Locating Offshore Wind in Australia

University of Technology Sydney
Institute for Sustainable Futures

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International Context

1. Achieving the Paris Climate Agreement: The Role of Offshore Wind

One Earth Climate Model (OECM):

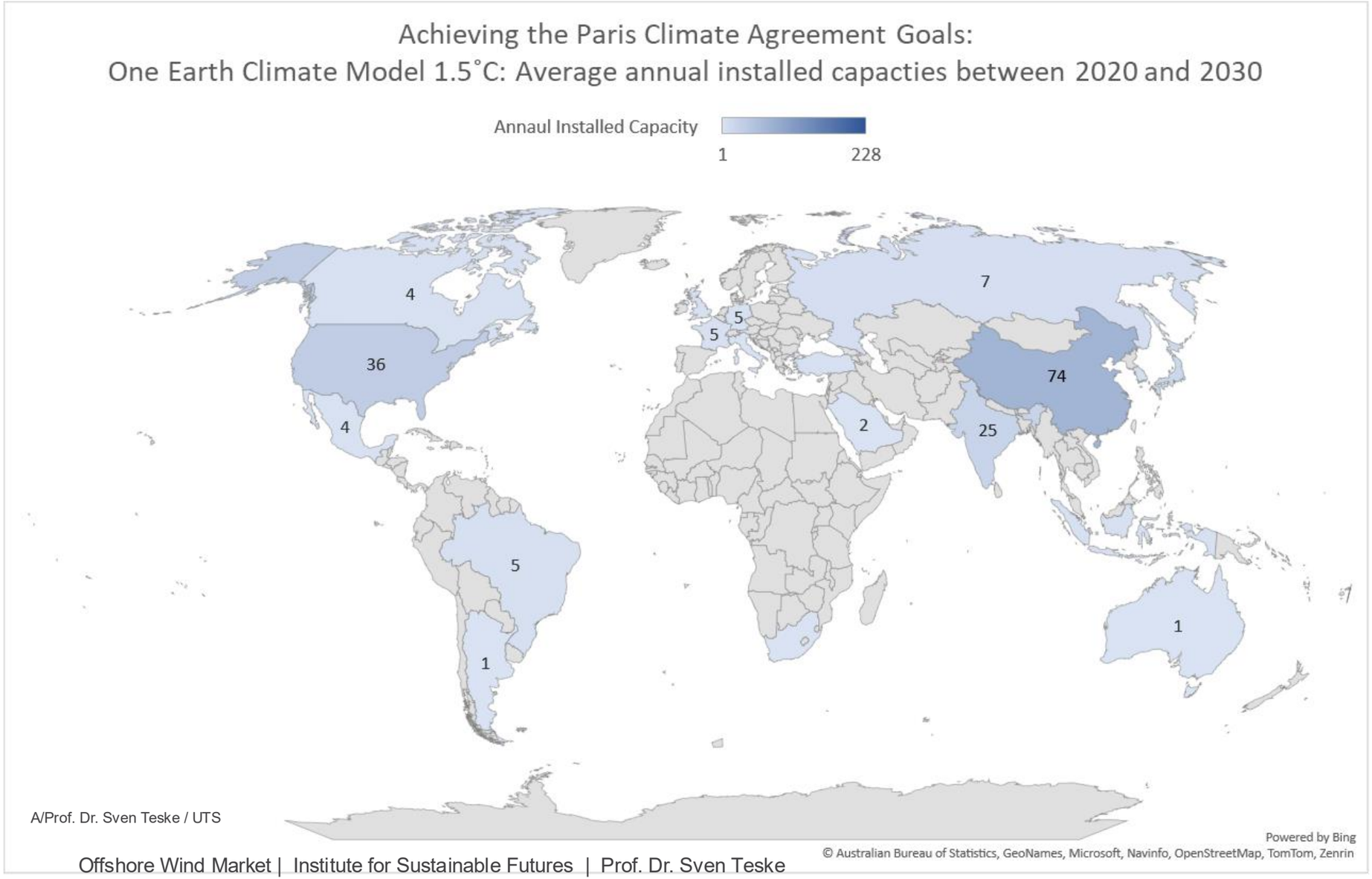
Analysis for G20 Countries

Global energy-related CO_2: < 450 $GtCO_2$ (2020 – 2050)

Offshore Wind Increases 100x until 2050

Region	Offshore Wind Capacities [GW]			
	2020	2024	2030	2050
Global	29	83	526	2,810
G20	44	96	652	2,887
Canada	0		8	52
USA	0		66	423
Mexico	0		28	63
Argentina	0		6	20
Brazil	0		20	73
EU-27	24	37	94	319
France	0	1	17	68
Germany	7	9	23	72
Italy	0	0.03	9	26
United Kingdom	11	16	24	65
Turkey	0		9	51
South Africa	0		8	23
Saudi Arabia	0		4	21
Russian Federation	0		20	89
India	0		89	339
China	10	44	203	945
South Korea	0	0.15	27	109
Japan	0	0.3	39	231
Indonesia	0		4	49
Australia	0		4	16

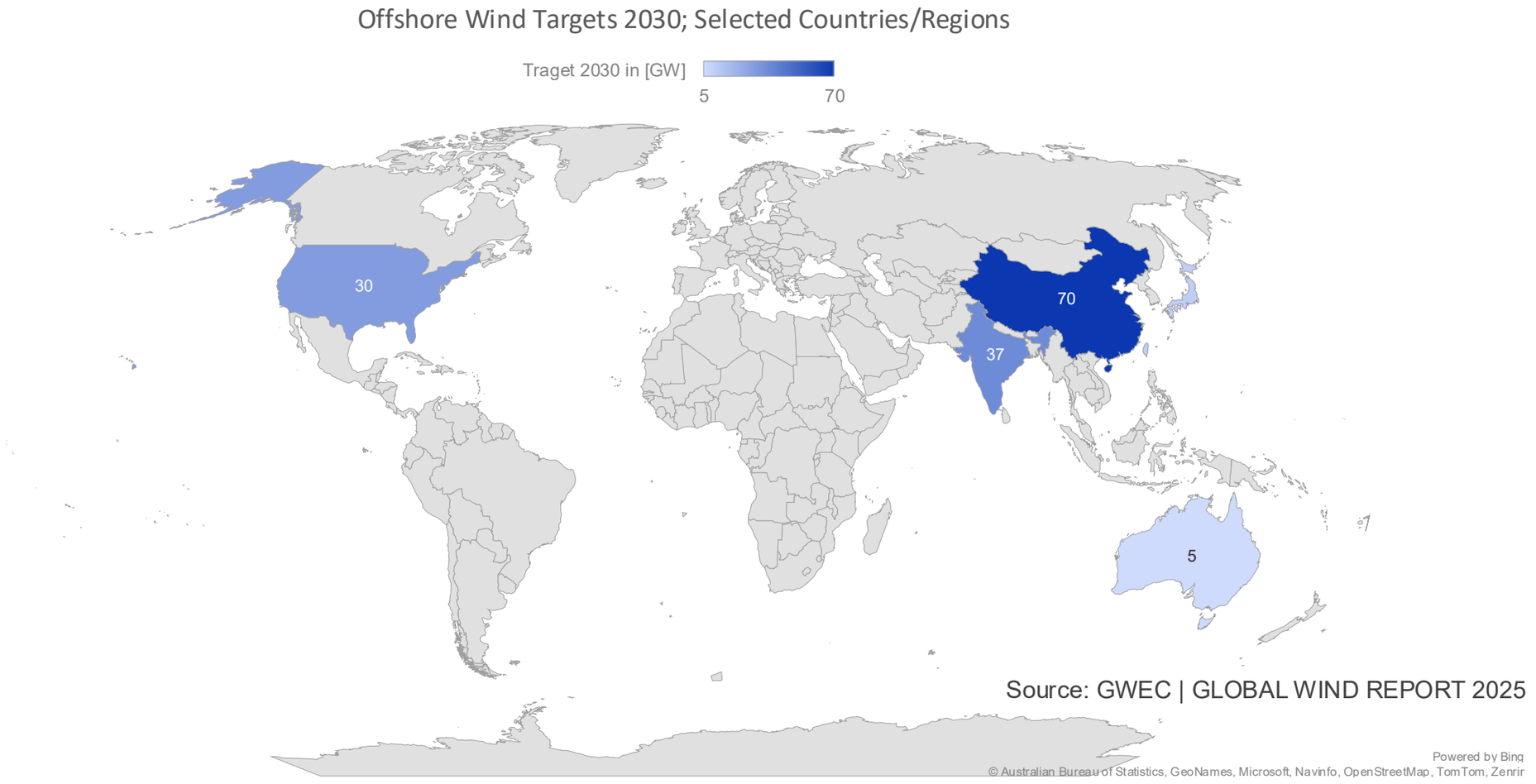
Achieving the Paris Climate Agreement: The Role of Offshore Wind



