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RIT-T Project Assessment Draft Report Consultations

Industry forum - Sydney

5 March 2020

Purpose of today

- Provide economic and technical insights from the Marinus Link RIT-T Project Assessment Draft Report (PADR) published in December 2019.
- Share evolution of Marinus Link RIT-T PADR post Draft 2020 Integrated System Plan release.
- Seek feedback from market participants.
- Encourage submissions to the Marinus Link RIT-T PADR, due 6 April 2020 **(timeline extended).**

Regulatory Investment Test – Transmission (RIT-T)

AGENDA

Topic	Objective	Presenter
Welcome	Welcome & introduction	Benjamin White (TasNetworks) (5min)
Project update and scene setting	Provide a high level overview of the project and RIT-T process	Bess Clark (TasNetworks) (20 min)
Credible options	Identified need & technical details	Stephen Clark (TasNetworks) (10 min)
Economic analysis – Marinus Link RIT-T PADR & Draft 2020 Integrated System Plan (ISP)	Net market benefits and sensitivity results	Prateek Beri (TasNetworks) (20 min)
Market modelling	PADR market modelling	Jordan Morse (Ernst & Young) (20 min)
Break		15 min
Summary of Draft 2020 ISP relating to Marinus Link	Optimal development pathway and role of Marinus Link	Andrew Turley (AEMO) (10 min)
Interconnector pricing	Sharing insights on pricing challenges and potential solutions	Prateek Beri (10 min)
Panel discussion and Q & A	Discussion and questions from the floor	Bess/Stephen/Jordan (40 min)
Close		Benjamin White (5 min)

Project Summary

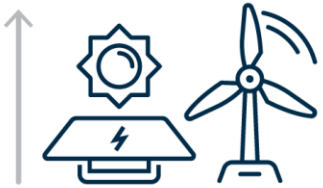
Bess Clark – General Manager
Project Marinus, TasNetworks

An energy sector in transition

By 2035 in the NEM

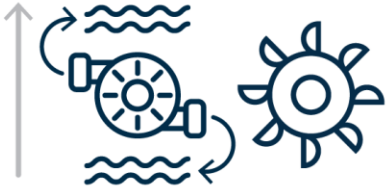
12,000 MW OF **COAL RETIRING**

=



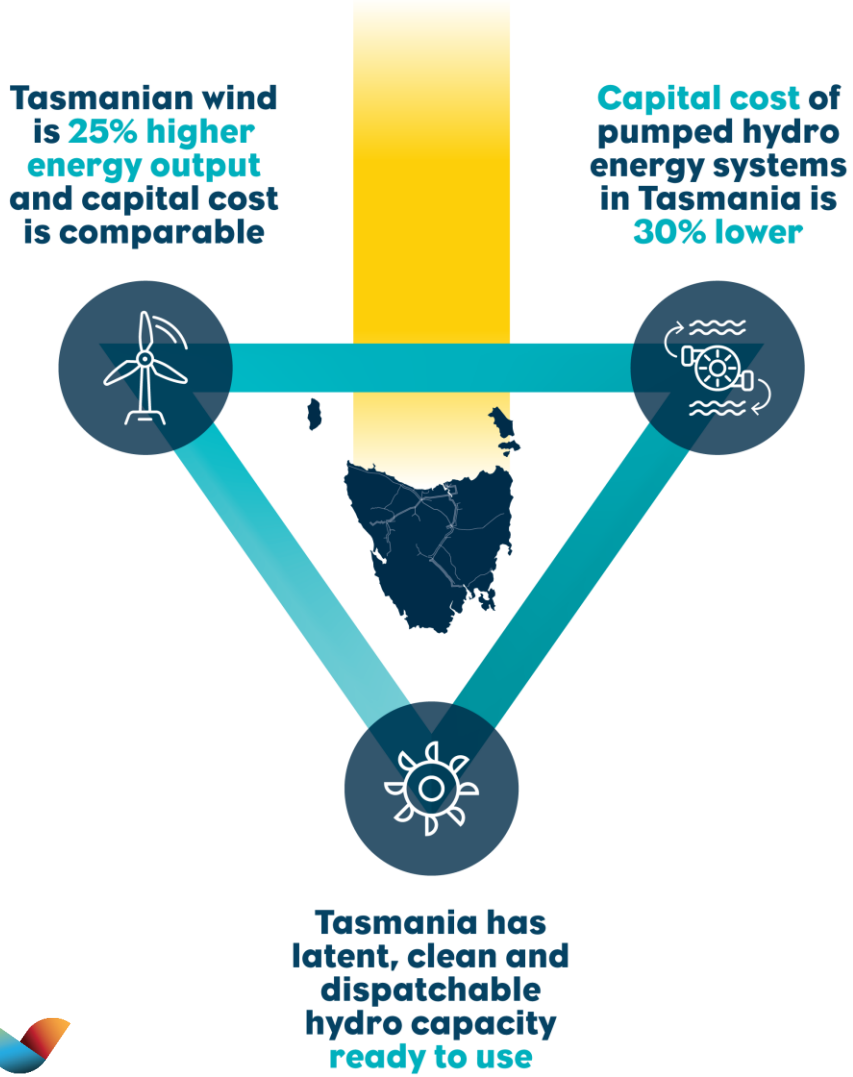
40,000 MW OF VARIABLE **RENEWABLE CAPACITY REQUIRED** TO REPLACE IT

+



8,000 MW OF **DISPATCHABLE CAPACITY REQUIRED** TO FIRM THE RENEWABLES

A positive business case



In Dec 2019 TasNetworks released the Project Marinus Business Case Assessment Report which shows Marinus Link:

- Delivers low cost, reliable and clean energy
- Technically and financially feasible for up to 1500 MW capacity delivered in two 750 MW links

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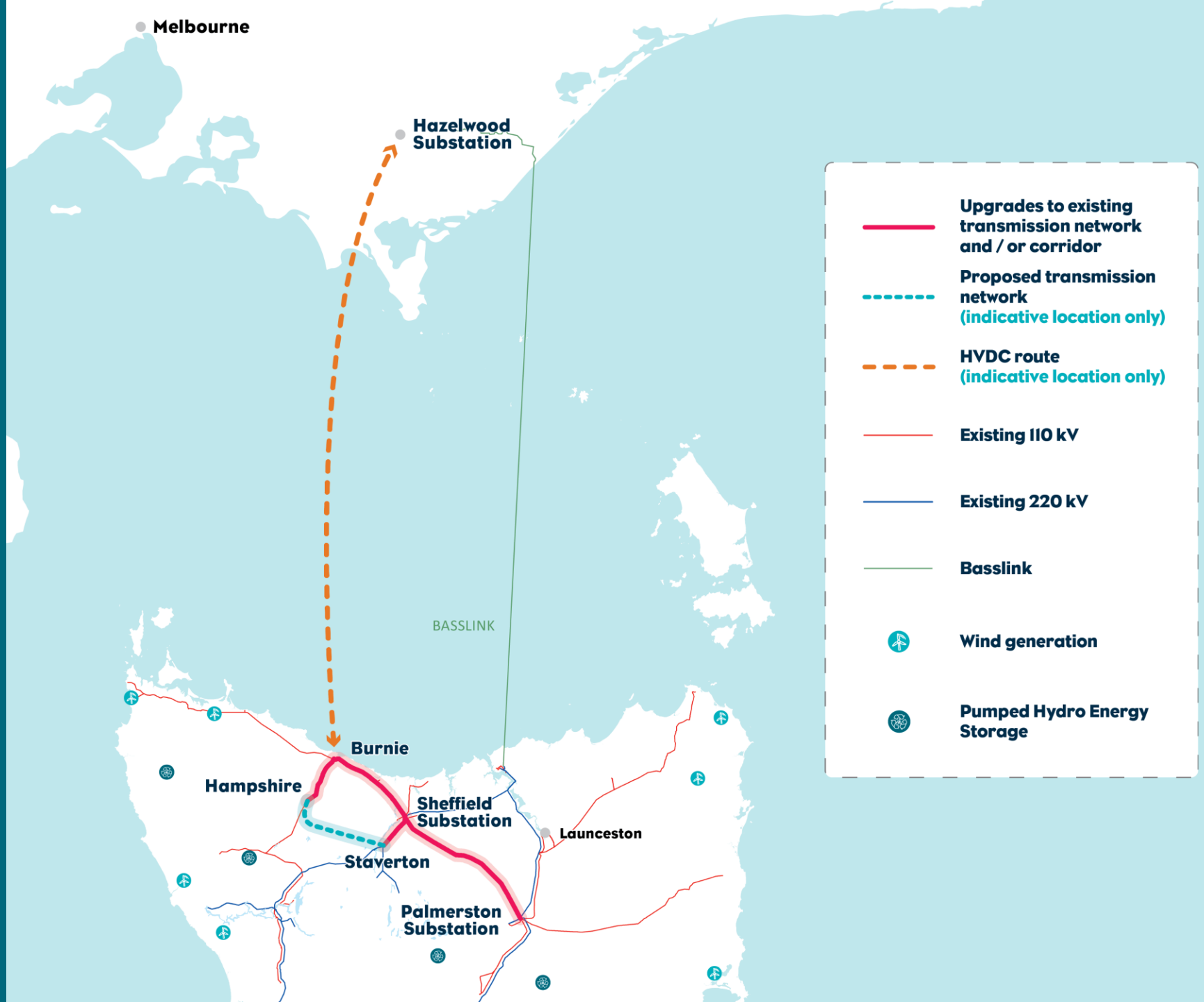
Marinus Link and supporting North West Tasmania transmission developments



Significant broader economic contribution

TASMANIA

UP TO $1.4* BN

ECONOMIC STIMULUS CONSTRUCTION + OPERATION

AND 1400 JOBS

DIRECT AND INDIRECT JOBS AT PEAK CONSTRUCTION

VICTORIA

UP TO $1.5* BN

ECONOMIC STIMULUS CONSTRUCTION + OPERATION

AND 1400 JOBS

DIRECT AND INDIRECT JOBS AT PEAK CONSTRUCTION

* JOBS FIGURES ARE ESTIMATED FOR THE PERIOD SPANNING 2025-27. ALL FIGURES ARE ESTIMATES BASED ON ERNST & YOUNG MODELLING NOVEMBER 2019.

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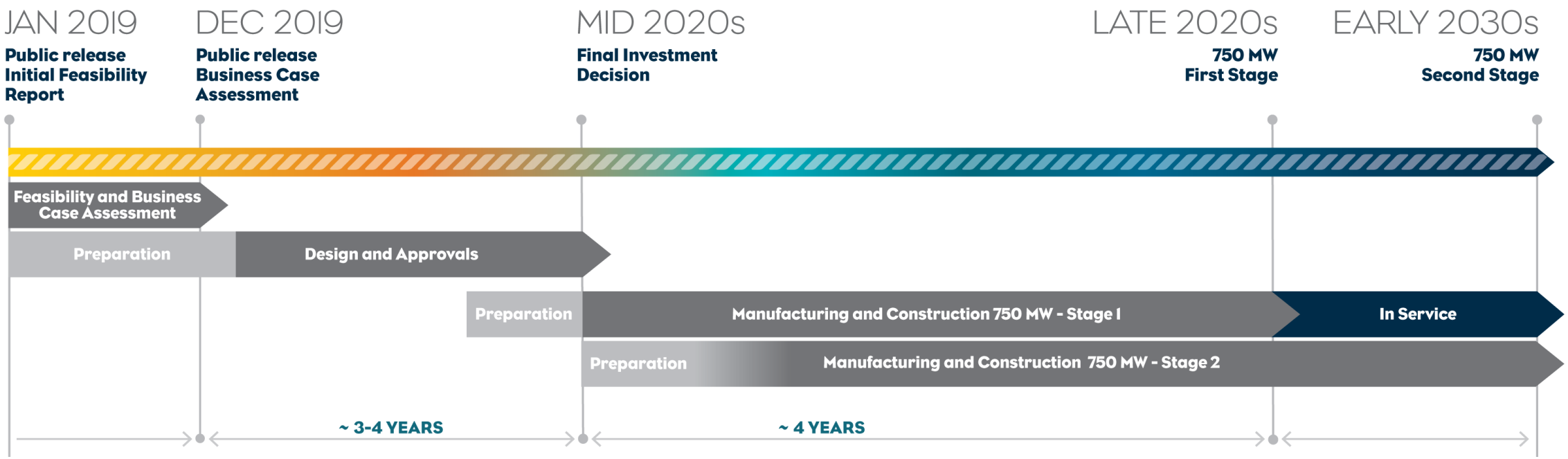
Stakeholder and community engagement

- Cradle Coast Future Energy Hub up and running in Burnie
  - Working towards a regional presence in Victoria
- Further route disclosure to landowners and community in North West Tasmania (commenced) and Victoria (2020)

CRADLE COAST
FUTURE ENERGY HUB

A Cradle Coast Authority and Industry Partnership

Working timeline



Robust RIT-T assessment process

- NEM cost benefit analysis of an increase of transmission capacity between Victoria and Tasmania
- If the project passes the RIT-T the Australian Energy Regulator determines a revenue allowance
- Fair pricing outcomes will be needed before revenue is recovered from customers
- Provides confidence for customers of a robust, independent, process

Regulatory Investment Test – Transmission (RIT-T)

Marinus Link Project Specification Consultation Report (PSCR) – Submissions and key themes

- Ensure allocation of project costs proportionate to beneficiaries
- In broad agreement with the credible need
- Requested detailed modelling with close attention to losses, system strength and Frequency Control Ancillary Services (FCAS)
- Consideration for non-network solution
- Potential for hydrogen production in Tasmania

Industry segment	Submissions
Generators/Retailers	6
Networks	1
Industry bodies, energy users and individuals	8
Total	15

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Progress Milestones

Milestones	Date
PADR published	6 December 2019
Draft 2020 ISP released	12 December 2019
PADR industry forum – Melbourne, Sydney & Hobart	February – March 2020
Submissions close on Marinus Link PADR	April 6, 2020 **(timeline extended)**
2020 ISP released	Mid 2020
Updated modelling in light of final ISP and submissions received	Mid- late 2020

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Credible Options

Stephen Clark – Technical and Economic Leader
Project Marinus, TasNetworks

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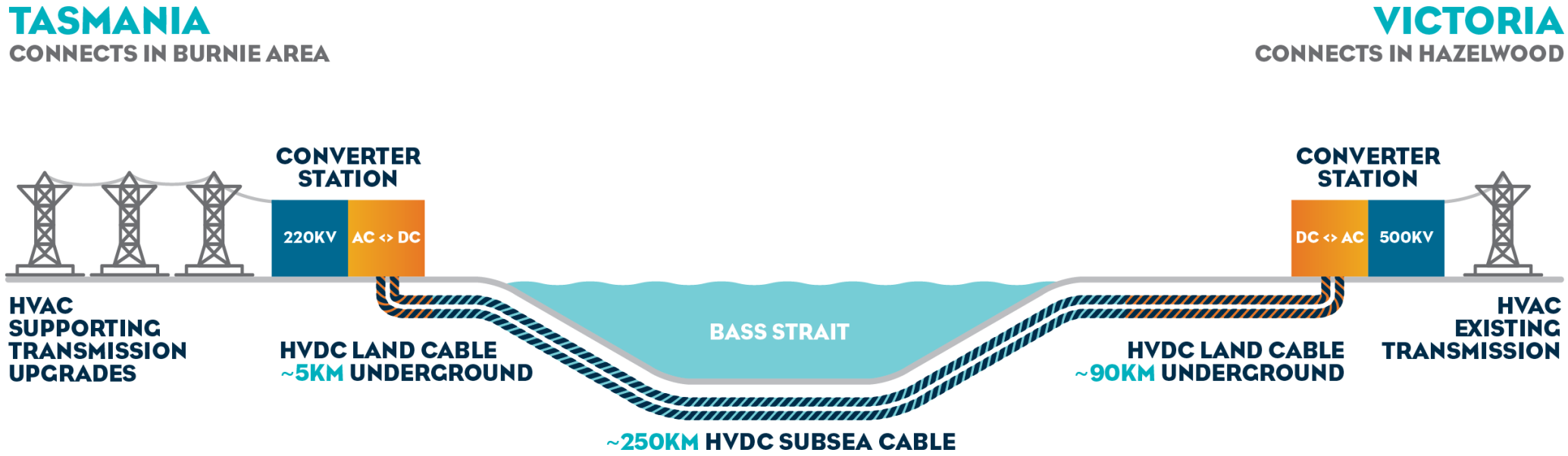
Identified need

"The characteristics of customer demand, generation, and storage resources vary significantly between Tasmania and the rest of the NEM. Increased interconnection capacity between Tasmania and the other NEM regions has the potential to realise a net economic benefit by capitalising on this diversity."