2. International Targets for Offshore Wind

Global Offshore Wind Capacity in 2024: 83 GW

Estimation for additional capacity 2025 - 2034: 350 GW



Source: GWEC | GLOBAL WIND REPORT 2025

The Potential for Offshore Wind in Australia

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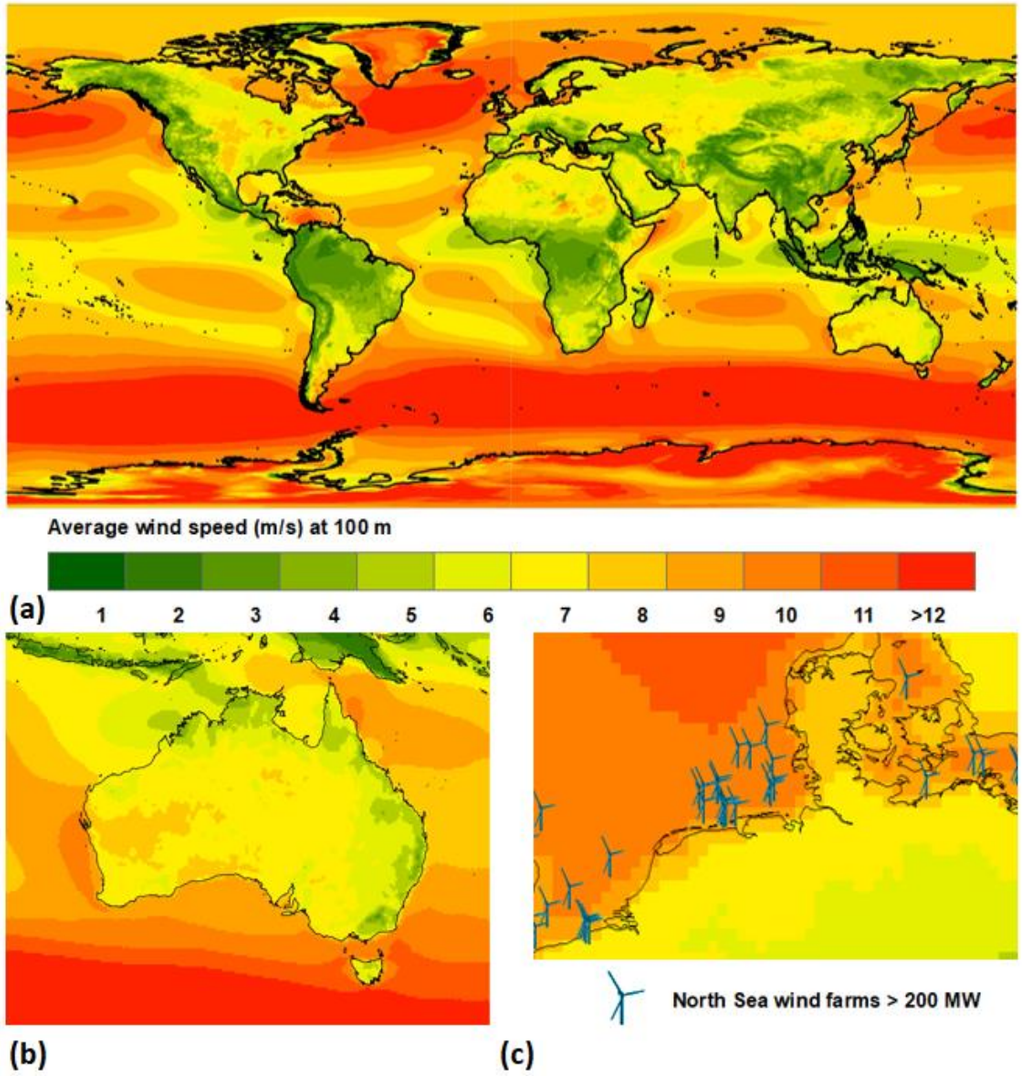
Australian offshore wind resource quality



Australia has very high-quality OSW resources, as good or better than other international regions where offshore wind has proven itself commercially.

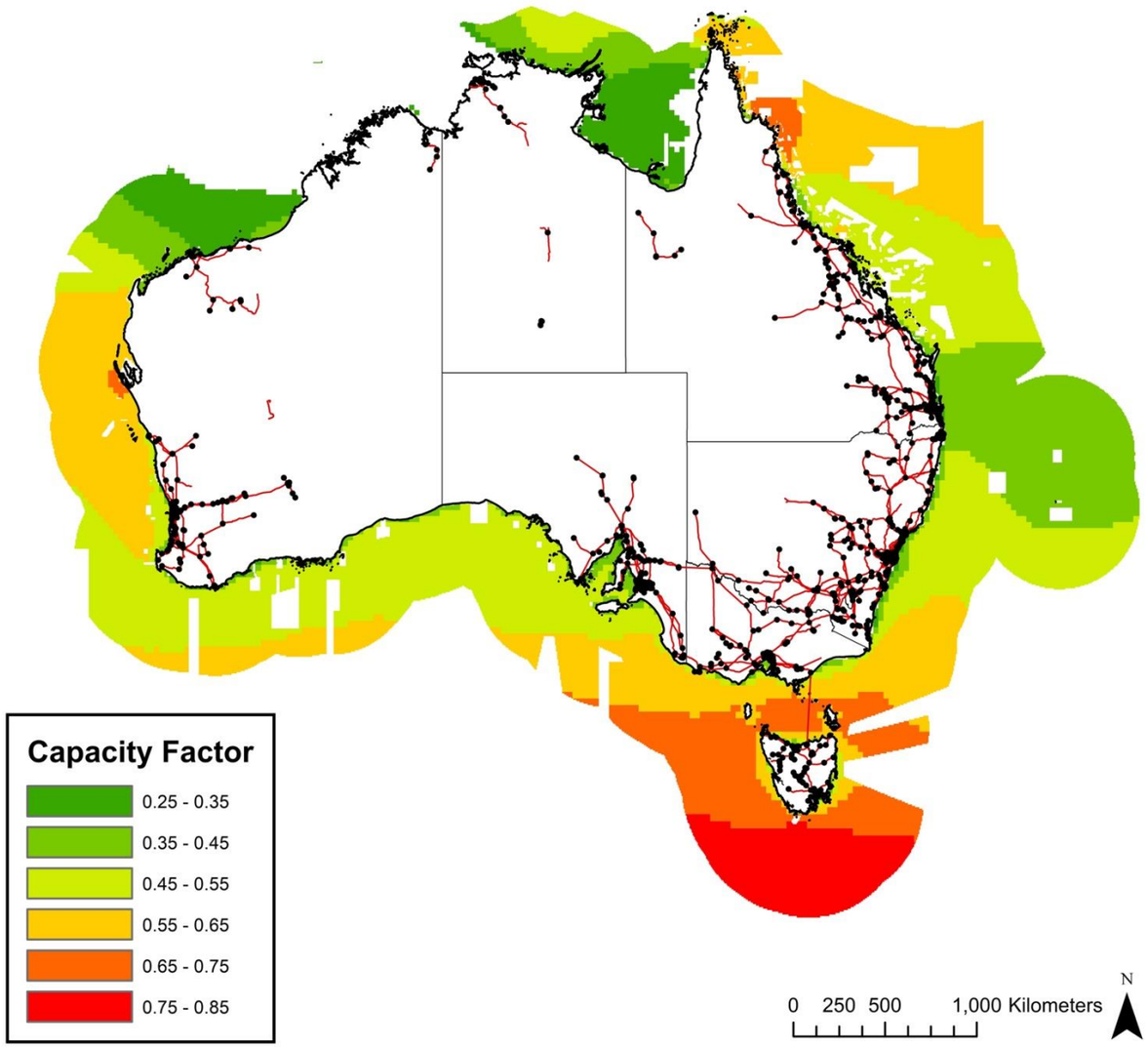
Mean wind speed (m/s) at 100 m level showing

(a) global and

(b) Australian wind distribution.

(c) North Sea: Location of existing offshore wind farms with nameplate capacity > 200 MW.

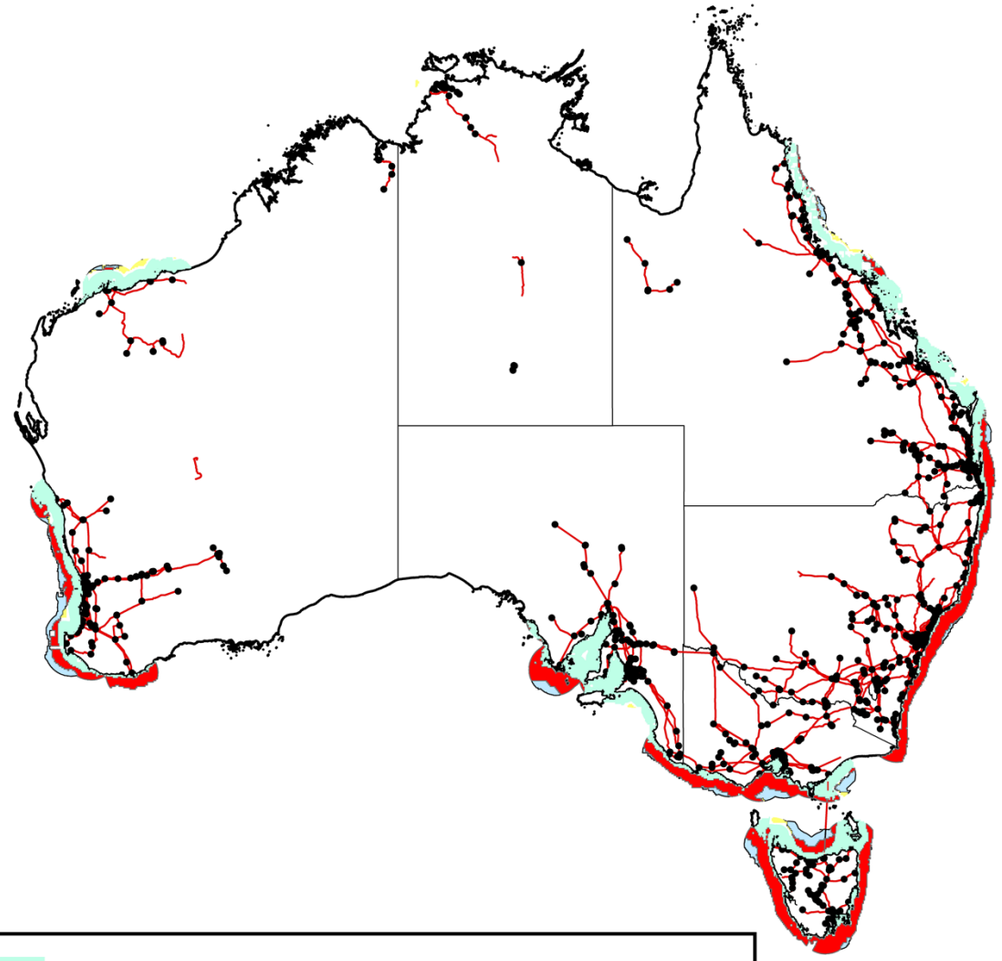
Australian offshore wind resource quality



Australia's offshore wind resources lead to high gross capacity factors, suggesting a near 'base-load' variable renewable energy resource around much of Australia

Gross Capacity Factor determined using ERA5 hourly 100-m wind speeds for the NREL 15 MW IEA reference offshore wind turbine.

Accessibility of Resource



Shallow close (Water depth < 60 m, < 100 km from connection / coastline)

Shallow far (Water depth < 60 m, > 100 km from connection / coastline)

Deep close (Water depth > 60 m, < 100 km from connection / coastline)

Deep far (Water depth > 60 m, > 100 km from connection / coastline)

Accessible, technological resource: over 2000 GW

Location by water depth and distance to grid:

1. Shallow (<60 m)
2. Deep water (60 m to 1000 m) sites near (<50 km)
3. and far (50 km to 100 km) from the Australian coastline for sites
4. < 100 km from electricity substation and transmission lines.

Offshore Wind in Australia: Resource Modelling and Grid Integration

Data

- Variable renewable power-generation technologies are dependent on the local meteorological conditions.
- Analysed potential offshore wind sides and the comparison with onshore wind and solar photovoltaic generation used regional hourly time series for a whole year (8760h) :
    - Data for solar generation & onshore wind were derived from the database Renewable Ninja (http://renewables.ninja, Staffell & Pfenninger, 2016).
    - The onshore wind indicative site selected for each region was situated in an area with a currently existing wind farm. Meteorological data for solar photovoltaic power generation has been chosen for the location of existing utility scale solar photovoltaic power stations.

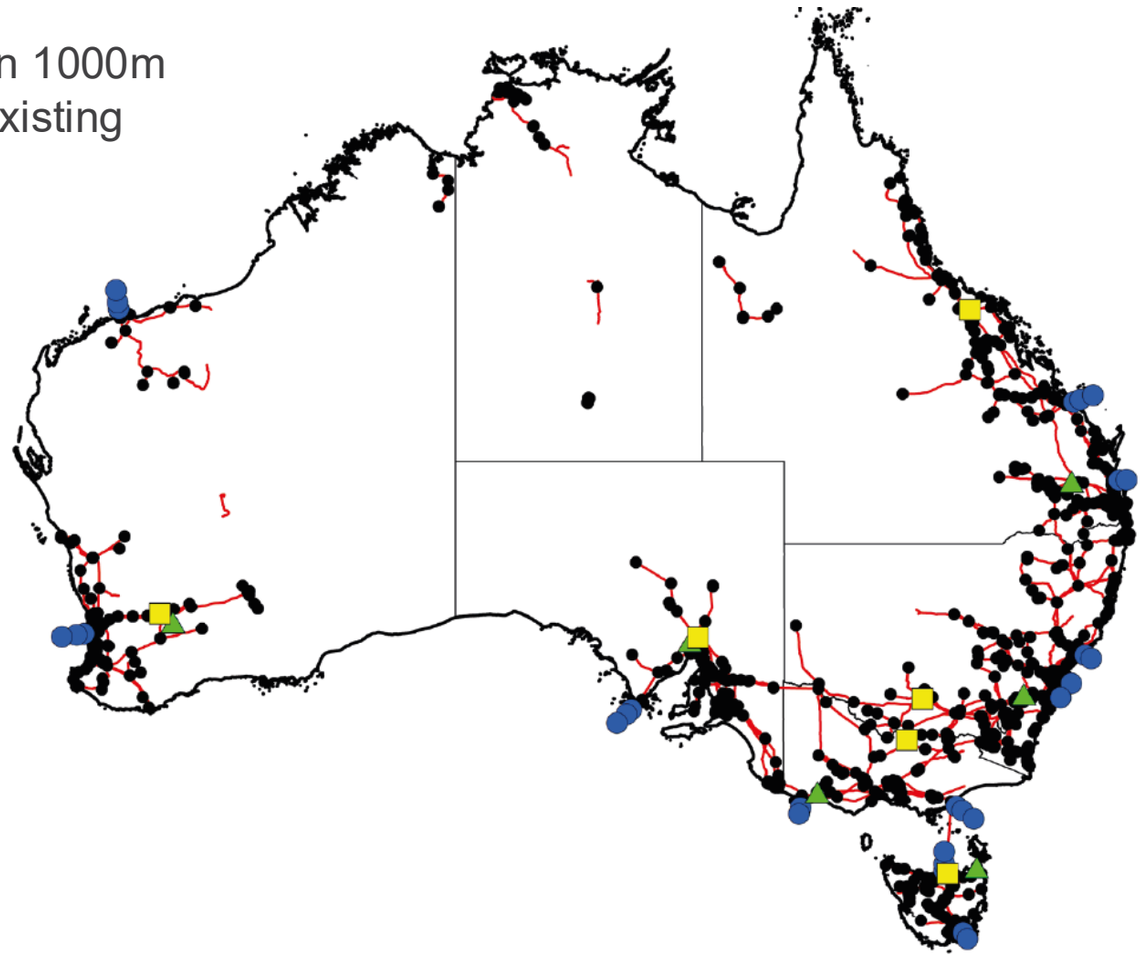
Offshore Wind Resources in Selected Locations

Possible offshore wind locations around Australia have been selected based on existing high voltage transmission substation close to the shore line, as a possible interconnection point for offshore wind farm.