Credible options and schematic representation of Marinus Link

- 600 MW HVDC interconnector and associated AC network upgrades;
- 750 MW HVDC interconnector and associated AC network upgrades;
- 1200 MW HVDC interconnector, consisting of two 600 MW interconnectors, plus associated AC network upgrades;
- 1500 MW HVDC interconnector, consisting of two 750 MW interconnectors, plus associated AC network upgrades.



Advantages of Modern HVDC Technology

- Fully controllable – no commutation faults, no dead zone, no transient overvoltage issues, no minimum system strength requirements.
- Bi-directional current - fast reversal, can continuously provide frequency control services
- Stabilises the power system during electrical faults – fast recovery after faults
- Almost zero ‘electrical pollution’ in the form of harmonics
- Uni-directional Voltage – less stress on cable (can use XLPE cable)
- Converter power losses similar to LCC converters
- Significant advances in technologies monitoring cable operational temperature allows safer operation of the cable. Improved fault location

Supporting Transmission Developments

Marinus Link Cost breakdown for each credible option

Cost item	Cost in $ millions			
	Option A: 600 MW	Option B: 750 MW	Option C: 1200 MW	Option D: 1500 MW
Pre-construction	180	180	180	180
HVDC supply and installation	1,034	1,114	1,813	1,955
Supporting AC supply and installation	201	201	372	372
Interest during construction	64	69	114	121
Project management	71	76	124	134
Total estimated base cost	**1,550**	**1,640**	**2,603**	**2,762**

Source: Table 19, Marinus Link PADR, Page 119

- Costs consistent with RIT-T guidelines, except Interest During Construction (IDC) included
  - P50 excludes accuracy and contingency allowances
- Costs aligned with Draft 2020 ISP
- $20M feasibility funds and $56M Australian Government grant not included in RIT-T costs

Scenarios and Economic Analysis

Prateek Beri – Economic Team Leader
Project Marinus, TasNetworks

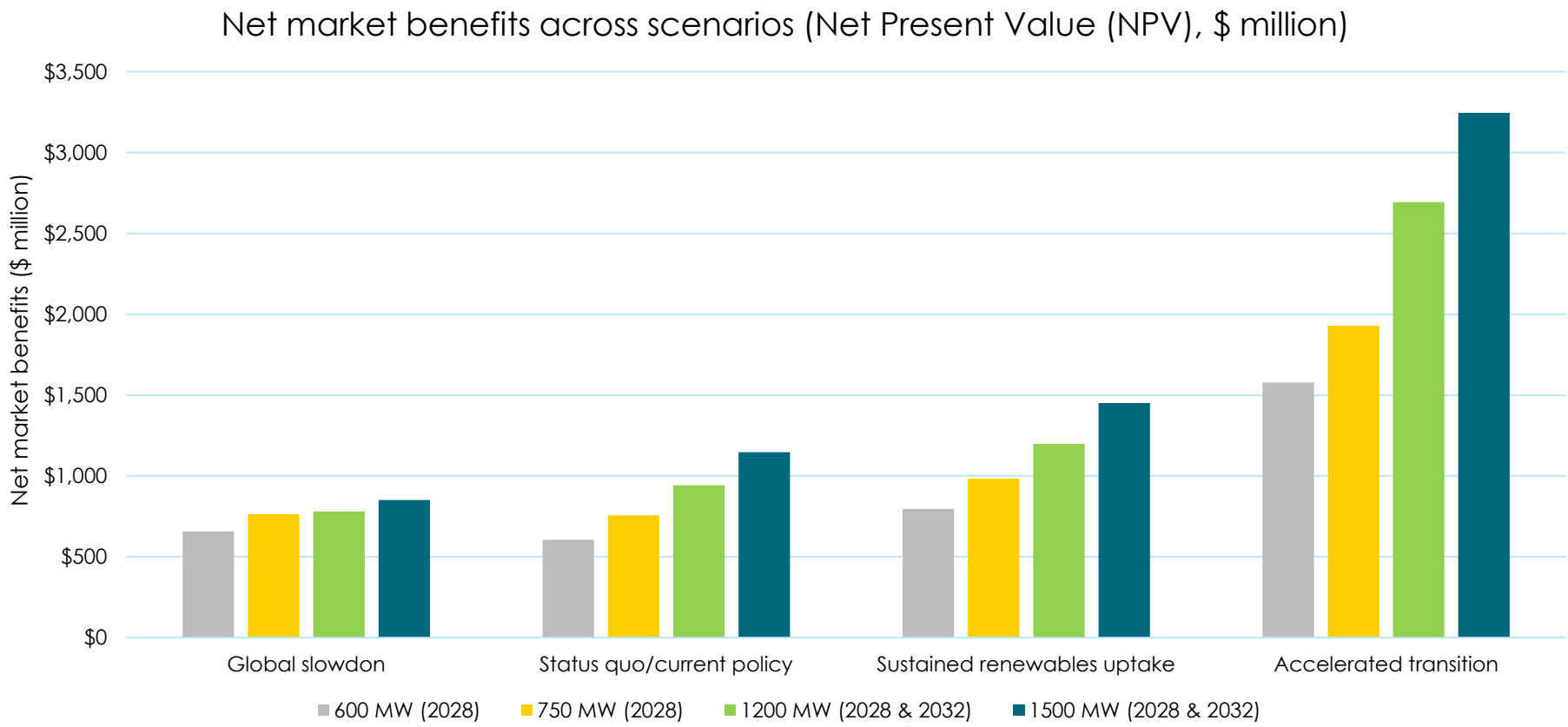
PADR Scenarios

Variables	Global slowdown	Status Quo/Current policy	Sustained renewables uptake	Accelerated Transition to a Low Emissions Future
Weighting	**25%**	**25%**	**25%**	**25%**
Coal retirement schedule	Coal capacity constraint means coal retirements commence 2025 and are accelerated by 3-5 GW from Status Quo scenario	Generator information[1]	3-5 years earlier than Status Quo due to renewables growth	Economic retirement driven by emissions
Electricity Demand	2018 ESOO Slow + 240 MW LIL load reduction in TAS[2]	2018 ESOO Neutral		2018 ESOO Fast
Emission reduction trajectory	None	28% - 2030; 70% - 2050 (does not bind)		Paris 2°C Target 52% - 2030; 90% - 2050
State-based renewables schemes	No VRET or QRET	VIC - 25% by 2020 & 50% by 2030 QLD - 50% by 2030		
Snowy 2.0	1/7/2030	1/7/2027		
Average Gas Price Forecast [3]	Slow Change	Neutral		Fast Change

1. Source: Retirement schedule as outlined on AEMO's Generator information page as of 25 June 2019
2. LIL stands for Large Industrial Load. This reduction is to ensure alignment in large industrial load assumption across NEM.
3. Source: February 2019 ISP assumptions workbook. Coal price forecast is constant across all scenarios.

Net market benefits – credible options

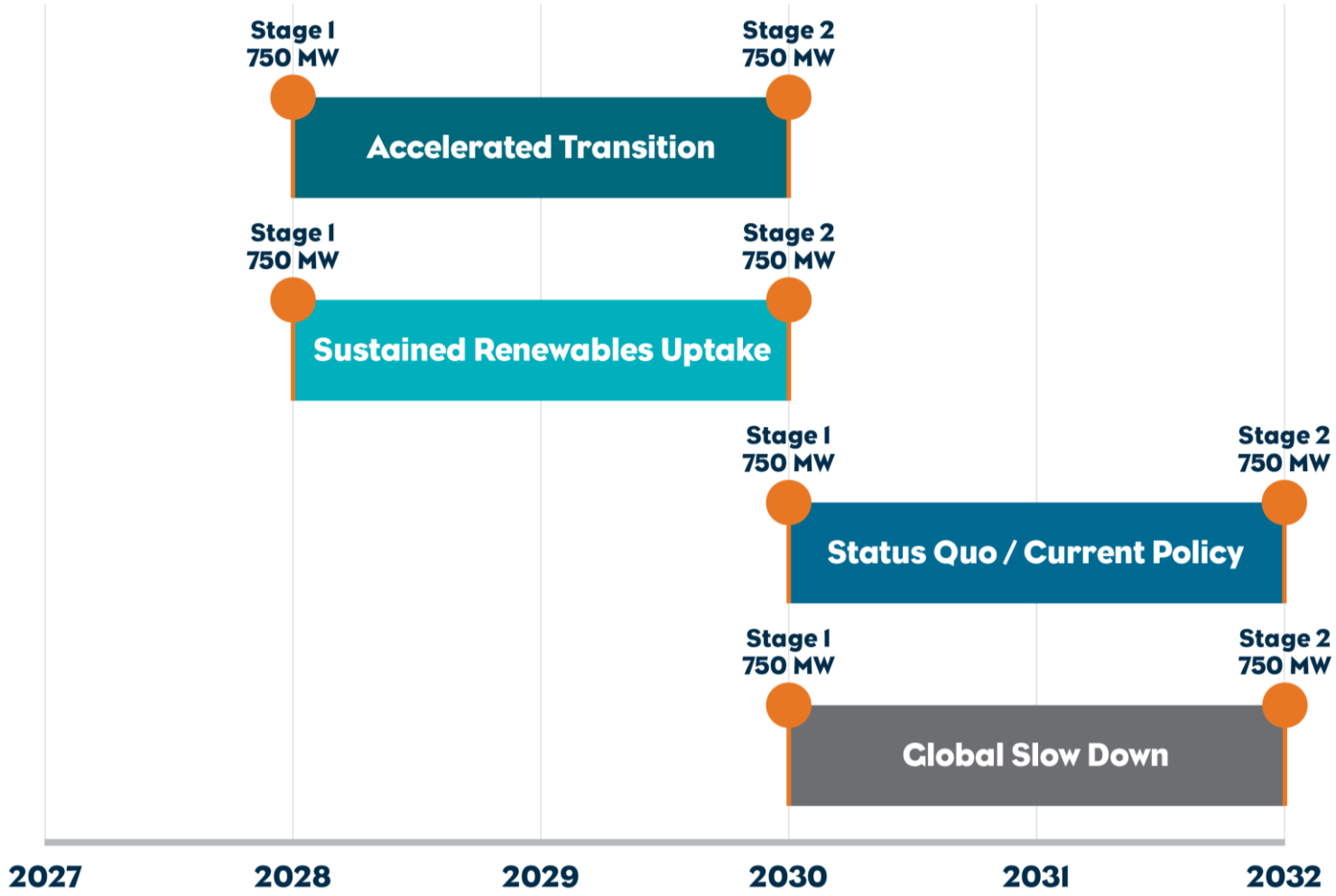
- Positive market benefit for each credible option under all PADR scenarios
- 1500 MW provides greatest net market benefits



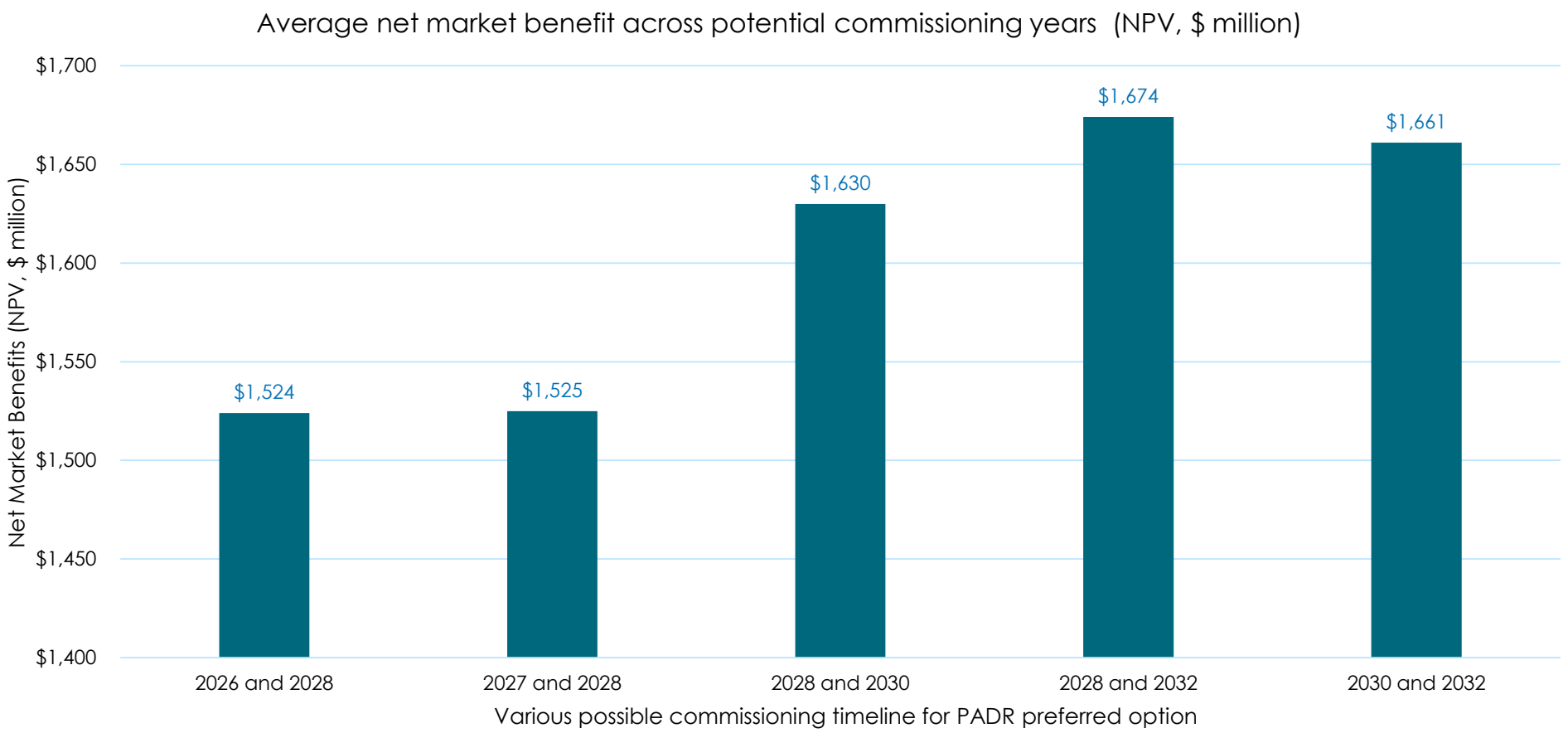
Note: All values are expressed in present value terms ($2019), with analysis of costs and benefits over the period from 2020 until 2050

Optimal timing varies depending upon scenarios

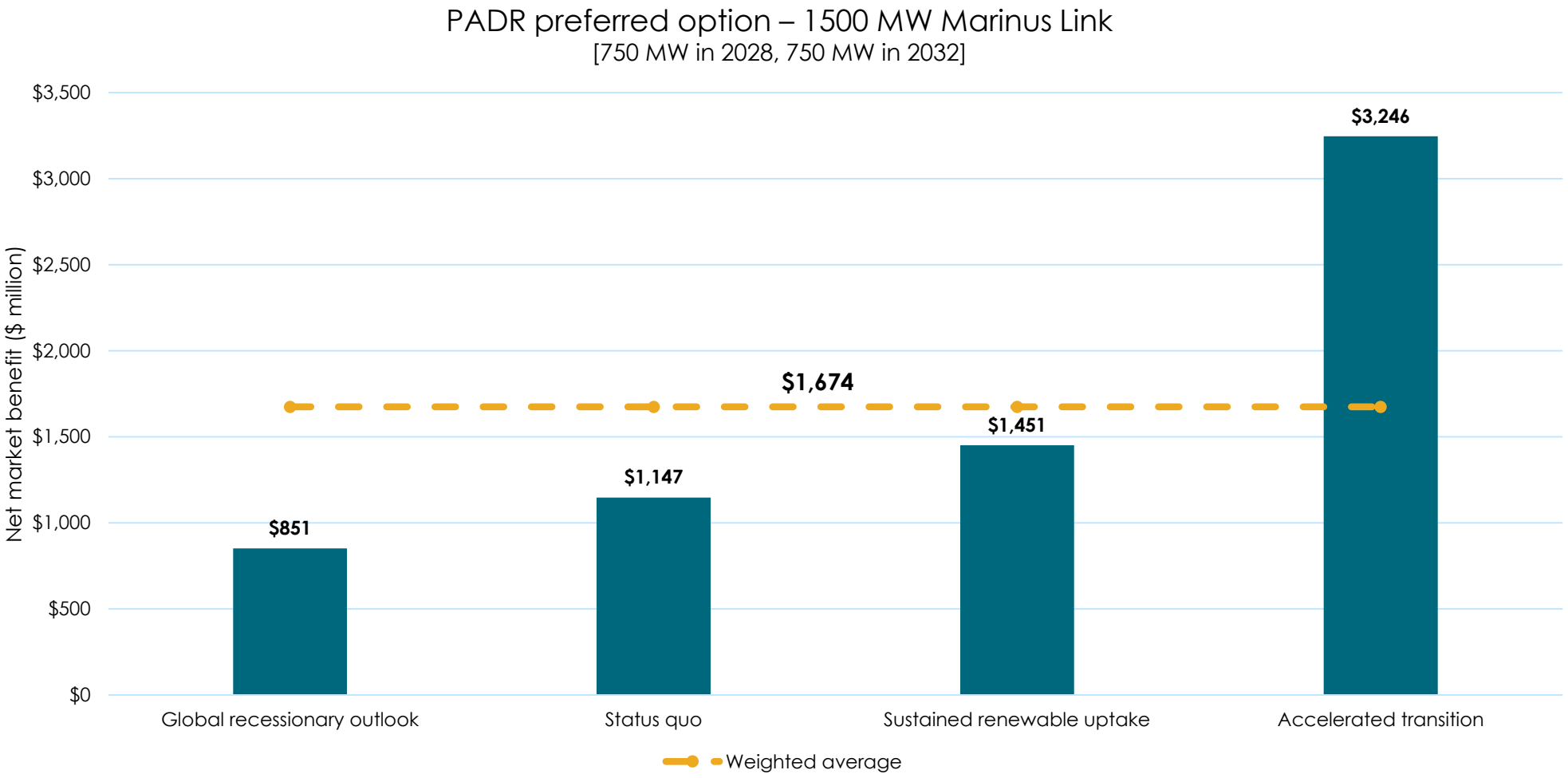
Timing of Marinus Link under different scenarios



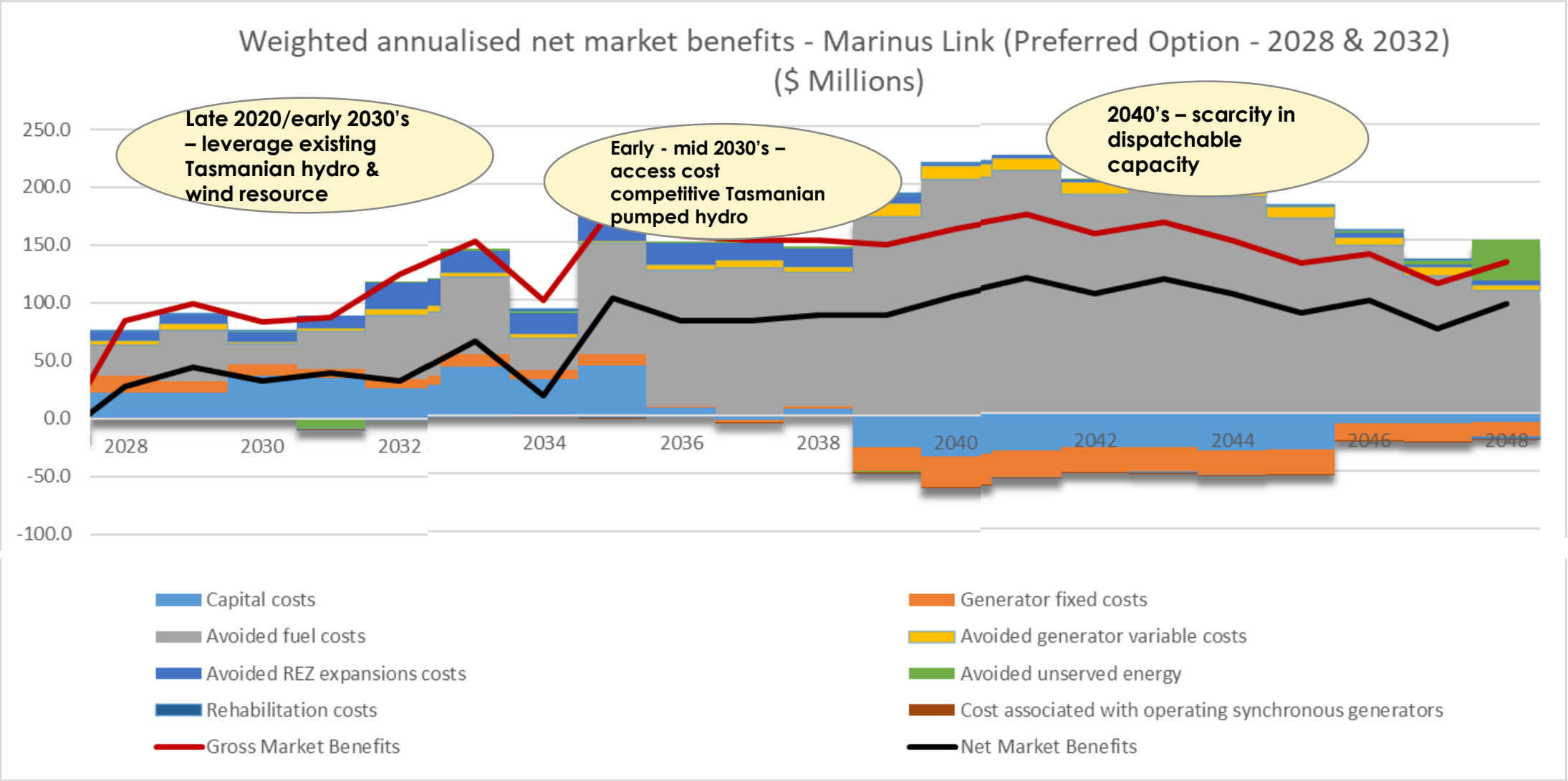
PADR preferred option: Staged 1500 MW Marinus Link in 2028 and 2032



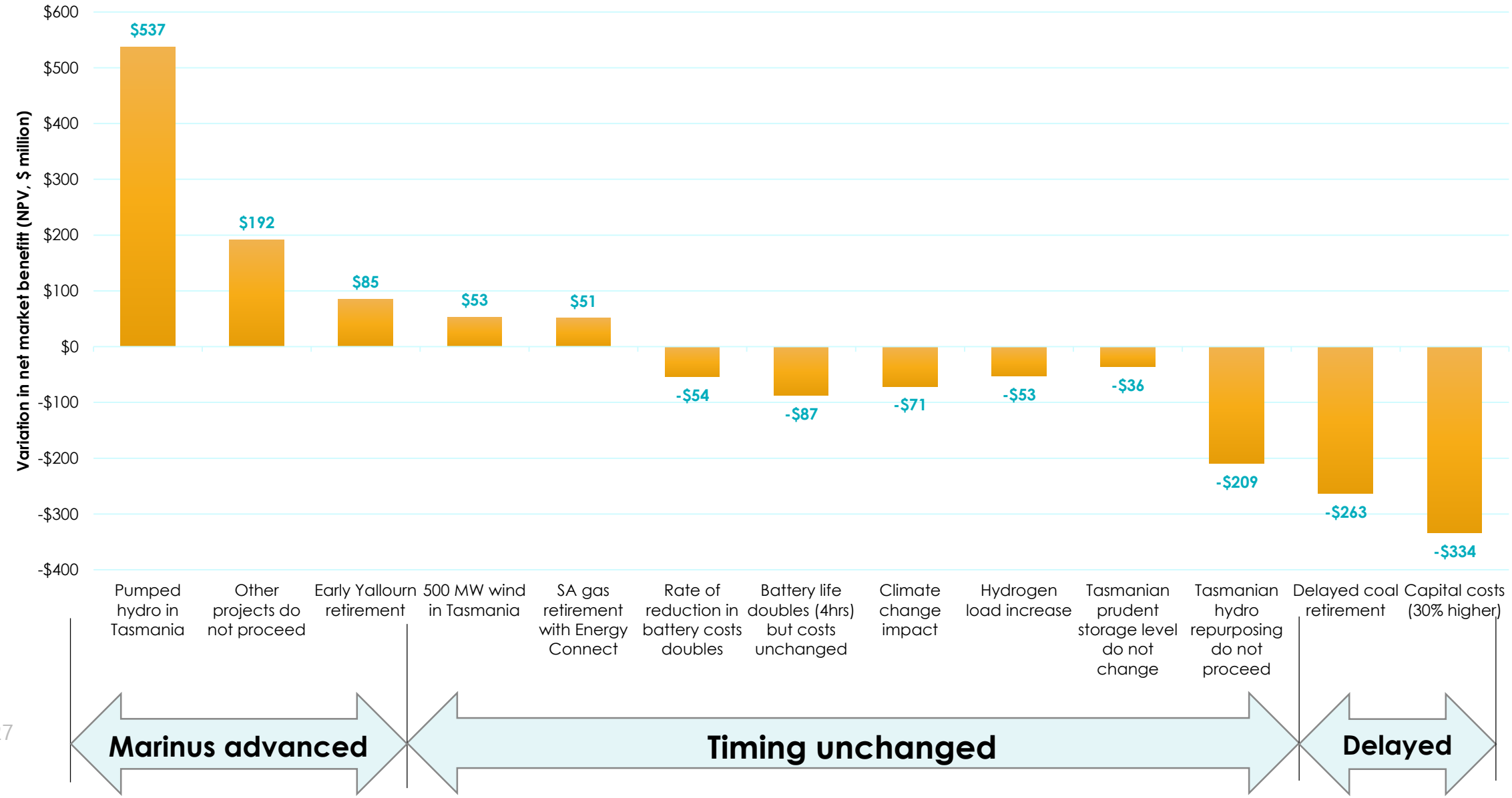
PADR preferred option: value proposition across scenarios



PADR preferred option delivers positive benefits on an annual basis



Sensitivity analysis – variation from status quo scenario for preferred option



Evolution of Marinus Link Project Assessment Draft Report post AEMO Draft 2020 Integrated System Plan (ISP) release

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Draft 2020 Integrated System Plan road map

Marinus Link classified as recommended project for 'shovel ready' works

Completion of Design and Approvals phase and to be shovel ready requires an estimated additional $130m

ISP actionable projects

Project	Capacity (MW)[1]	Cost (Million)[2]	Region	Commissioning Year
QNI Minor	150 – 175	$175	QLD to NSW	2021-22
VNI Minor	170	$81	VIC to NSW	2022-23
Project EnergyConnect	800	$1,530	SA to NSW	2023-24
Hume Link	2,000	$1,350	Snowy to Western Sydney	2024-25
VNI West[3]	1,800	$1,335	NSW to VIC	2026-27 (least-regret) – not optimal timing
QNI Medium	760 – 885	$1,483	QLD to NSW	2028-29

1. Capacity range reflects different northward and southward flows on the interconnector.
2. Costs are in 2019 real terms
3. KerangLink interconnection option between Victoria and NSW has been renamed as VNI West.

Working to understand differences in timing

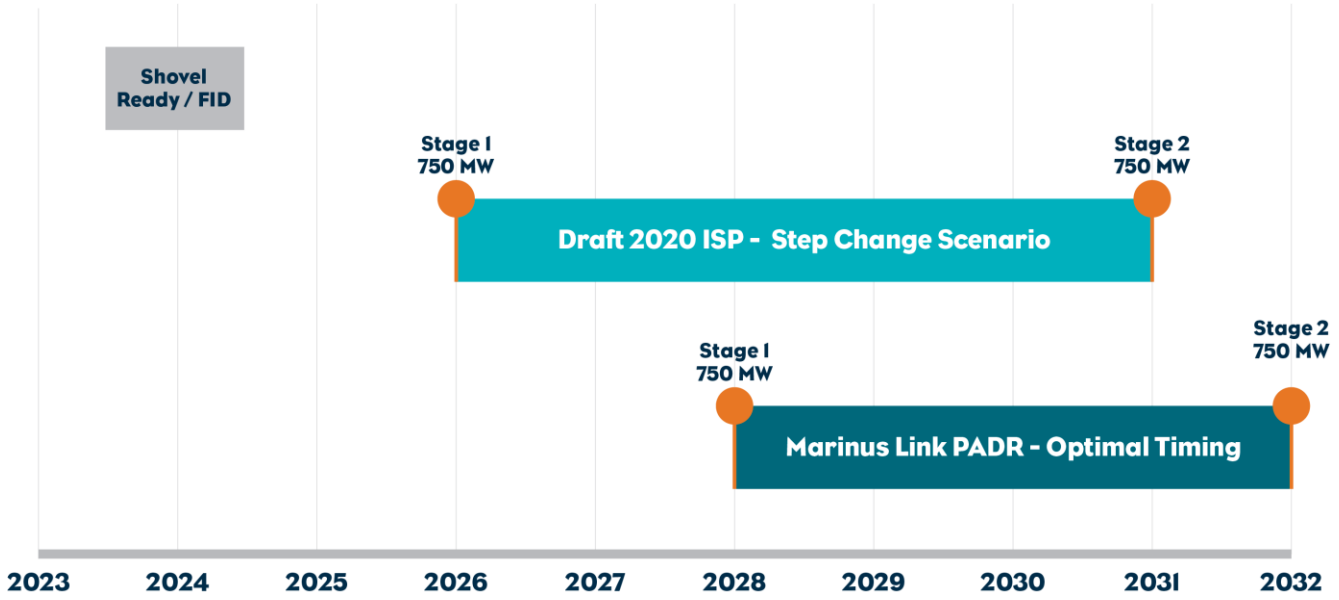
ISP Scenario	Slow	Central	Fast	High DER	Step Change
ISP Marinus Link Timing	Not required	2036[2]	2036[2]	2036[2]	2026 & 2031
Regret Cost 750 MW Marinus in 2026 ($ million)	$130	$288	$25	$279	$0

Most comparable Marinus PADR scenario[1]	Global Slowdown	Status Quo	Sustained Renewables Uptake	No equivalent	Accelerated Transition to a Low Emissions Future
PADR Marinus Link timing	2030 & 2032	2030 & 2032	2028 & 2030	Not analysed	2028 & 2030

1. No ISP and Marinus Link PADR scenarios are exactly equivalent, however there is general alignment between the ISP scenarios and those developed for the Marinus Link PADR.
2. Draft ISP recommends only a single cable of 750 MW.