No.	State	Nearby City / Region	Transmission Substation	Voltage Level
1	TAS	George Town	Bass link Four Mile Bluff	330 kV
2	TAS	Hobart	Chapel Street	220 kV / 132 kV
3	VIC	Portland	Portland Aluminium	500 kV
4	VIC	Latrobe	Bass link	330kV
5	NSW	Newcastle	Waratah	330 kV / 132 kV
6	NSW	Sydney	Sydney South	330 kV / 132 kV
7	NSW	Port Kembla	Dapto	330 kV / 132 kV
8	QLD	Gladstone	Gladstone Power Station (coal)	275 kV (multiple)
9	QLD	Maroochydore (north of Brisbane)	H9 Palmwoods	275 kV / 132 kV
10	SA	Lincoln (near Adelaide)	Sleaford	132 kV
11	WA	Perth	Kwinana Terminal/Power Station	330 kV
12	WA	Karratha	NWIS	

Offshore Wind Resources in Selected Locations

Map of potential offshore wind farm locations at water depths of less than 1000m within 100 km of coastline and pre-existing electricity grid substations and lines.



Solar PV

Onshore Wind

Offshore Wind

Electricity Transmission Substations

Electricity Transmission Lines

N

0 250 500 1,000 Kilometers

Offshore Wind Resources in Selected Locations: Victory -Latrobe / Bass Link North

The Macarthur Wind Farm location - approx. 600 km west of Melbourne - has been selected as the onshore wind generation.

The Numurkah Solar Farm - 250 km north of Melbourne – is the reference plant for the solar electricity generation curves.

Both locations represent good to very good conditions for those technologies.

Generation data calculated with meteorological data and installed capacities – not actual generation data.

Offshore wind resource for Latrobe is greater than the high quality onshore wind resource at MacArthur:

- Capacity factor 25 km offshore exceeds that seen onshore by 1-2%, and by over 15% at the location 100 km offshore .
- The Latrobe sites display relatively low correlation with onshore wind generation (35-40%) and anti-correlation with solar PV generation, reflecting the potential phasing value of offshore wind in Victoria's renewable energy mix.

Location	Type	Installed Capacity	Generation	Capacity Factor	CF increase (Base +25km)
		[MW]	[MWh/a]	%	
Latrobe	Offshore Wind (+ 25 km)	1,000	3,935,131	44.9	
Latrobe	Offshore Wind (+ 50 km)	1,000	4,760,329	54.3	9.4
Latrobe	Offshore Wind (+ 100 km)	1,000	5,166,717	59.0	14.1
Macarthur Wind Farm	Onshore Wind	6,000	22,790,239	43.4	
Numurkah Solar Farm	Solar PV	6,000	9,998,652	19.0	
Victoria	Total	15,000	46,651,069	Supply (1)	103%
				(1) based on demand FY 2015/2016	
		Peak Load [MW]	Demand [MWh/a]	Average Load [MW]	
VIC - 2015		9,230	45,325,827	5,174	
		Onshore	Wind	Solar	Photovoltaic
		Annual per MW	Correlation	Annual per MW	Correlation
Additionality		[MWh/a]	[%]		
	Offshore Wind (+ 25 km)	136.8	38.63%	2,269	-4.08%
	Offshore Wind (+ 50 km)	962.0	35.64%	3,094	-4.24%
	Offshore Wind (+ 100 km)	1368.3	35.94%	3,500	-2.25%

Offshore Wind Resources in Selected Locations: Newcastle / NSW

The Goulburn Wind Farm location - approx. 200 km south west of Sydney - has been selected as the onshore wind generation.

The Darlington Point Solar Farm - 600 km west of Sydney – is the reference plant for the solar electricity generation curves.

Offshore wind resource for Newcastle region is the best of the three analysed in NSW.

- Capacity factor exceeds 39% (44% 50km offshore), with the lowest correlation to the onshore wind resource (31%),
- anti-correlation with solar PV generation.

Existing infrastructure around Newcastle / NSW includes not only a strong transmission grid, but highly developed port facilities, steel mills, fabrication and manufacturing facilities and a skilled workforce.

Location	Type	Installed Capacity	Generation	Capacity Factor	CF increase (base +25km)
		[MW]	[MWh/a]	%	
Sydney	Offshore Wind (+ 25 km)	9,000	28,592,450	36.3	
	Offshore Wind (+ 50 km)				
	Offshore Wind (+ 100 km)				
Goulbourn	Onshore Wind	9,000	24,805,410	31.5	
Darlington Point Solar Farm	Solar PV	10,000	17,273,517	19.7	
NSW	total	15,000	70,671,377	Supply (1)	101%
				(1) based on demand FY 2015/2016	
		Peak Load [MW]	Demand [MWh/a]	Average Load [MW]	
NSW - 2015	NEM-NSW	13,459	70,097,989	8,002	
		Onshore	Wind	Solar	Photovoltaic
		Annual per MW	Correlation	Annual per MW	Correlation
Additionality		[MWh/a]	[%]		
	Offshore Wind (+ 25 km)	420.8	32.68%	1,450	-11.49%
	Offshore Wind (+ 50 km)				
	Offshore Wind (+ 100 km)				

Offshore Wind Resources in Selected Locations: Newcastle / NSW

Two examples of generation curves from solar photovoltaic, onshore wind and offshore wind.

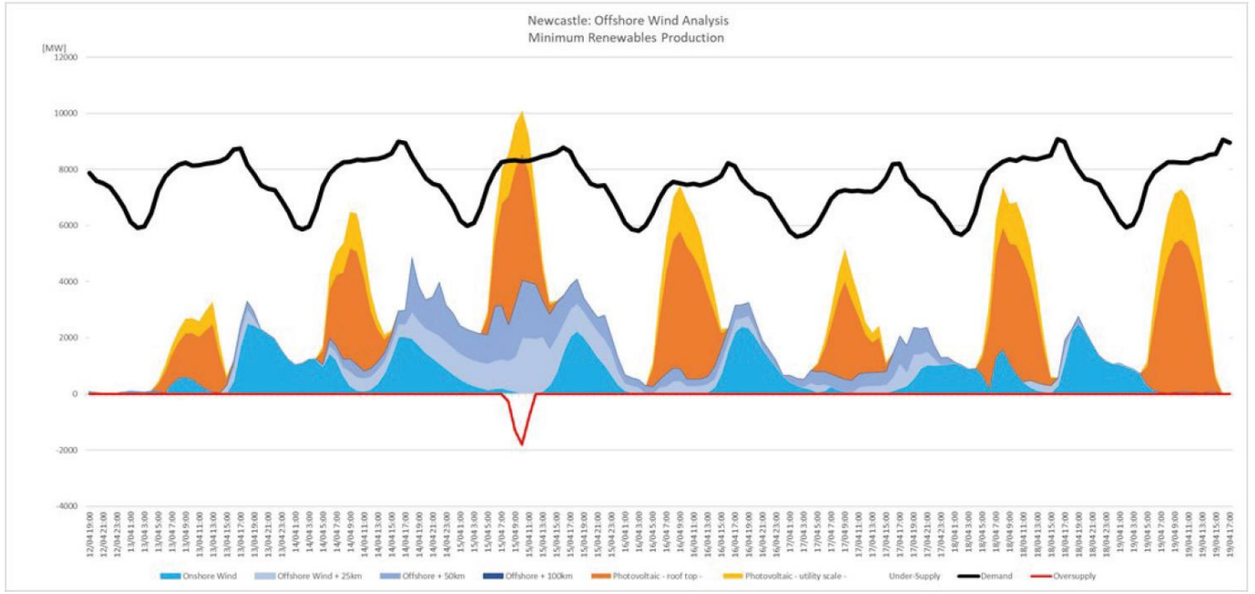
The utility scale solar PV plant and the onshore wind farm are located further away from the selected offshore wind location in Newcastle.