Progressing Marinus to 'Shovel ready' status is critical

- Considering the uncertainty associated with evolution of NEM, maintaining current project momentum is vital
- Funding to D&A stage enables Marinus Link to achieve Final Investment Decision (FID) in mid 2020s, with the option to complete construction in late 2020s
- Up to the FID, a decision can be taken regarding commissioning of the second link based on more information



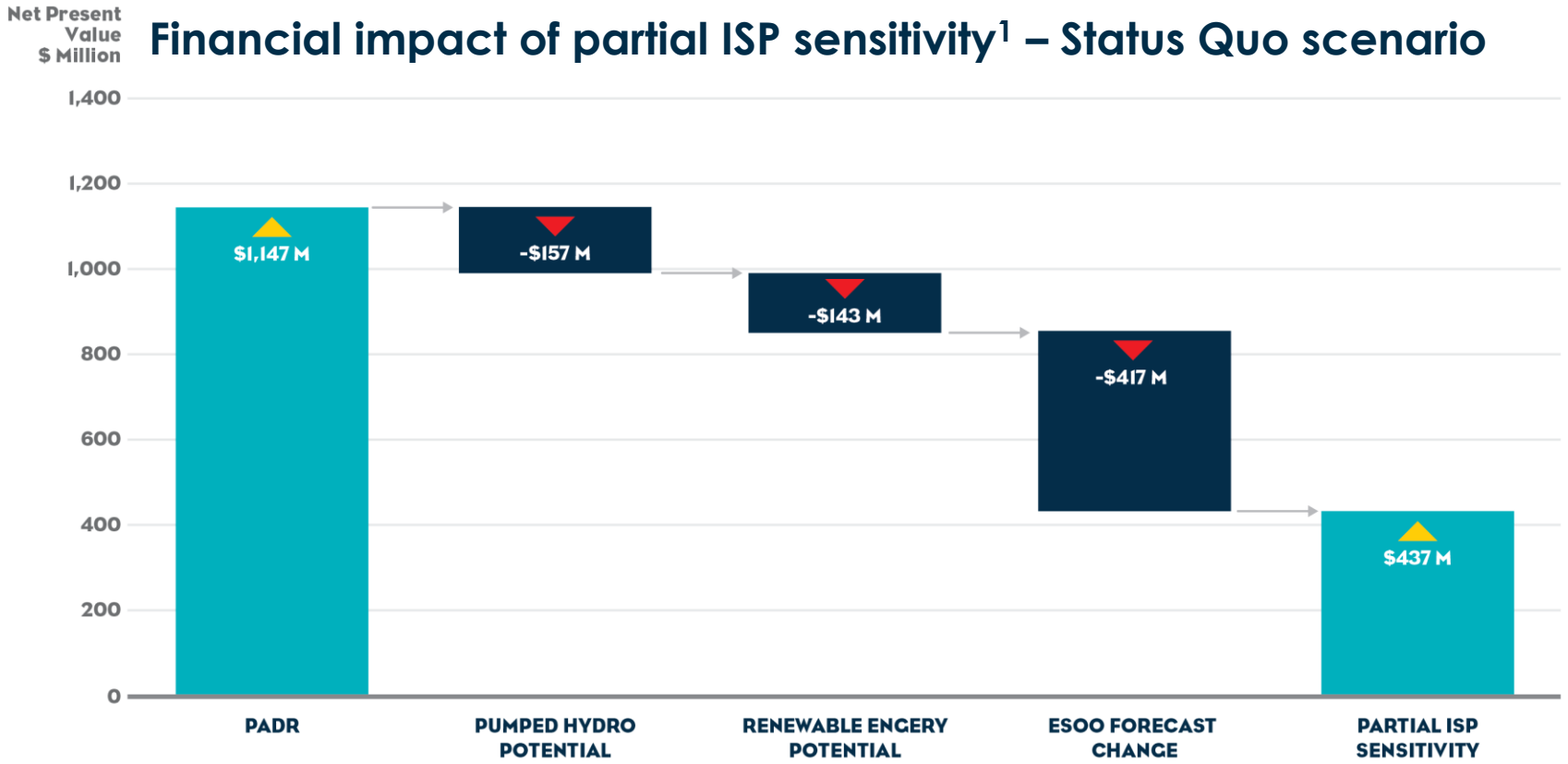
"We could be in Step Change Scenario but just don't know it!"

Alignment with Final 2020 Integrated System Plan (ISP)

- TasNetworks submission to Draft 2020 ISP will highlight the resilience benefits and overall value proposition of Marinus Link.
- Publication of PACR will be delayed until after release of Final 2020 ISP.
- TasNetworks will consider implications of 2020 ISP findings :
  - Supplementary market modelling report may be released with the ISP inputs and assumptions taken into account, with a further round of consultation.

Financial impact of key September assumptions

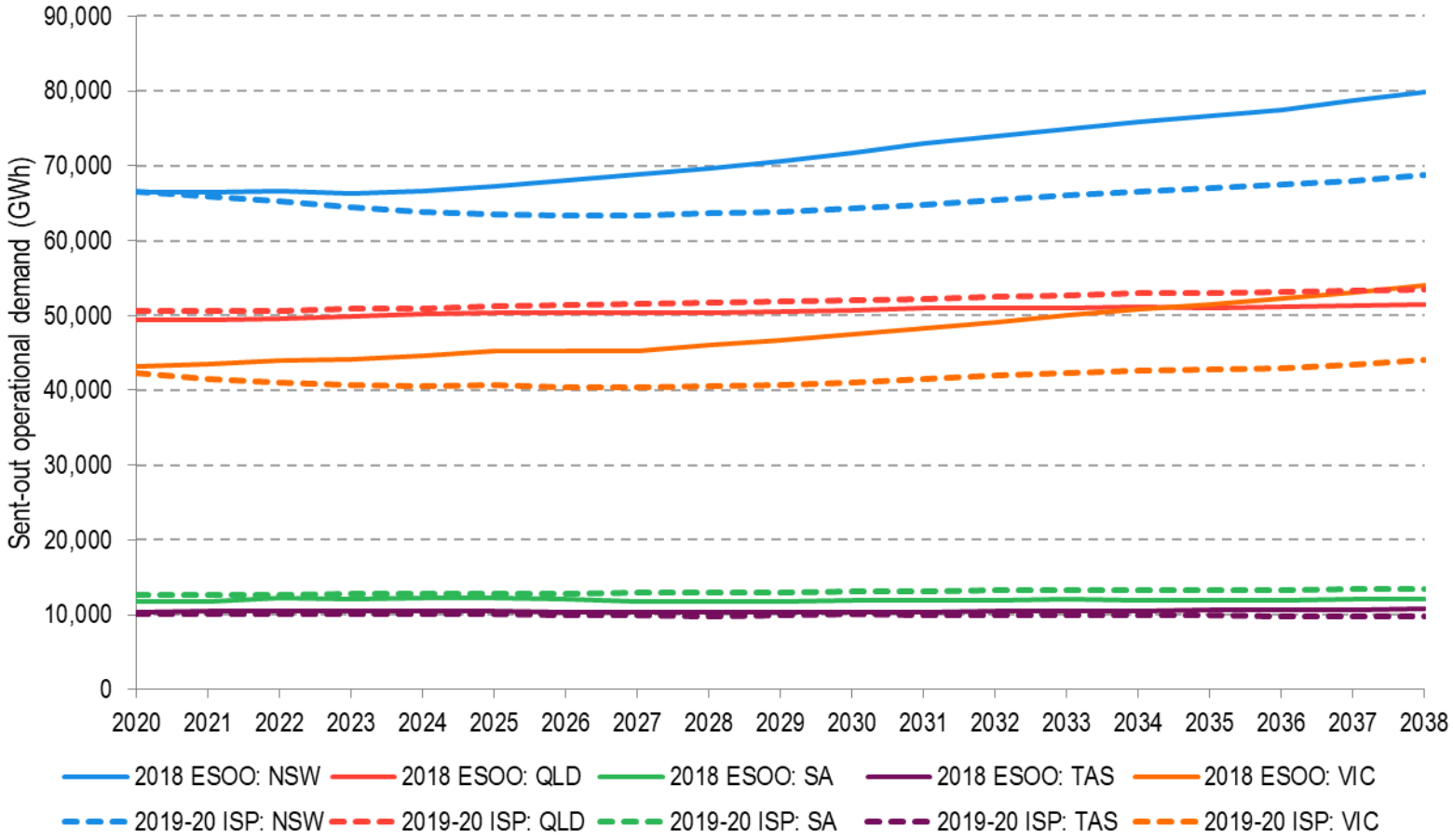
- PADR based on February assumptions; Draft ISP based on September update
- On a scenario weighted basis, net market benefits will still be significant



1. Sensitivity analysis undertaken in Marinus Link PADR, published December 2019

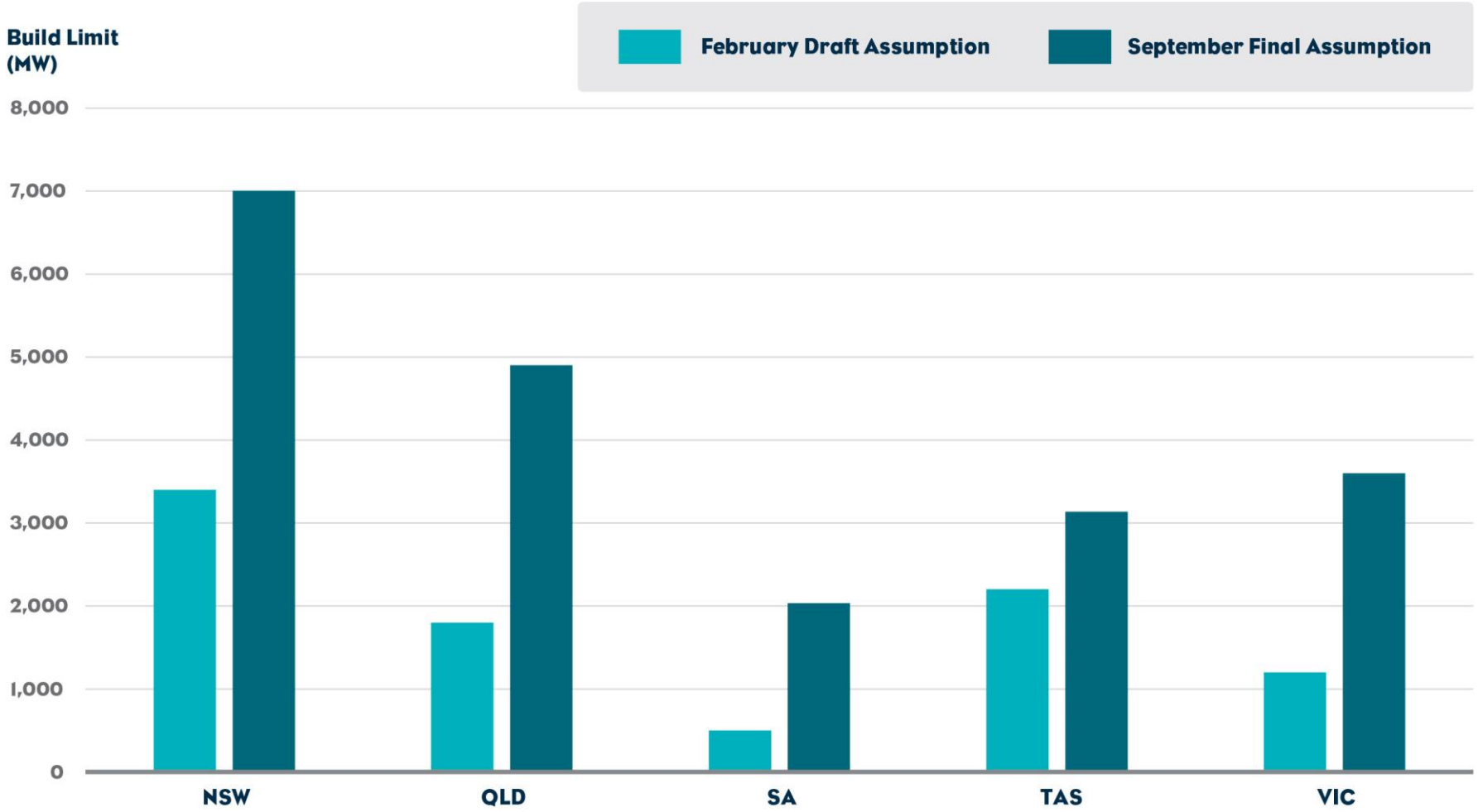
Significant reduction in Victorian and NSW demand

2018 and 2019 ESOO Forecast



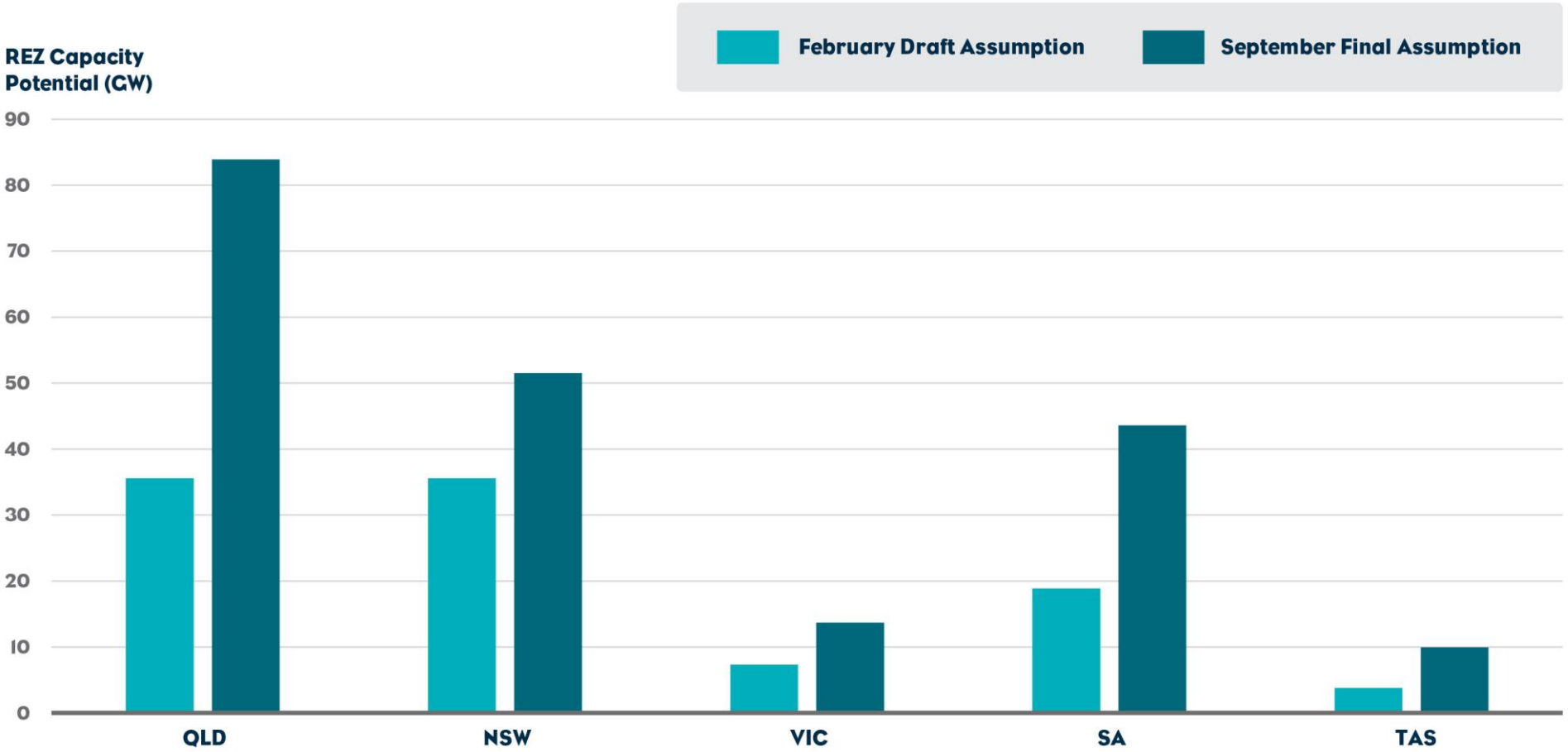
60% increase in pumped hydro capability

Pumped Hydro Potential in NEM (MW)



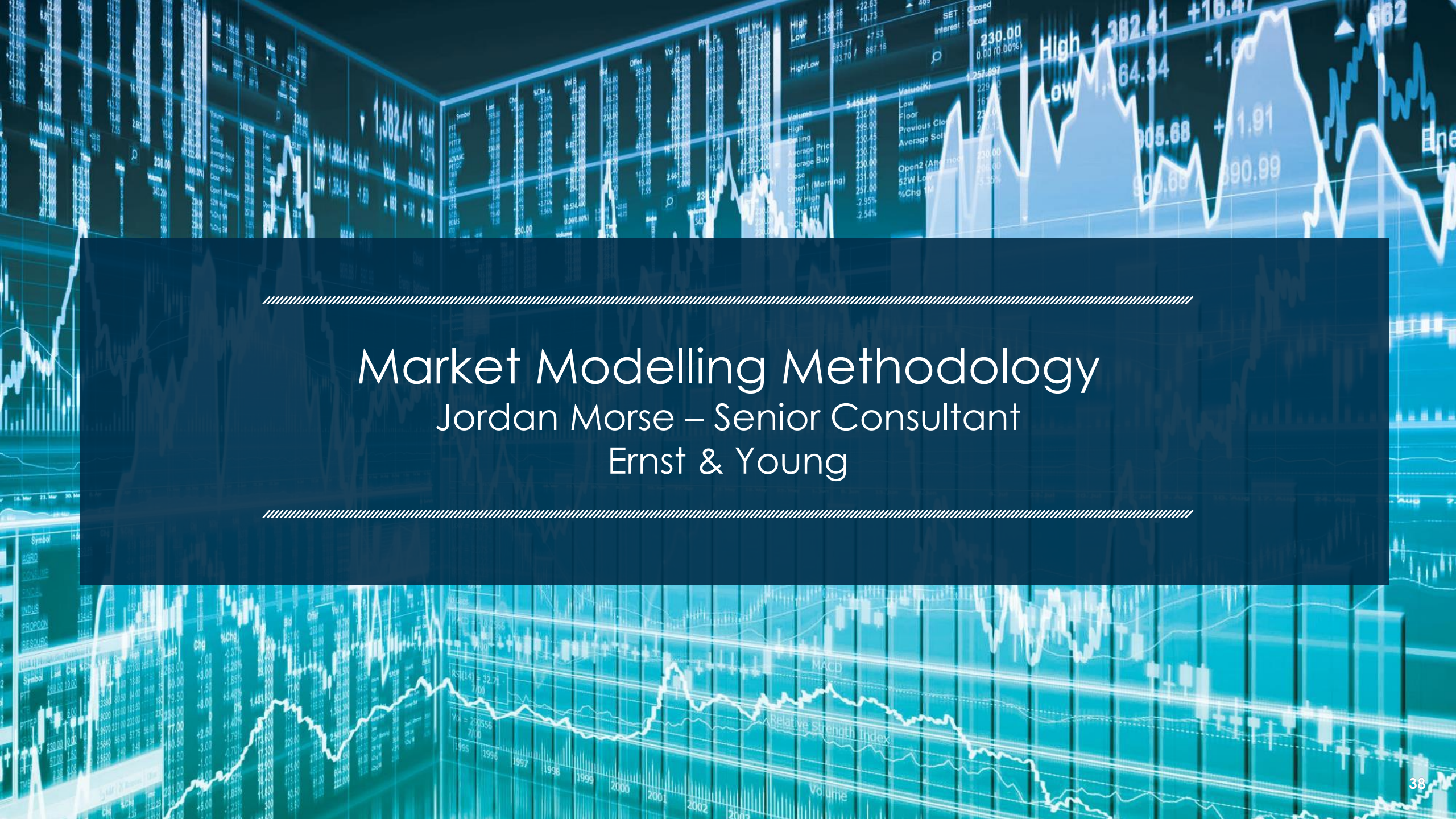
100% increase in REZ capacity + revisions in capacity factors

Expansion in Renewable Energy Zone capacity (GW)



In summary

- Market benefits are robust to assumptions update since Marinus Link unlocks:
  - Value from the existing Tasmanian hydro schemes
  - Premier REZs in the NEM
  - Ability to absorb excess mainland Australia renewable energy
  - Access to most cost effective pumped hydro sites in the NEM
- Alignment with Final 2020 ISP
- Submissions to PADR will be considered as input to next stage of our investigation
- ***Hourly simulation data available for download upon request***

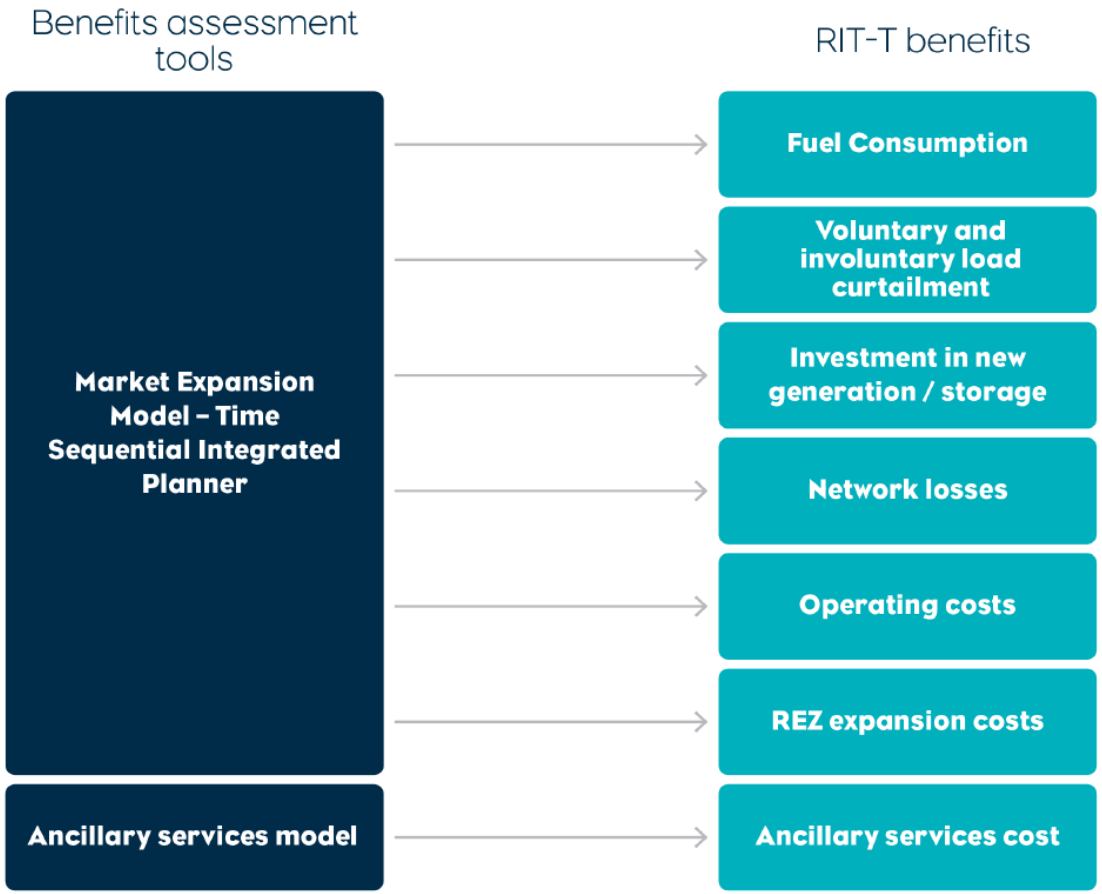


Market Modelling Methodology

Jordan Morse – Senior Consultant
Ernst & Young

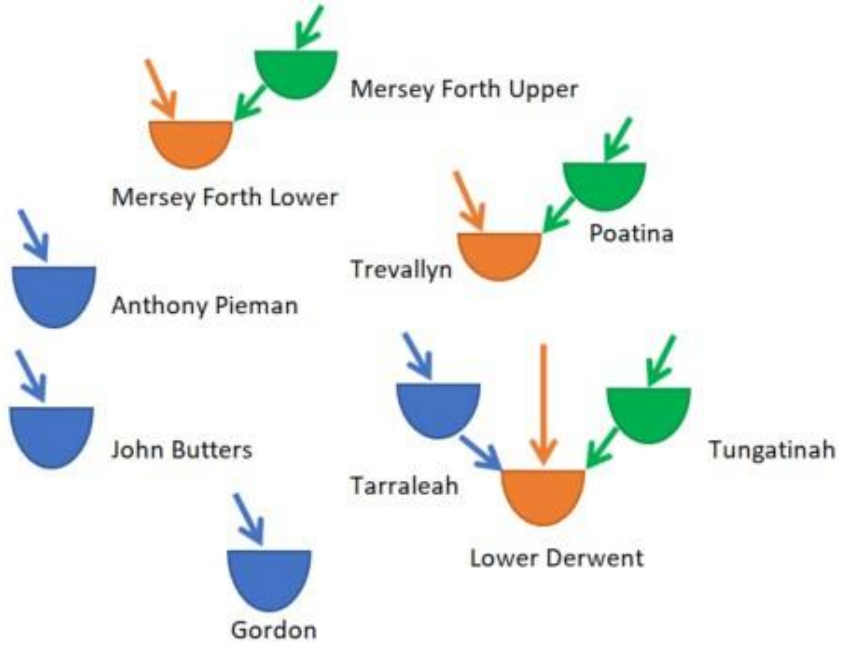
Modelling Overview

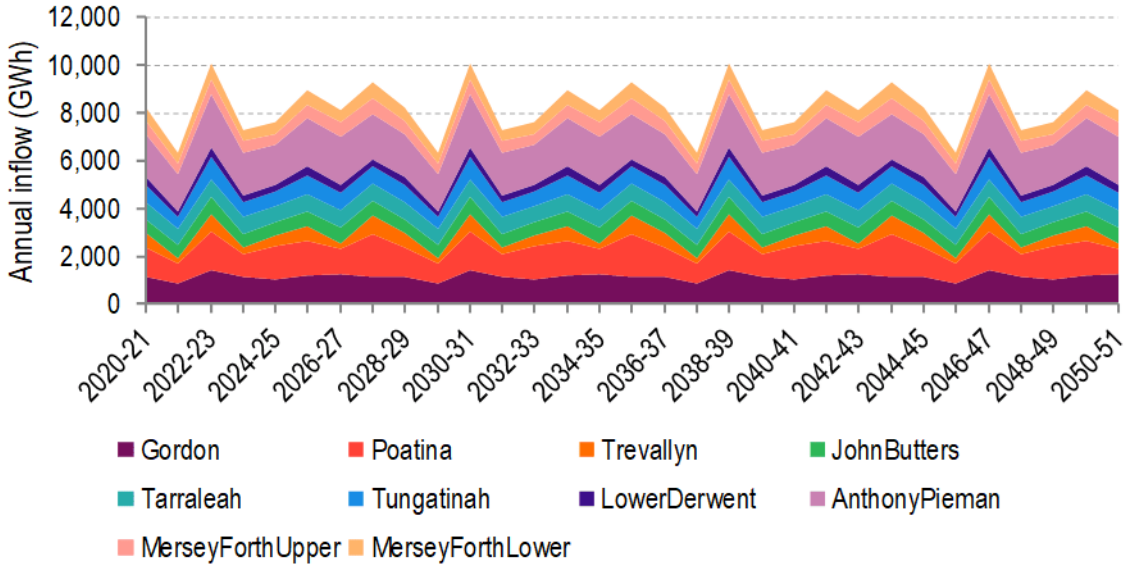
- Least-cost NEM generator expansion model in accordance with AER RIT-T guidelines
- Modelling conducted at hourly time-sequential granularity utilising a least-cost planning model that solves dispatch intervals for 30 years (FY2020-21 – FY2049-50) simultaneously.
- Least cost solution minimises cost of supply to meet demand and other constraints
  - Generation of each plant and charging and discharging of storage.
  - Commissioning new plant installed 'linearly'.
  - Retiring existing plant to reduce FOM, fuel cost and VOM.
  - Other constraints include minimum loads, generator availability, emissions constraints etc.
- Model utilises 8 year historical trace for hydro inflows, wind and solar availability and demand shape. This trace includes concurrent wind and hydro drought years.
- 10 pond hydrological model developed for Tasmanian hydro scheme.
- General alignment with AEMO Planning and Forecasting Consultation (Feb 2019).
- Inertia constraint modelling for transitioning NEM.
- Minimum reserve level constraint is modelled ensuring N-1 contingency is met in each region either with excess regional generation capacity or interconnector capacity.



Tasmanian hydro model

- 10 ponds in 6 cascades
- Annual hourly inflows from 8 historical year modelled.
- Inflows are inclusive of historical spill and spill from all ponds determined by model based on economics
- Small and non-scheduled generators optimised by model (inflow data included these generators, and historical operational demand adjusted appropriately)
- Whole-of-system reservoir volume minimums imposed monthly
  - 10% decrease in these minimums with Marinus Link entry
- Gordon capacity is dependent on reservoir level
- 250 MW upgrades with Marinus Link
- The least-cost planning model determines generation profiles that optimise water use subject to inflows, storage minimums and maximums
  - Shifting a MWh from one hour to another would increase the system cost across 30 years.





Modelling – With and Without Marinus Link

- Besides undertaking resource planting trajectory in a with and without Marinus Link case, we also introduce following factors in the with and without Marinus Link scenarios.

	Without Marinus Link	With Marinus Link	Computation method
Hydro Tas capacity upgrades	Units repurposed for efficiency	250 MW of additional capacity with Tarraleah and West Coast repurposed.	EY market modelling all scenarios & sensitivities
Prudent (minimum) storage levels for Tasmanian hydro. Enforced monthly.	Min 29.2% 1 June Max 39.5% 1 Nov	10% decrease with Marinus Link commissioning	EY market modelling all scenarios & sensitivities
FCAS	Separate mainland and Tasmanian FCAS markets	Enables global FCAS markets	GHD FCAS analysis

Reflections on Electranet RIT-T determination

Approval of SAET PACR validates market consensus that interconnection is likely to play a critical role in a transitioning NEM. AER determination and accompanying RIT-T assessment by Frontier Economics provide valuable learnings for Marinus Link RIT-T.

Already captured in Marinus Link PADR modelling:

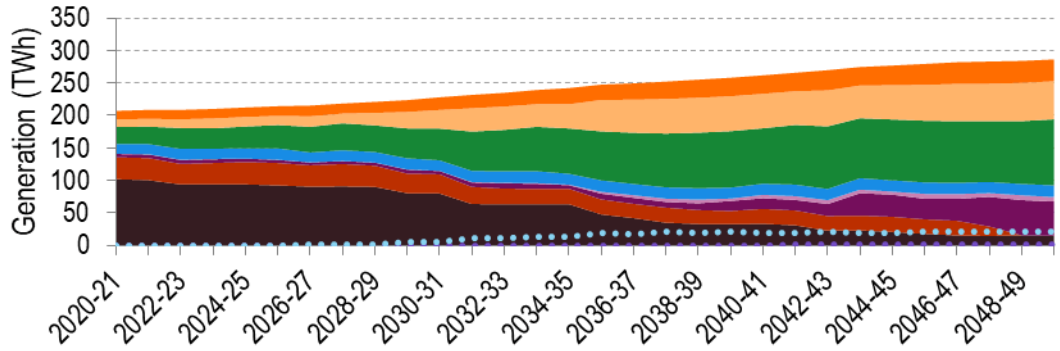
- Generator retirement are endogenous decisions driven by market economics
- Inertia constraints applied to Tasmania to ensure the forecast power system is technically feasible
- Long-term (**LT**) capacity expansion and short-term (**ST**) simulation undertaken in a single step to ensure good connection between LT and ST models.
- Retained the correlation between underlying demand and renewable output
- Reason for load reduction in Global Slowdown scenario is adequately justified.

Improvements for future modelling:

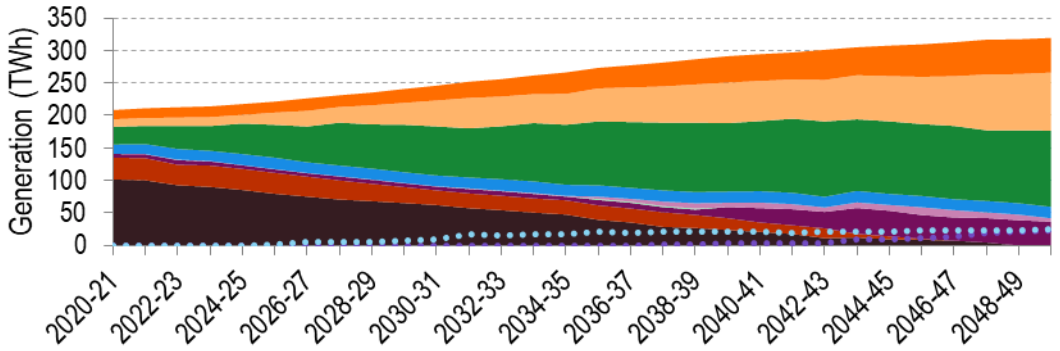
- Undertake additional modelling to reflect netback prices for NSW and QLD coal generators exposed to export exposed mines.
- TasNetworks is currently not imposing start up costs for gas and coal generators. We are aiming to asses the impact of cycling. Given ACIL Allen estimates are from 2014-15, TasNetworks are looking at engaging external consultants.