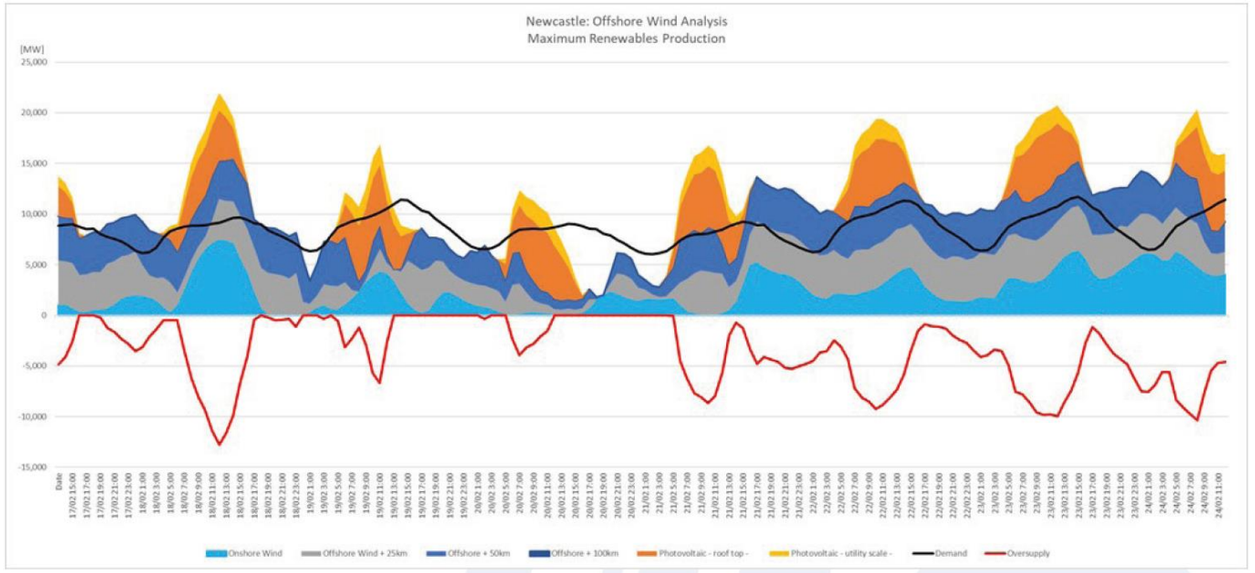
Rooftop PV (yellow), Utility scale PV (orange), Onshore wind (turquoise) and Offshore wind (at distances offshore of 25, 50 and 100 km shown with different shades of blue) are all represented. The darker the blue, the further away f rom the coast.

The upper panel displays a week with the lowest variable power generation, and the lower panel displays the week with the highest production during the simulated year.

Offshore and onshore wind generation display low correlation, and offshore wind is seen to continue generating during periods when onshore wind is not available.

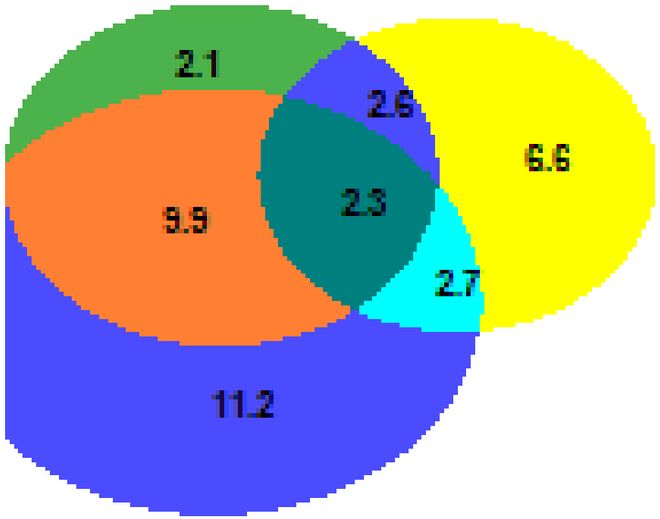
Throughout the year, wind generation fills the solar production gap during nights with a high certainty and increases security of supply and reduces the need for electricity storage.



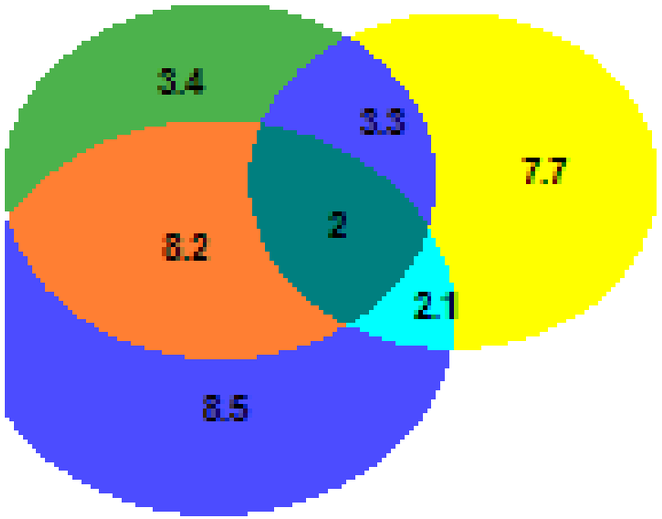


Percentage of hours during the year during which each form of generation operates at high capacity (>50%), while others operate at low (<25%) capacity.