Scenario outcomes without Marinus Link - generation

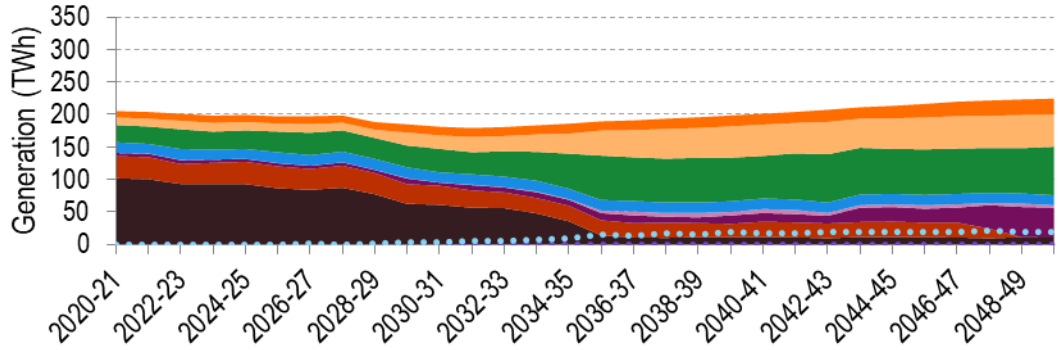
Status Quo



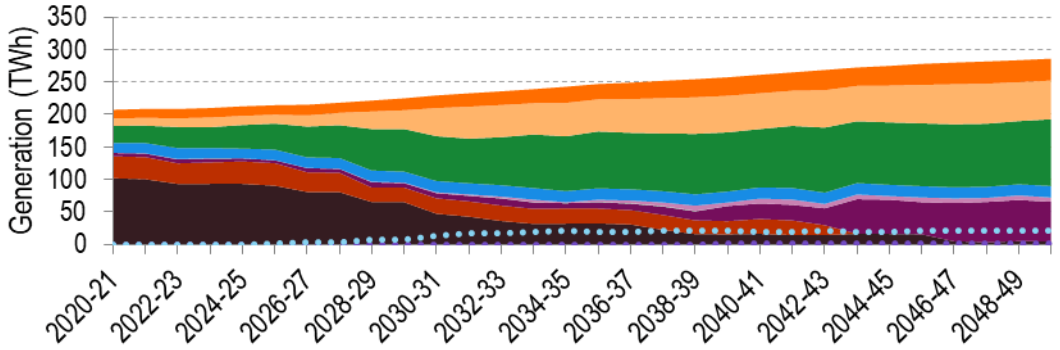
Accelerated Transition



Global Slowdown



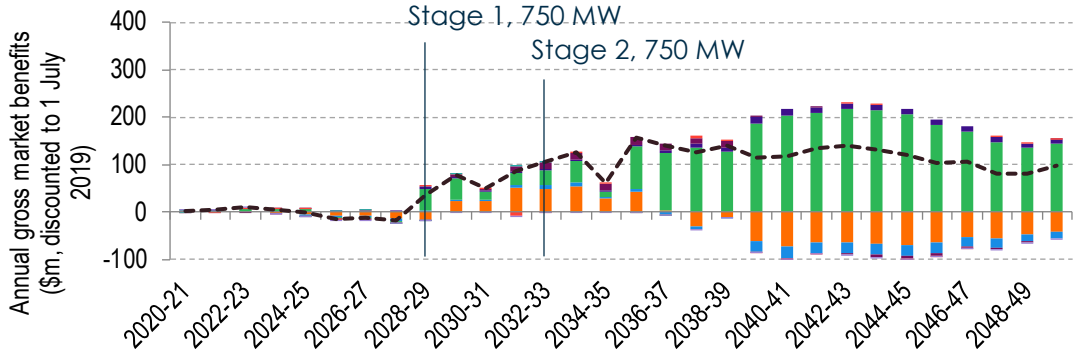
Sustained Renewables Uptake



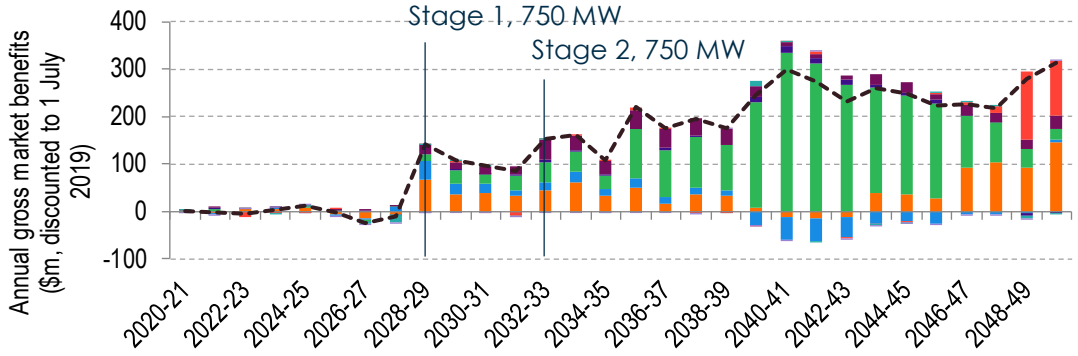
Black Coal
Brown Coal
CCGT
Gas - Steam
OCGT / Diesel
Hydro
Wind
Solar PV
Rooftop PV
LS Battery
PSH

What are the benefits?
Annualised[1] gross market benefits($m) for preferred option[2]

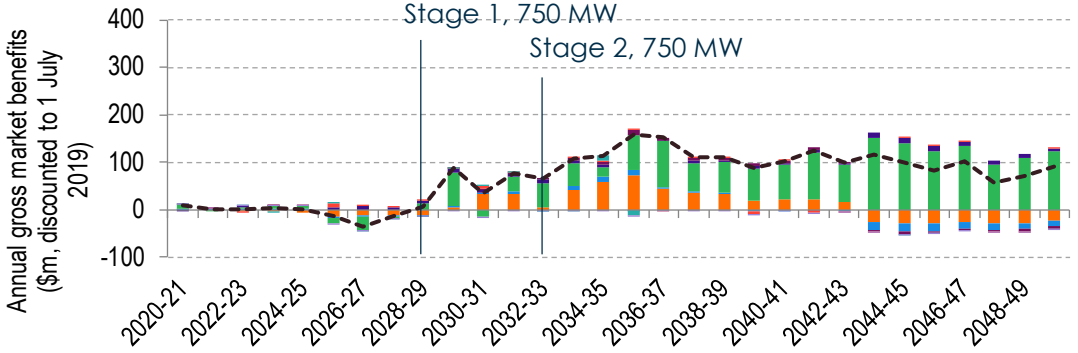
Status Quo



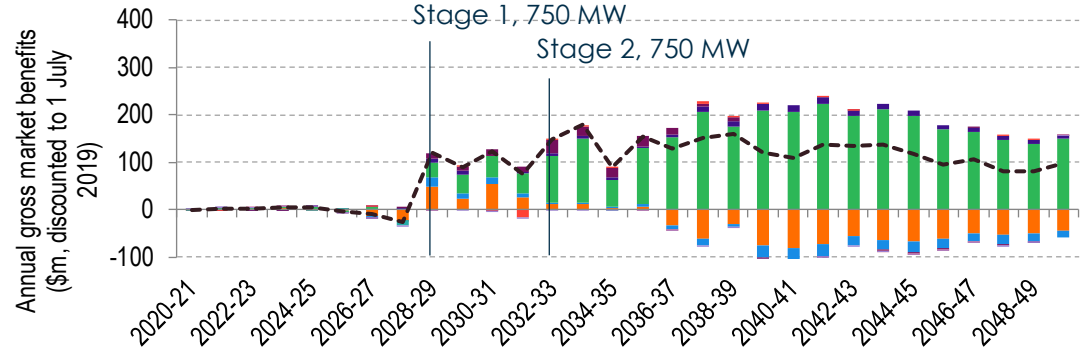
Accelerated Transition



Global Slowdown



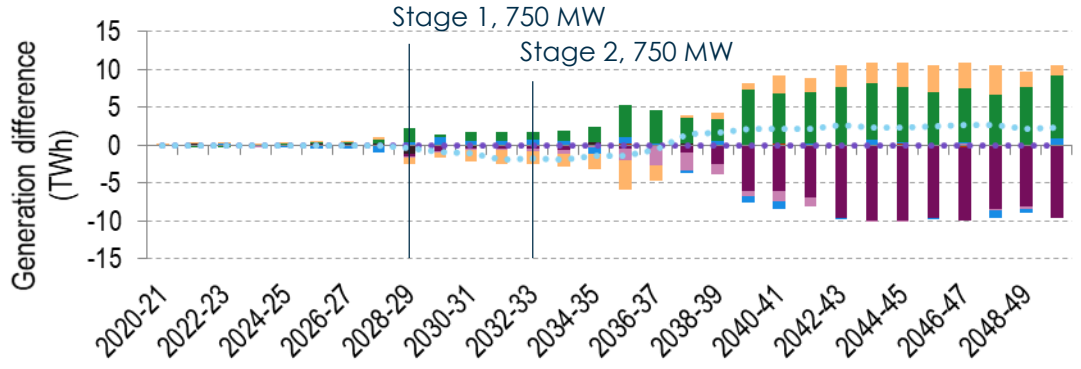
Sustained Renewables Uptake



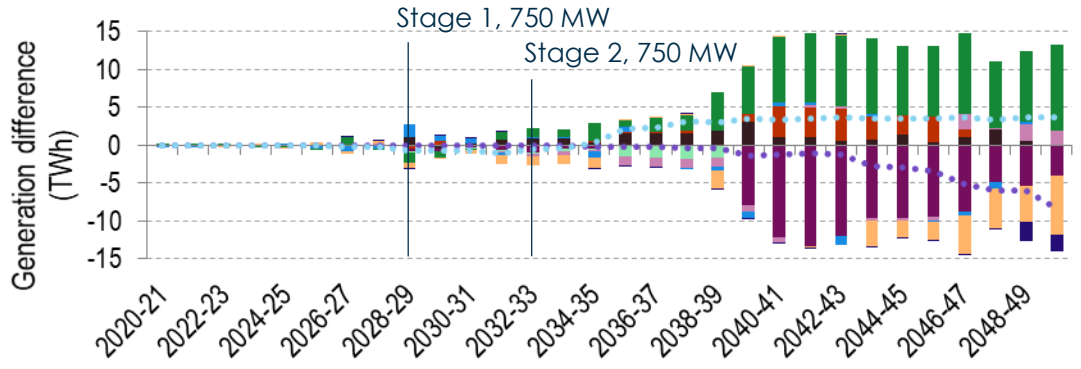
1. Capex and FOM is annualised over the lifetime of each project, as opposed to displaying these costs at a single point in time.
2. The preferred option as identified in the PADR is the 1,500 MW Marinus Link with Stage 1 commissioned in 1/7/2028 and Stage 2 in 1/7/2032.

What drives benefits?
Generation difference between preferred option[1] and Base Case

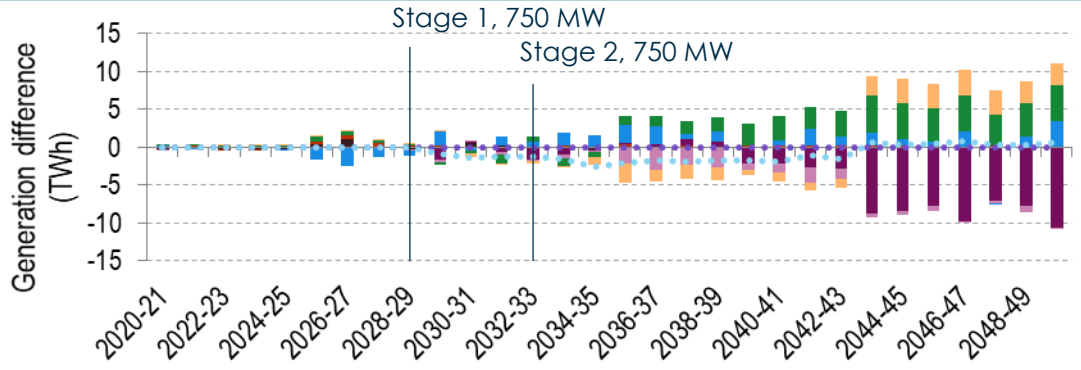
Status Quo



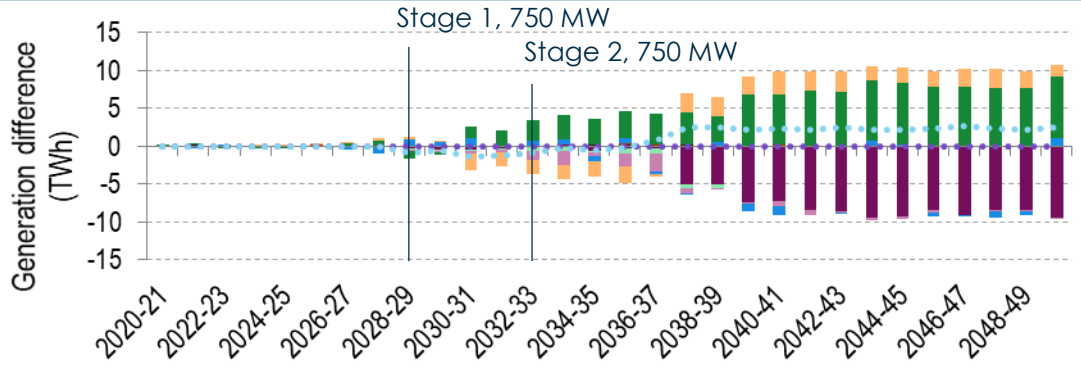
Accelerated Transition



Global Slowdown



Sustained Renewables Uptake



1. The preferred option as identified in the PADR is the 1,500 MW Marinus Link with Stage 1 commissioned in 1/7/2028 and Stage 2 in 1/7/2032.

Two modes of operation of Marinus Link

Lowering cost of energy supply on the mainland

- Importing variable renewable energy (solar PV and wind) from mainland to Tasmania at times of surplus generation and withholding Tasmanian hydro generation for use at times of higher value and/or pumping. Flow reverses daily to fill gaps in mainland variable supply in the mornings, evenings and overnight. In this operating mode, Marinus Link is acting to firm mainland states' variable renewable energy sources.
- Transmission losses across Bass Strait are smaller than cyclic losses of battery and pumped hydro storage.

Lowering cost of capacity supply on the mainland

- Exporting Tasmanian generation (wind and hydro) to support mainland regions (principally Victoria and New South Wales) during supply shortfalls. In this operating mode, Marinus Link is acting to provide a supply of low-cost energy to the mainland, displacing relatively high cost existing and new gas-fired generation capacity.