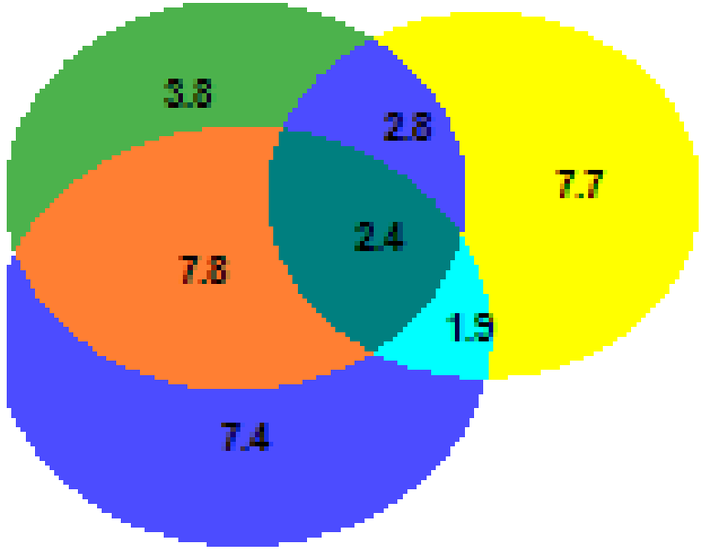
Newcastle



Sydney



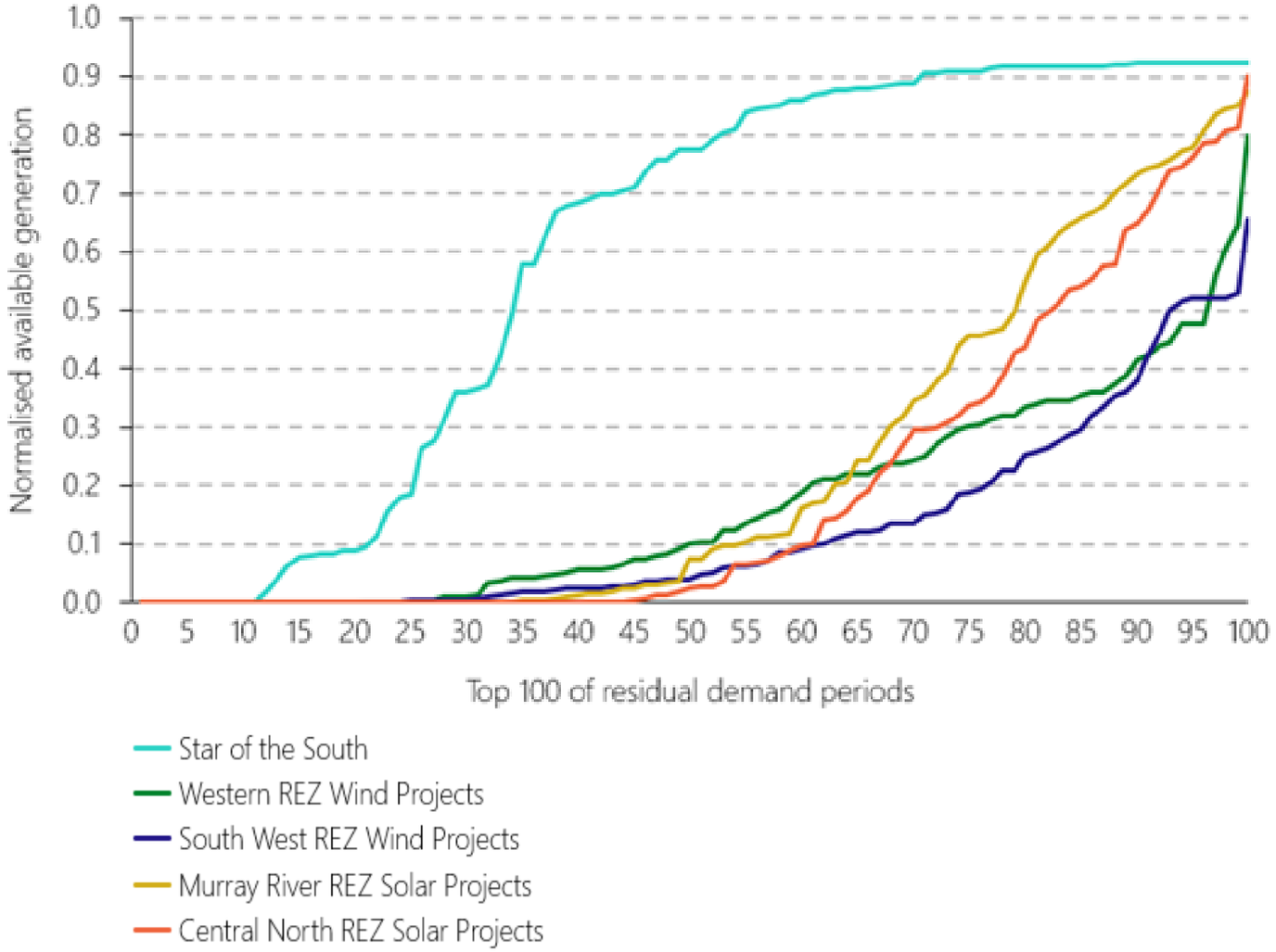
Port Kembla

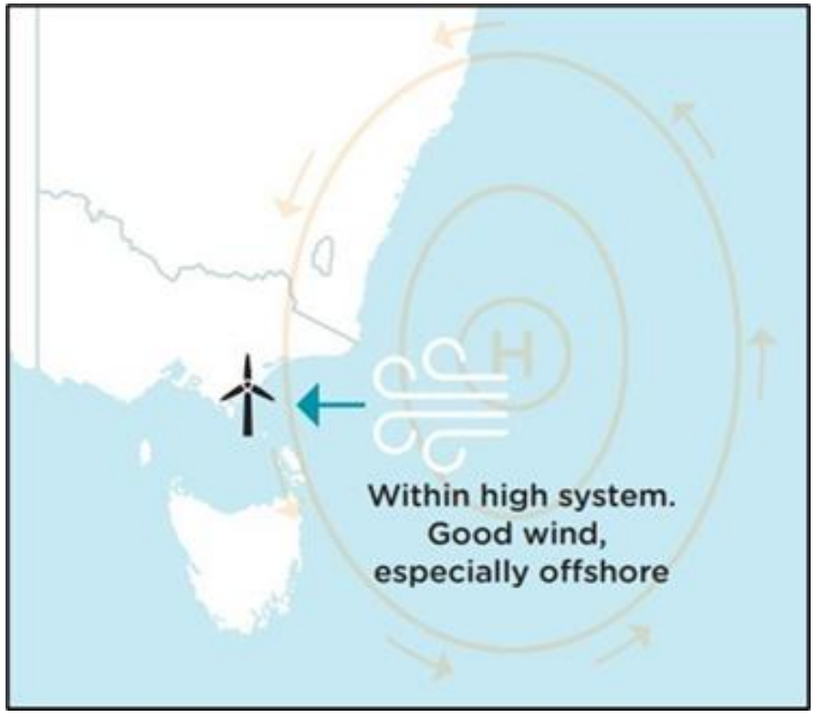


Blue: offshore wind
Green: onshore wind
Yellow: solar

Each offshore wind location is compared to the output from the Goulburn wind farm and the Darlington Point Solar Farm

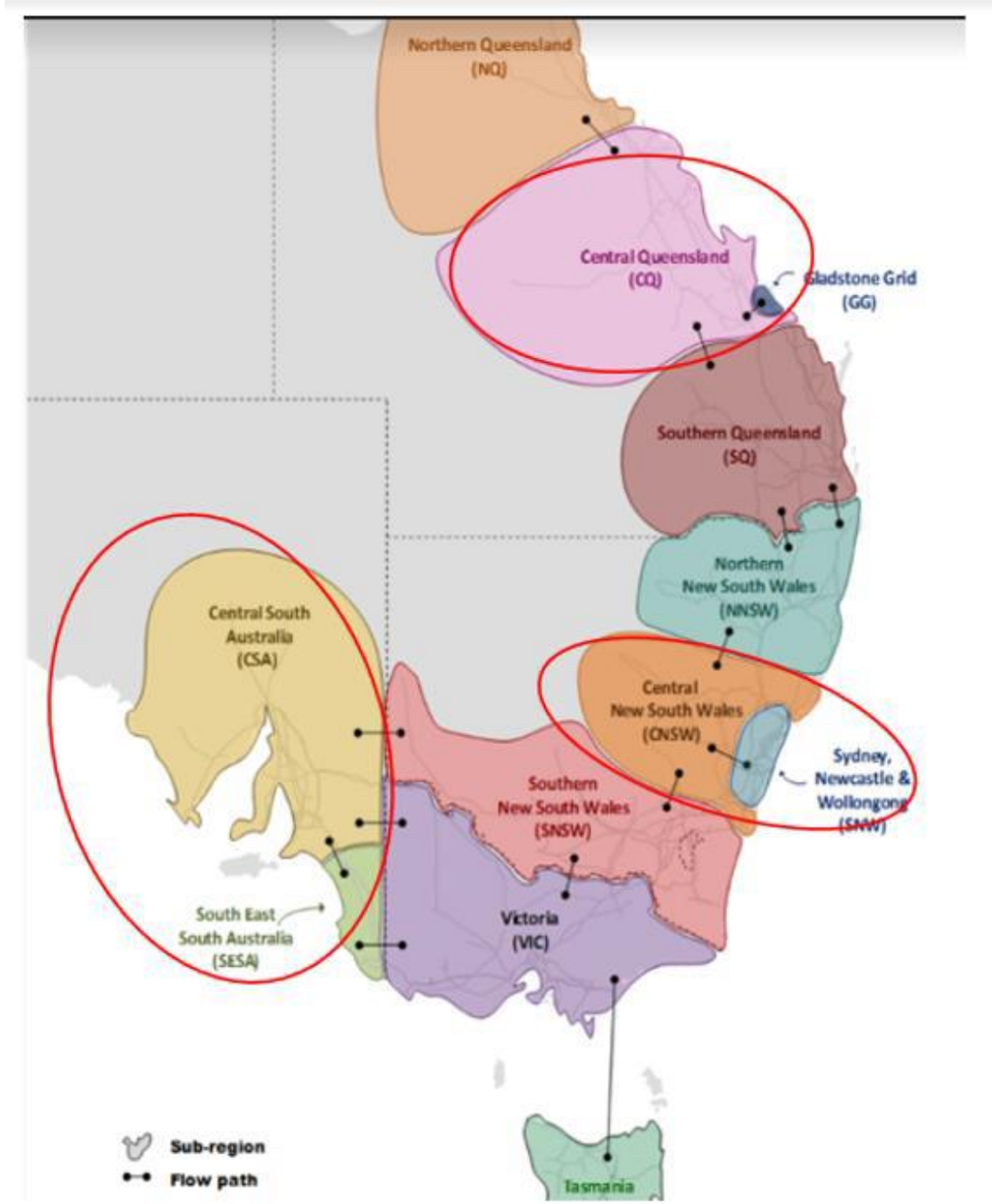
Contribution planned ‘Star of the South’ offshore wind project to peak electricity demand in Victoria





Weather system during Melbourne days over 35˚C

Power sector analysis of the National Electricity Market (NEM)—regional breakdown



Nation Electricity Market – Grid regions for Grid modelling:

1. North and Far North Queensland (NQ),
2. Central Queensland (CQ),
3. Southern Queensland (SQ),
4. North NSW (NNSW),
5. Central NSW & Sydney (CNSW),
6. Southern NSW (SNSW),
7. Victoria (VIC),
8. South Australia (SA),
9. Tasmania (TAS),
10. Northern Territory (NT), and
11. Western Australia (WA).