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RIT-T PADR Industry Forums

15 minute break for refreshments

AEMO's Draft 2020 Integrated System Plan

Project Marinus PADR industry forum
2 March 2020

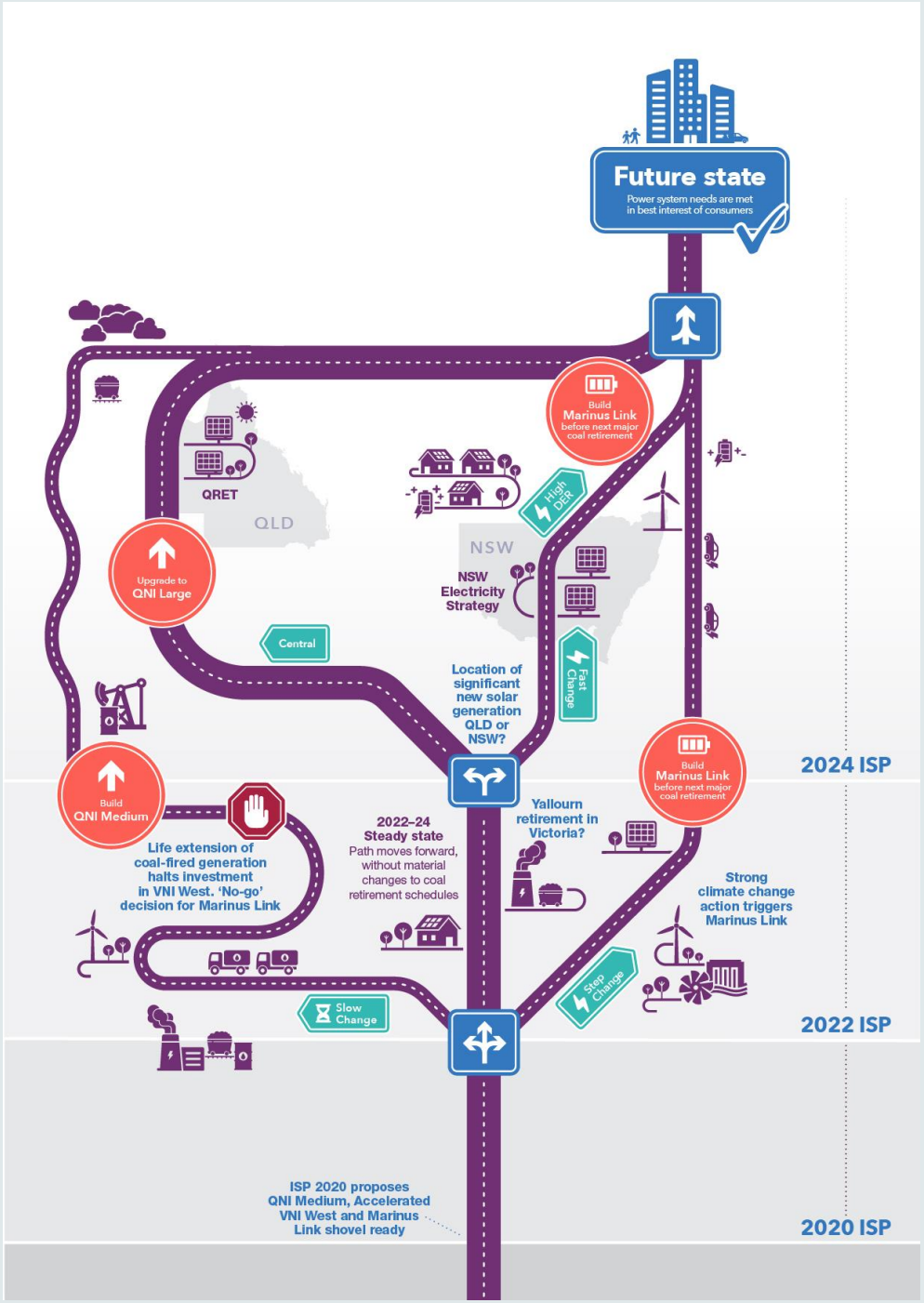
The Integrated System Plan (ISP)

Designing the power system of the future that delivers reliable and secure supply at lowest cost to consumers, while meeting policy objectives

- The ISP is a **whole-of-system plan** for the NEM that helps inform decision makers about future policy, investment and regulatory/market reform

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

The recommended actionable ISP is one that delivers positive net market benefits while retaining flexibility, resulting in a dynamic roadmap that deals with uncertainty and takes a whole-of-system view.



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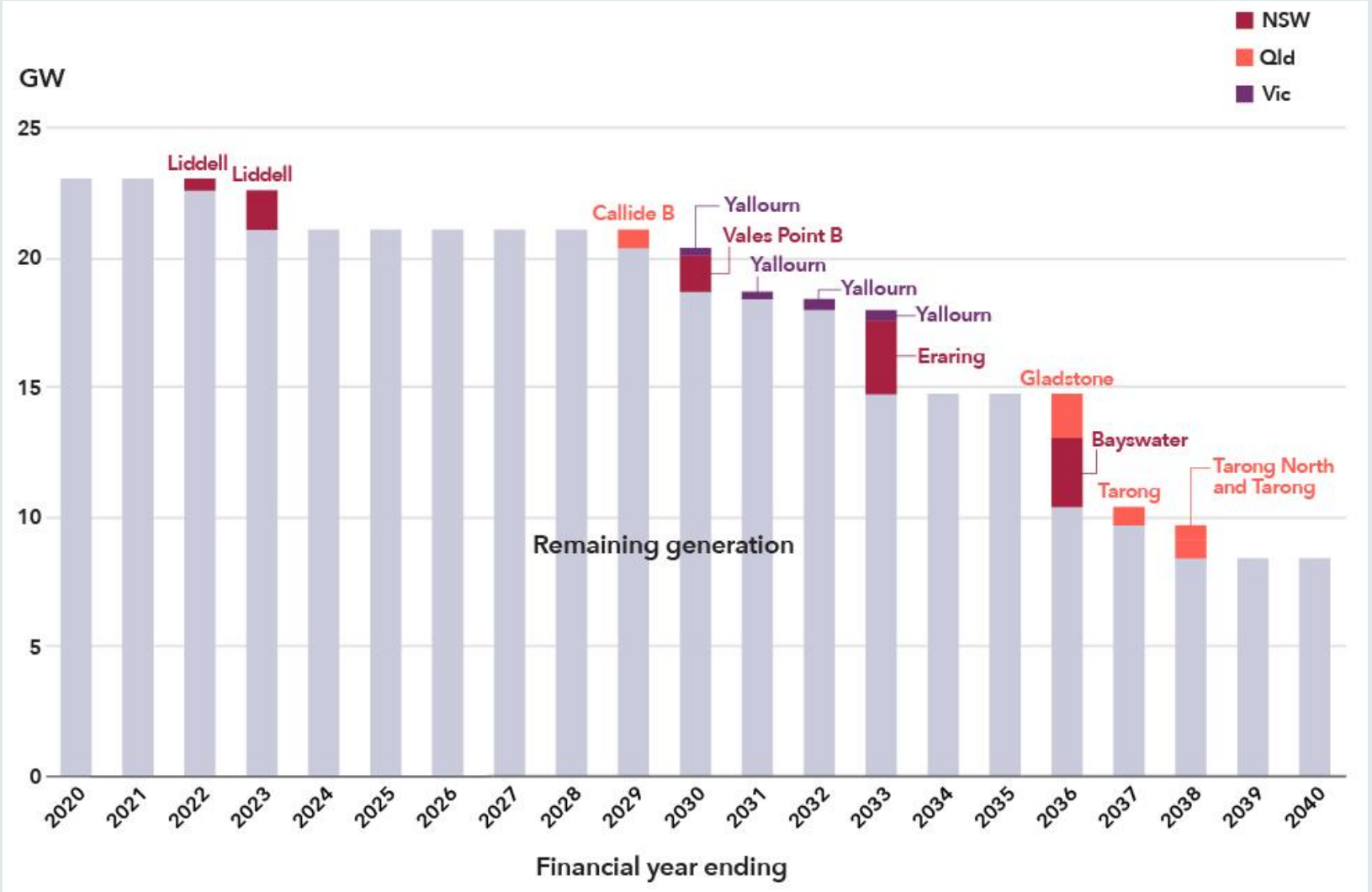
Key themes - replacement of retiring thermal generation and delivering policy

- Approximately 15GW or 63% of Australia's coal fired generation is set to retire by 2040.



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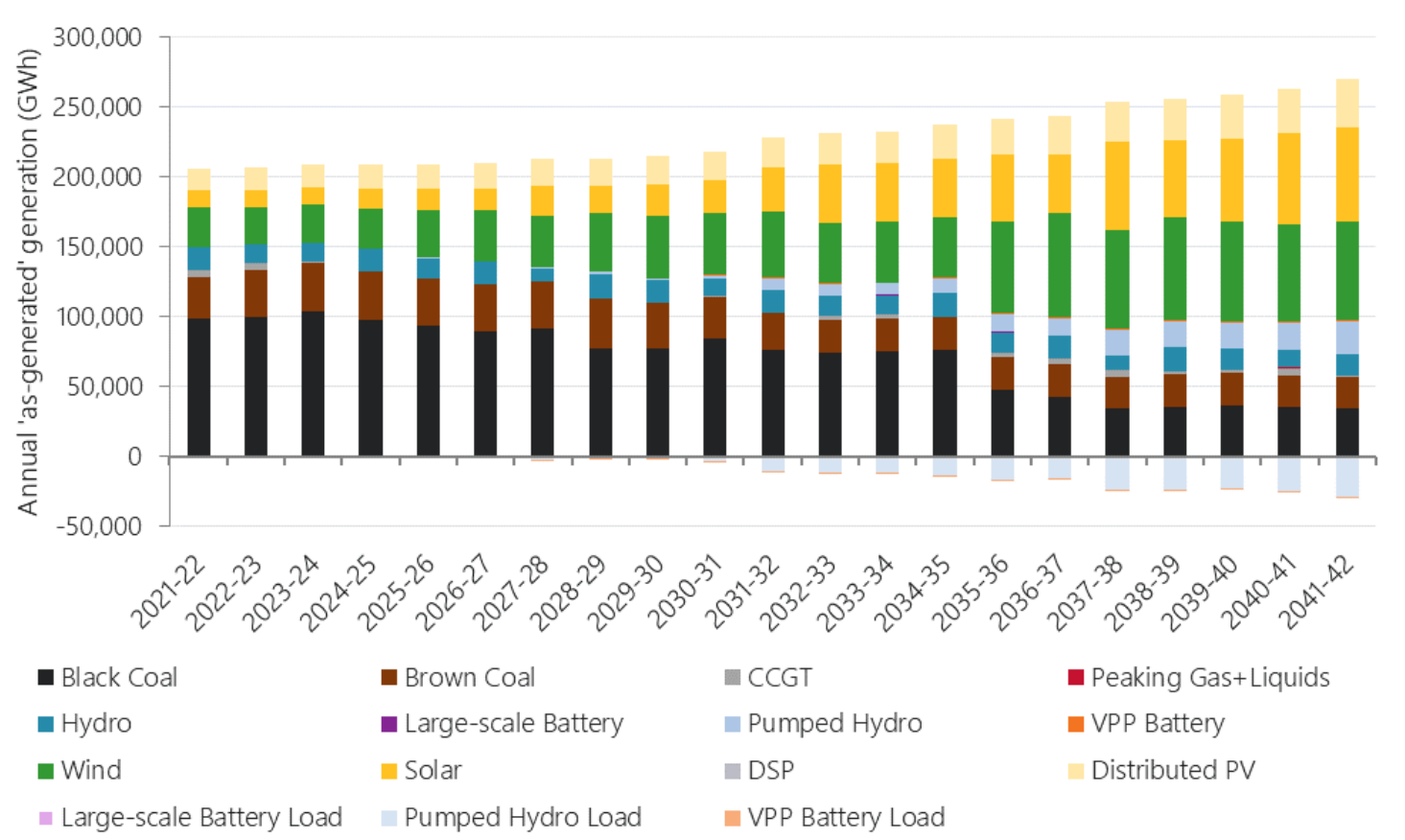
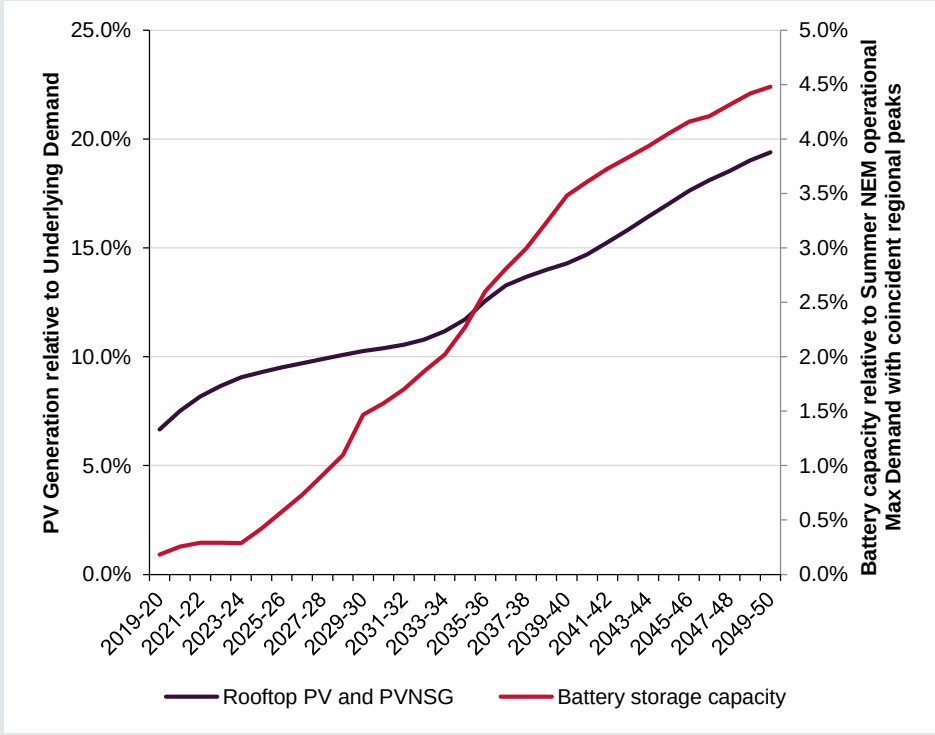
ISP central expansion plan



Distributed Energy Resources outlook:



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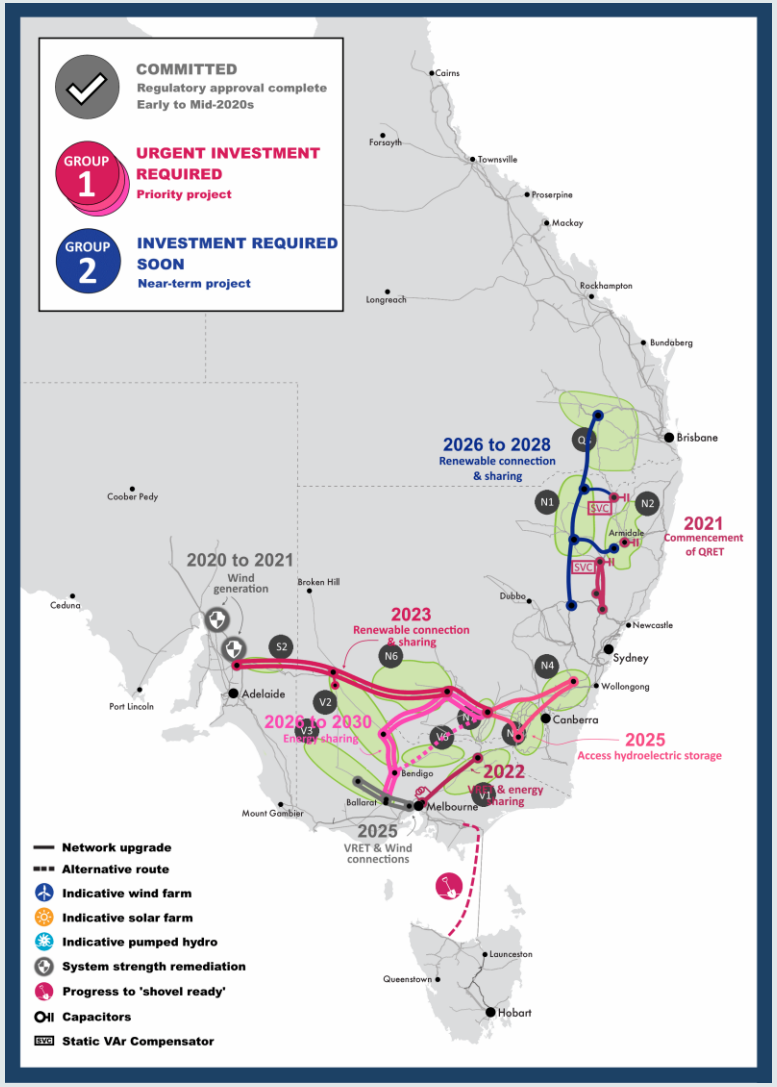
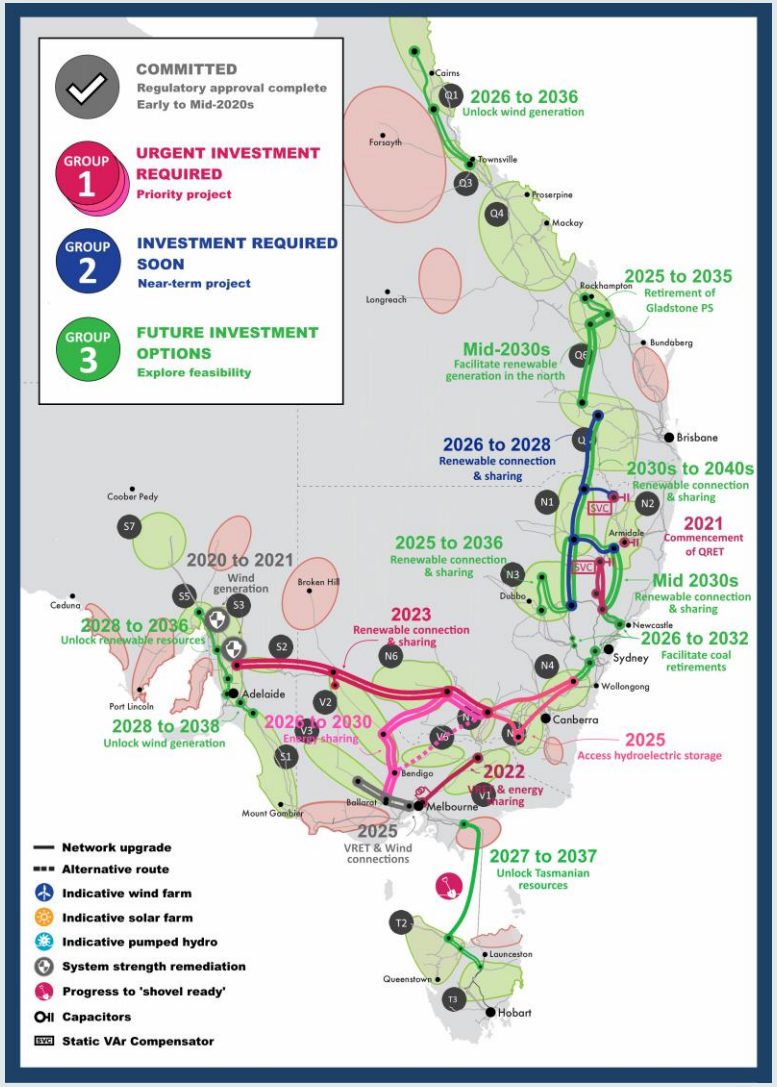
Draft ISP Development Path





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Progressing Marinus Link to become 'shovel ready'

- Marinus Link was recommended to continue to progress design and approvals to make the project 'shovel ready', while deferring final decisions until delivery signposts were clearer
- The identified need for Marinus Link is to:
  - Allow more efficient generation sharing between Tasmania and Victoria
  - Reduce generation dispatch costs
  - Reduce potential (voluntary and involuntary) load curtailment by improving reliability
    - In Tasmania the case of extended outage of Basslink
    - In the mainland following retirement of coal generators
  - Facilitate access to increased dispatchable generation and storage

Next steps

Consultation on Draft 2020 ISP closes on:

21/2 (network options)

13/3 (non-network options)

Finalise ISP by mid June

'Actioning the ISP' Rule Changes

Changes being developed by the ESB (and guidelines by AER) are to be in place prior to publishing the Final 2020 ISP

Renewable Integration Study:

Report published by end March 2020

Consultation April-May

ESCI near-term case studies:

The projected impact of extreme heat on VRE ratings in the Murray River REZ

The projected impact of bushfires on the line outage rates

The system impact of a coincident Adelaide, Melbourne, Hobart, Sydney heatwave

Interconnector Pricing Arrangements

Prateek Beri – Economic Team Leader
Project Marinus, TasNetworks

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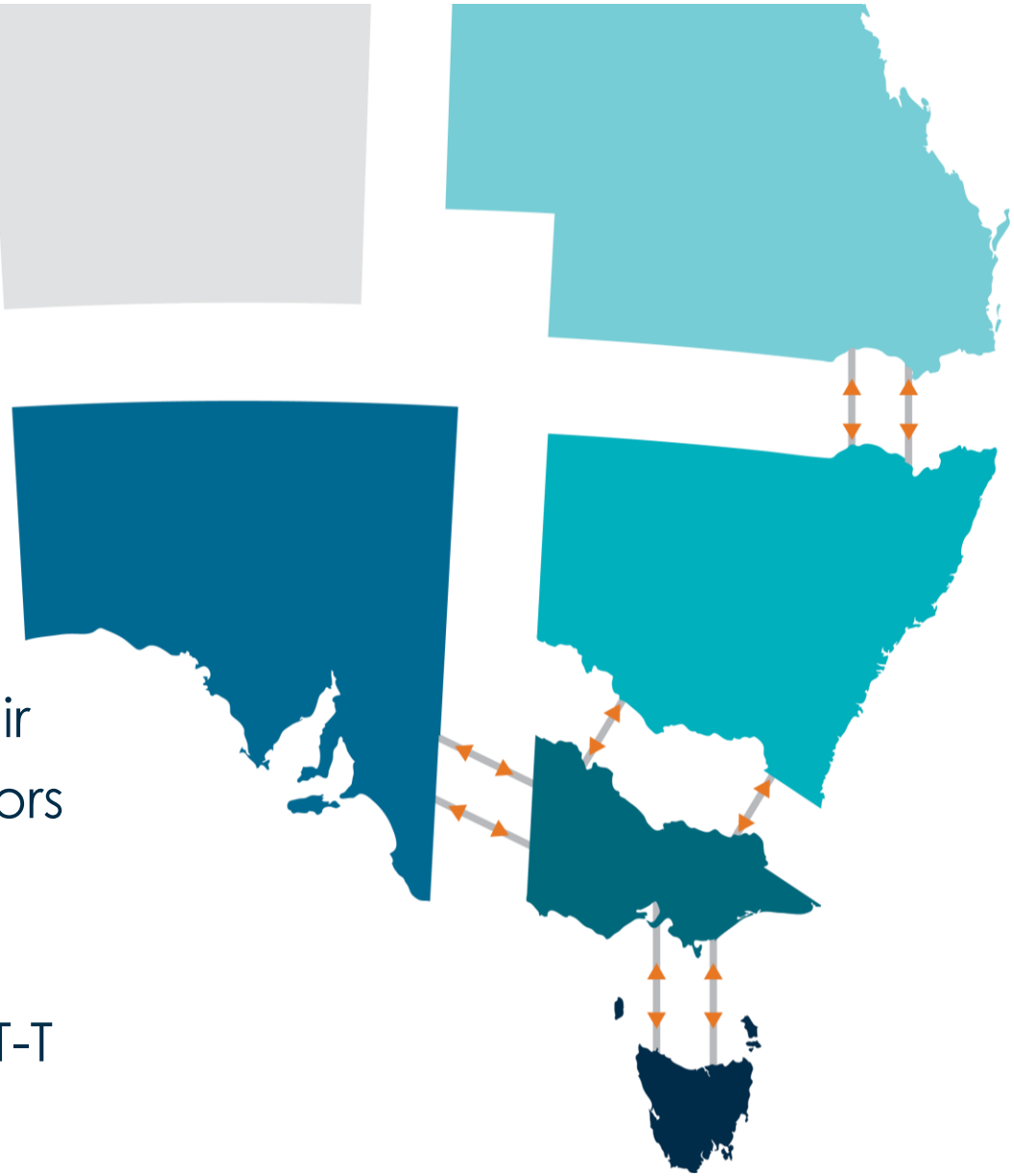
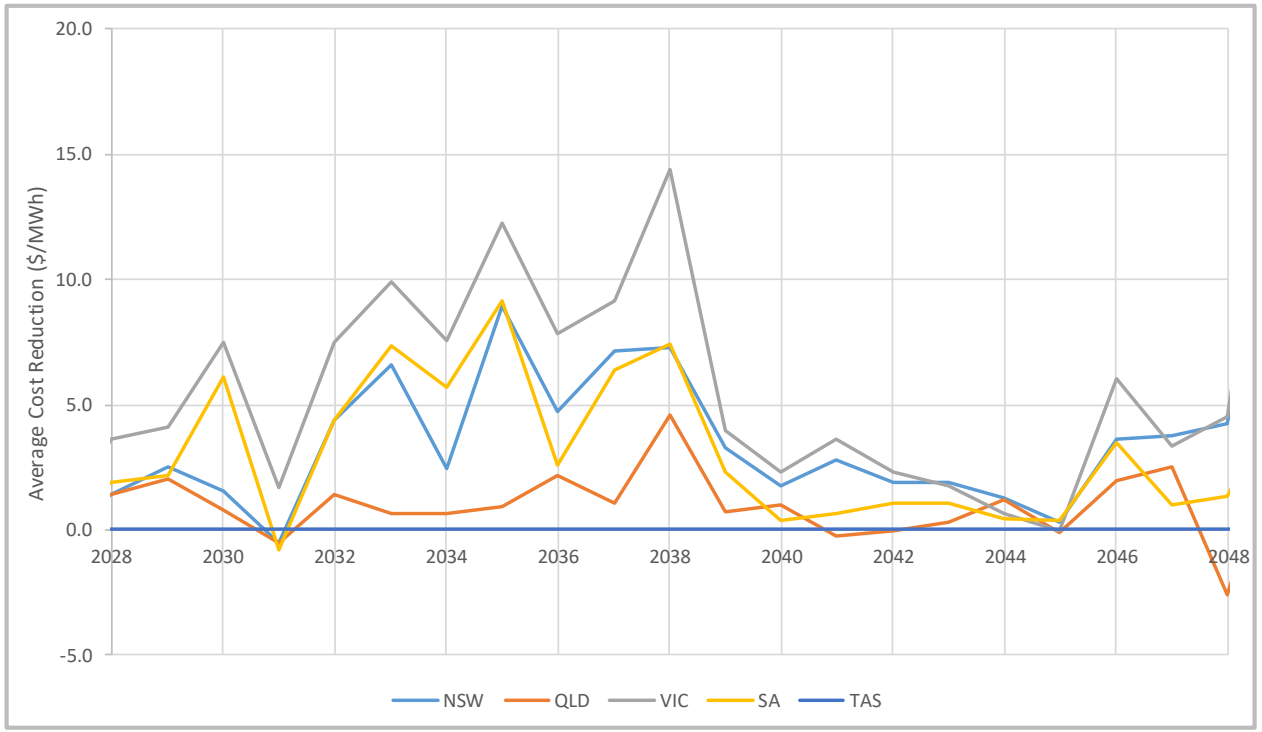
Working out who pays

- Benefits to the whole of the NEM
- Current pricing frameworks = only Vic and Tas customers pay
- Issue recognised by Council of Australian Governments (**COAG**) Energy Council; Energy Security Board (**ESB**) to provide advice on a fair cost allocation methodology for interconnectors
- TasNetworks will participate in this process
- TasNetworks discussion paper released with RIT-T

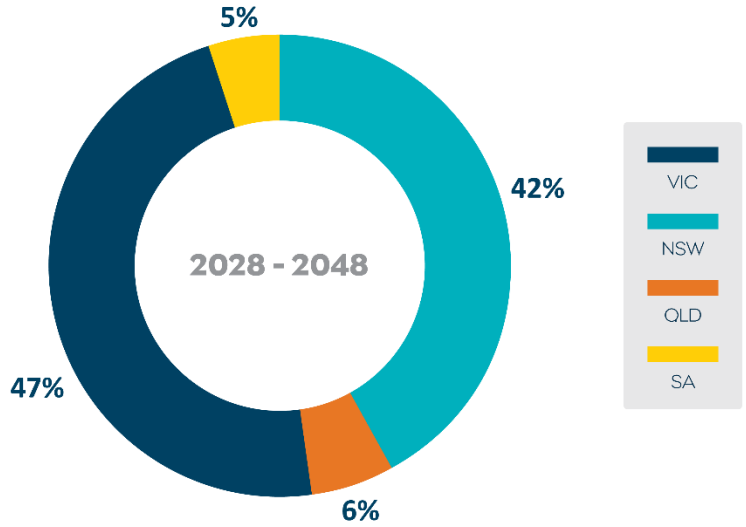


Allocation of benefits based on marginal cost of supply

Forecast annual reduction of marginal cost of supply



Regional distribution of benefits (2028-2048)



Source: Figure 18 & 19 of Marinus Link PADR. The benefits represent weighted average marginal cost of supply reductions across four scenarios.

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RIT-T PADR Industry Forum

Panel Discussion and Q&A

Chaired by Benjamin White, Head of Stakeholder Relations, Community, Environment and Planning

Bess Clark

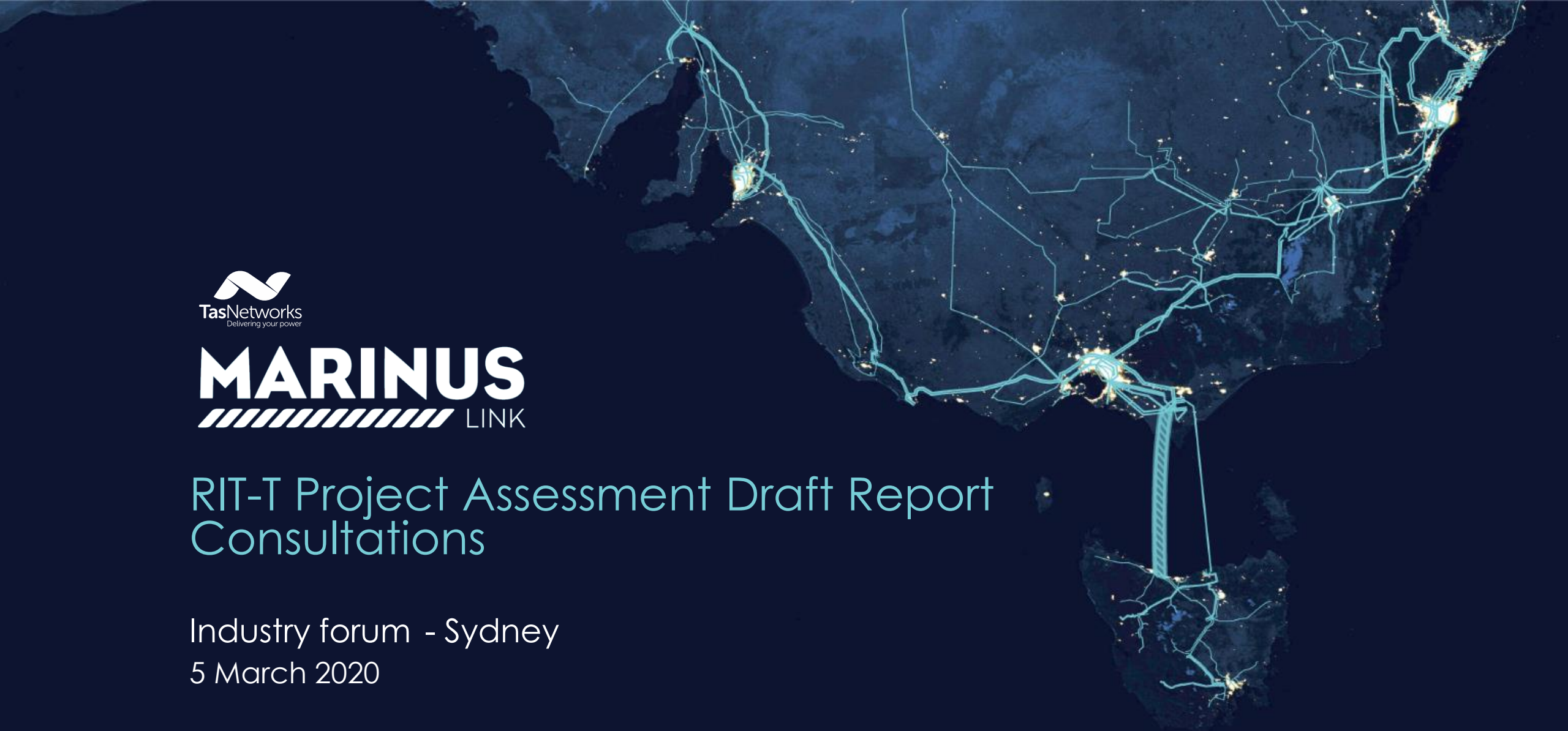
General Manager – Project Marinus, TasNetworks

Stephen Clark

Technical and Economic Leader – Project Marinus, TasNetworks

Jordan Morse

Senior Consultant - Ernst & Young



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RIT-T Project Assessment Draft Report Consultations

Industry forum - Sydney

5 March 2020