Source: Teske, S., Rispler J., Miyake, S. (2024) Australia: Aim High, Go Fast: Why Emissions Need to Plummet this Decade. Limiting global warming to 1.5 C.; Sectoral pathways & Key Performance Indicators for Net-Zero Target Setting Infrastructure Requirements for the National Electricity Market (NEM), Western Australian and the Northern Territory; prepared for the Climate Council. by the University of Technology Sydney, Institute for Sustainable Futures; March 2024

https://www.uts.edu.au/case-studies/australia

Interconnector capacities of the NEM—assumptions for [R]E24/7 analysis and sources

Cut-Set	Current max. capacity (MW)	Max. capacity to be built by 2030	Max. capacity considered in ISP—option short lead time	Max. capacity considered in ISP—option medium/long lead time (max. capacity option)	Notes/source
NQ–CQ	1200			5384	Peak demand value, can be up to 1400 MW in winter. [75]
CQ–GG	700		3300		Summer maximum, can be up to 1200 MW in winter.[15]
CQ–SQ	2100			5200	Five augmentation options outlined in document, including one that removes all transmission constraints[15].
SQ–NNSW	685			3685	Peak demand from NSW to QLD up to 745 MW and up to 1200 MW in the opposite direction[15].
CNSW–NNSW	910			4510	Five augmentation options outlined in document[15].
CNSW–SNW	2540			11140	As outlined on page 57 of the reference document, northern flow assumed with 4,500 MW capacity[15].
CNSW–SNSW	2320		4520	8320	Source[15]
SNSW–CSA	0	800			Source[15]
SNSW–VIC	400	2069			Max. loads assumed with 800 MW and an average of 400 MW during daytime[15].
VIC–TAS	462	1212	2174		Source[15]
VIC–SESA	650			3650	Source[15]
VIC–CSA	220				Source[76]
SESA–CSA	650			3650	

Source: Teske, S., Rispler J., Miyake, S. (2024) Australia: Aim High, Go Fast: Why Emissions Need to Plummet this Decade.
Limiting global warming to 1.5 C.; Sectoral pathways & Key Performance Indicators for Net-Zero Target Setting
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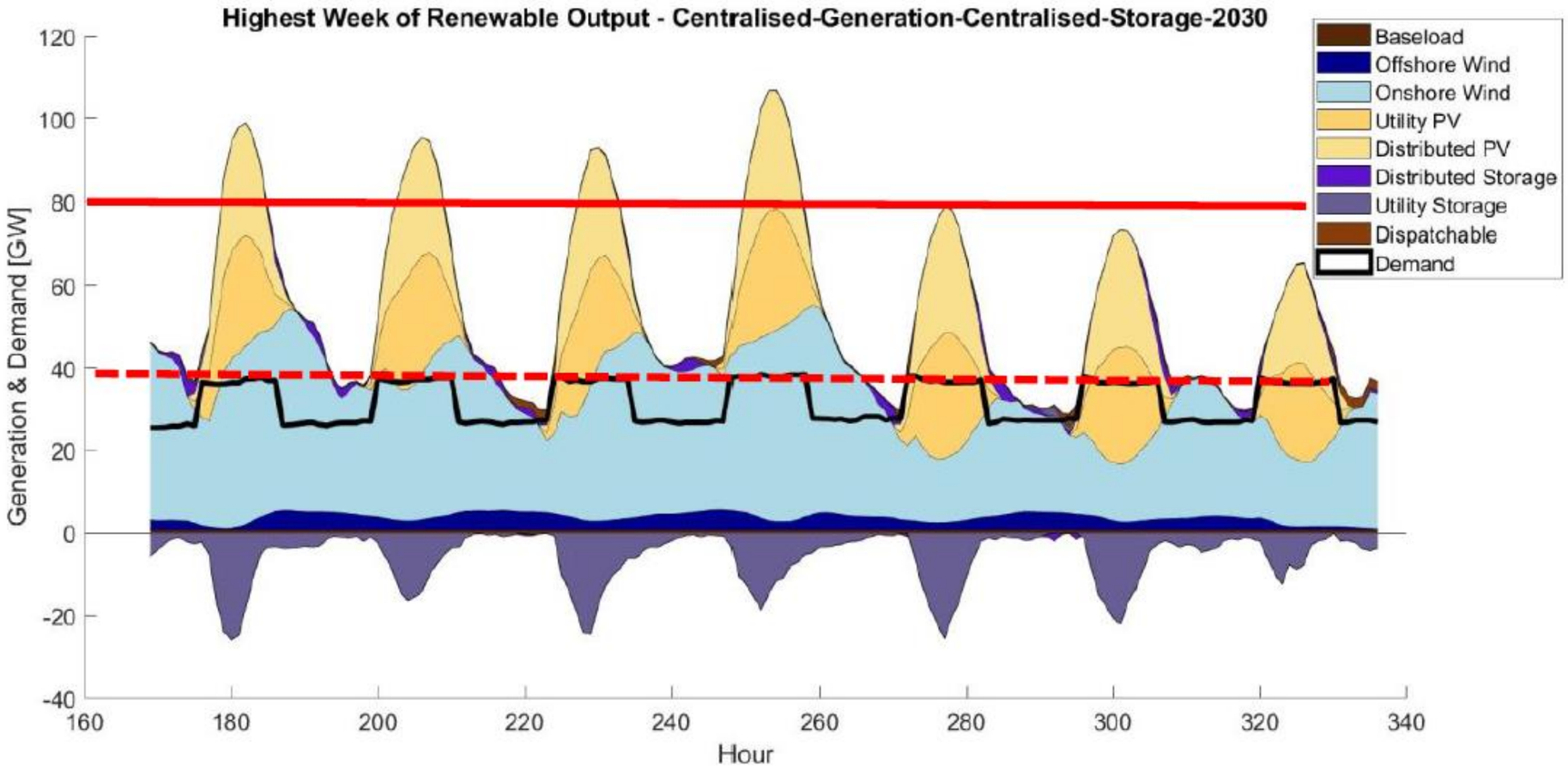
Simulation of Australian NEM Grid:



Assumed installed capacities in the NEM in 2030:

PV:	70GW
Onshore Wind:	61 GW
Offshore Wind:	2.2 GW
CSP:	0.6 GW

Source: Teske, S., Rispler J., Miyake, S. (2024) Australia: Aim High, Go Fast: Why Emissions Need to Plummet this Decade. https://www.uts.edu.au/case-studies/australia

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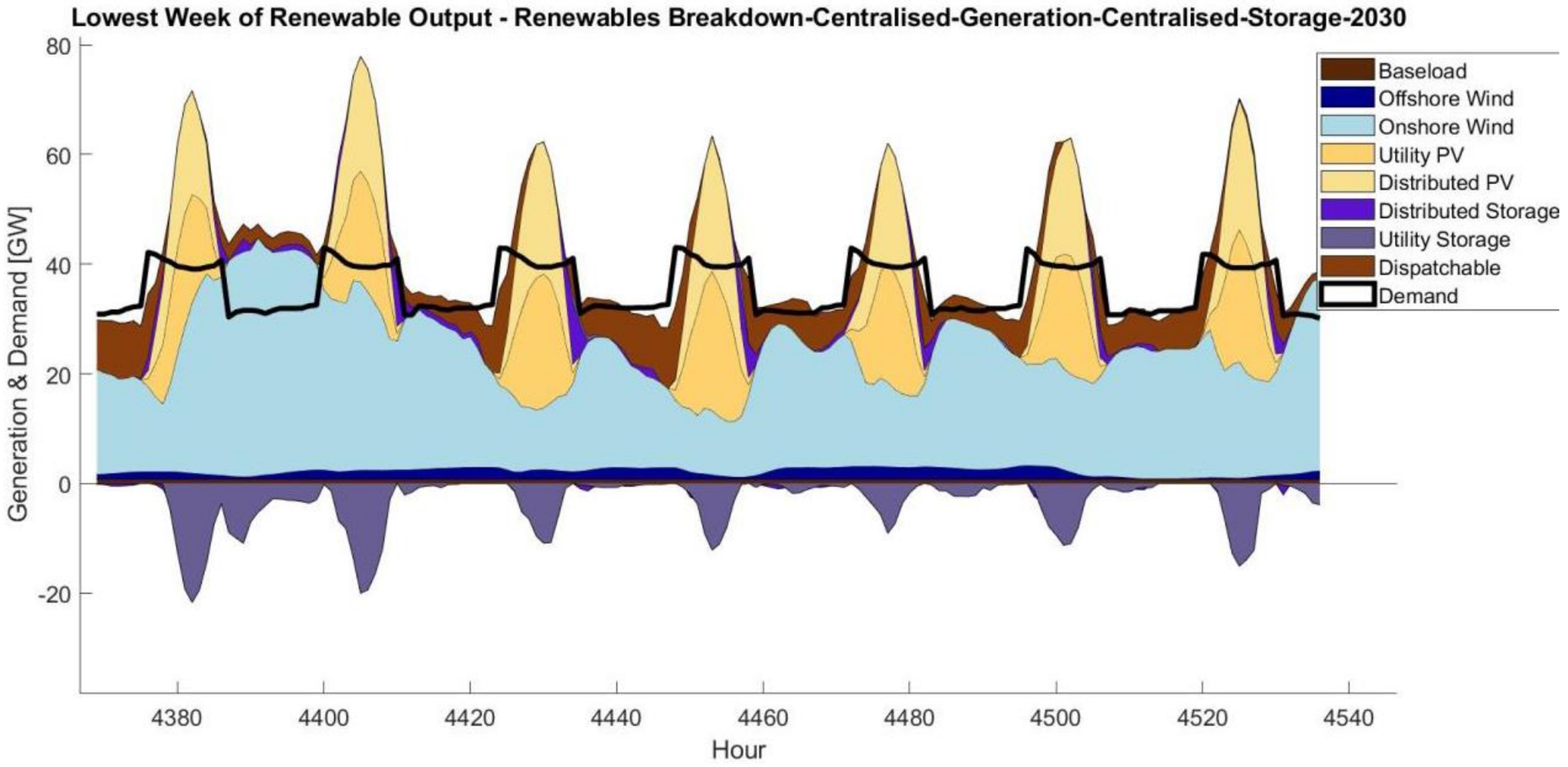

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Status Quo – Offshore Wind in Australia

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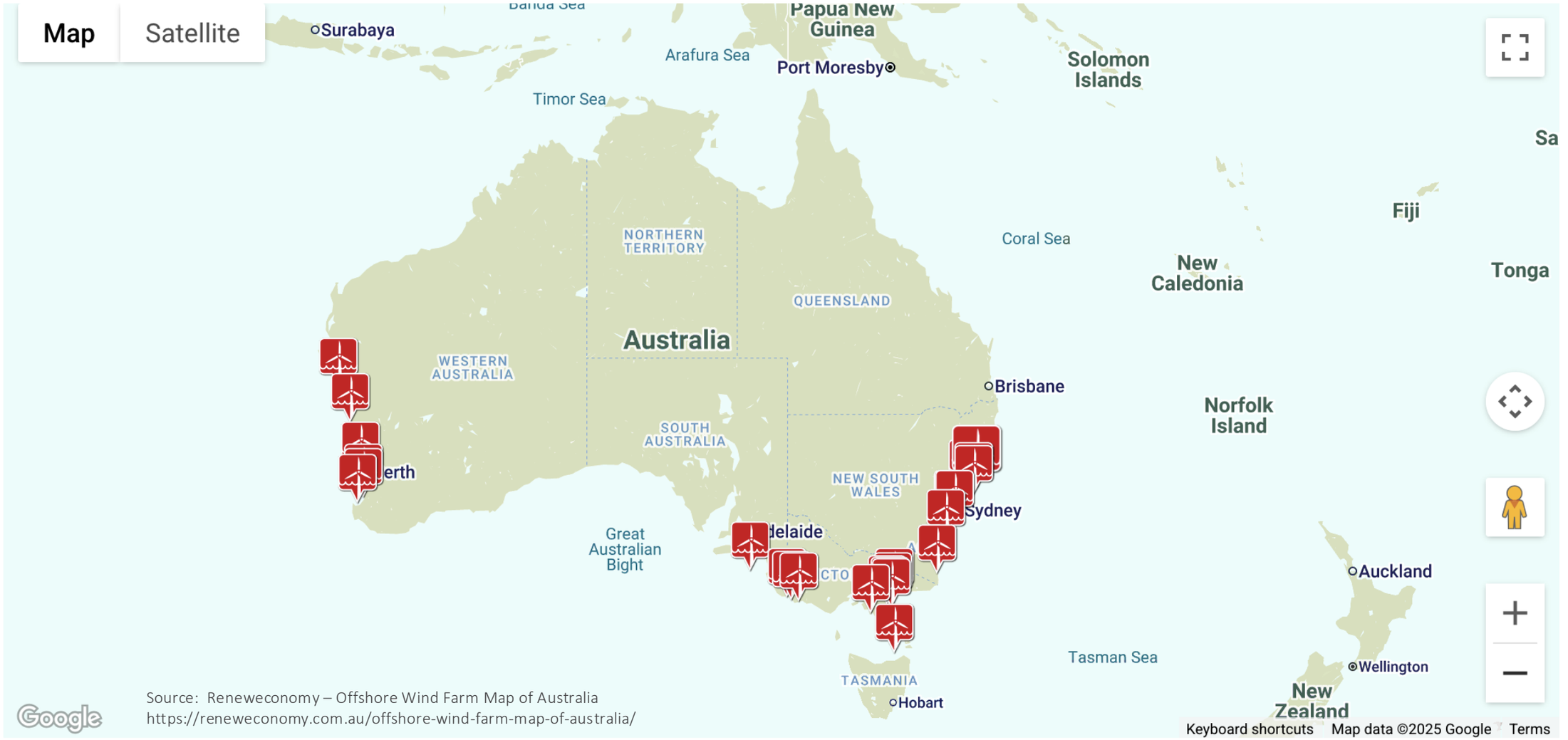


Source: Reneweconomy – Offshore Wind Farm Map of Australia
https://reneweconomy.com.au/offshore-wind-farm-map-of-australia/

Status Quo – Offshore Wind in Australia

In 2024 consultations for proposed the following offshore wind areas were finalized:

1. Southern Ocean, (South Australia)
2. Illawarra (NSW)
3. Indian Ocean (Bunbury) (Western Australia)
4. Bass Strait (Northern Tasmania)
5. Gippsland (Victoria) - finalized in 2023
6. Hunter offshore (NSW) – finalized in 2023

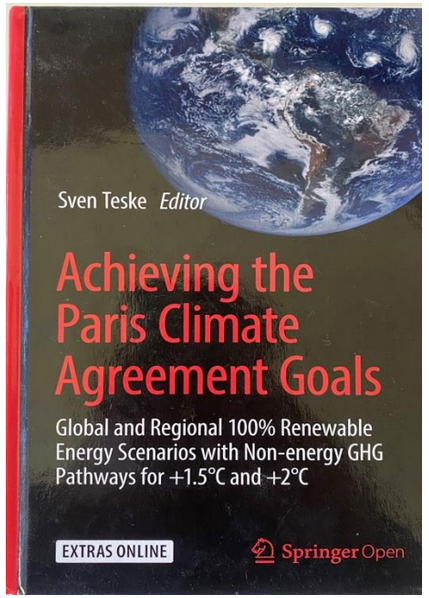
Following the awarding of 12 GW of feasibility licences across six projects in the Gippsland offshore wind area in 2023, an additional six licences were awarded in July 2024 –

- 3 GW Aurora Green project,
- 2.1 GW Greater Gippsland project,
- 1.5 GW Navigator North project,
- 2.0 GW (approximate) Kent Offshore Wind project,
- 2.5 GW Great Eastern Offshore Wind Farm project, and
- 2 GW Gippsland 2 project.

This brings total capacity of feasibility licences awarded in the Gippsland offshore wind area to 25 GW.

Source: Clean Energy Council, https://cleanenergycouncil.org.au/news-resources/clean-energy-australia-report-2025

Thank you.



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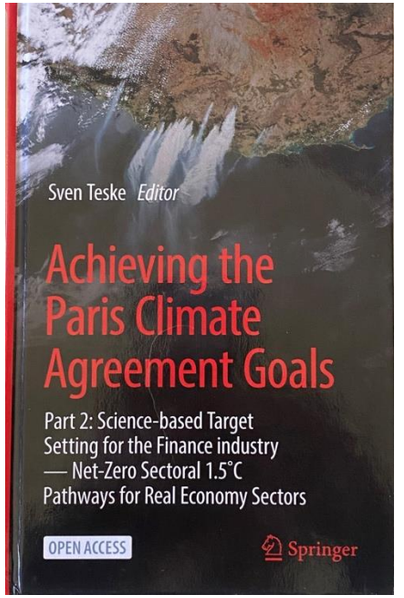

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