Is There a Role for Offshore Wind Power in Renewable Hydrogen Production in Australia?

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Australia: legal and regulatory framework

- In December 2021, the Commonwealth Government introduced the Offshore Electricity Infrastructure Act 2021 (Cth) ('OEI Act') and the Offshore Electricity Infrastructure (Regulatory Levies) Act 2021 ('Regulatory Levies Act').
  - The laws entered into force from June 2022.

- The OEI Act:
  - Enables the Minister to declare specified areas suitable for offshore infrastructure activities;
  - Requires the establishment of a licensing scheme to allow the Minister to grant licenses authorizing offshore infrastructure activities in specified areas;
  - Establishes statutory authorities to administer and regulate the framework;
  - Provides for compliance and enforcement of the regulatory framework.

Australia: legal and regulatory framework

- On 2 November 2022, the Commonwealth Government released the Offshore Electricity Infrastructure Regulations 2022 (‘Regulations’) and the Offshore Electricity Infrastructure (Regulatory Levies) Regulations 2022 (‘Regulatory Levies Regulations’).

- The Regulations provide a distinct license application process for each license type:

  - Feasibility
  - Commercial
  - Research and demonstration
  - Transmission and infrastructure

Licence Type	Initial Term
Feasibility Licence	7 years
Commercial Licence	40 years
Research and Demonstration Licence	10 years
Transmission and Infrastructure Licence	To be confirmed upon licence offer

Australia: legal and regulatory framework

August 2022

- Six locations designated by minister under the OEI Act:
  - Pacific Ocean region off the Hunter in NSW
  - Pacific Ocean region off the Illawarra in NSW
  - Southern Ocean region off Portland in Victoria
  - Area in the Bass Strait off Gippsland, Victoria
  - Bass Strait region off Northern Tasmania
  - Indian Ocean region off Perth/Bunbury, WA.

December 2022

- 15,000 square kilometres area in Bass Strait off Gippsland, Victoria named as suitable for offshore renewable energy.
- Minister for Climate Change and Energy issued invitation to apply for feasibility licences.
- Feasibility Licence applications accepted from 23 January 2023 to 27 April 2023.

Potential H2 export volume

TABLE ES 1 PROJECTED GLOBAL DEMAND FOR HYDROGEN (PJ)

Country	2025			2030			2040		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
Japan	10.6	62.0	160.7	105.1	211.5	463.3	227.7	496.1	1,149.7
Republic of Korea	8.9	26.7	59.3	44.8	87.4	187.5	120.2	261.2	637.1
Singapore	0.3	1.8	3.8	3.3	6.1	12.4	11.5	20.2	57.7
China	5.8	27.1	83.8	123.5	398.5	841.8	943.1	2,093.3	4,922.7
Rest of the World	11.7	53.8	140.6	126.5	321.6	688.0	595.5	1,312.4	3,093.6
Total	**37.4**	**171.6**	**448.1**	**403.2**	**1,025.2**	**2,193.1**	**1,898.0**	**4,183.2**	**9,860.8**

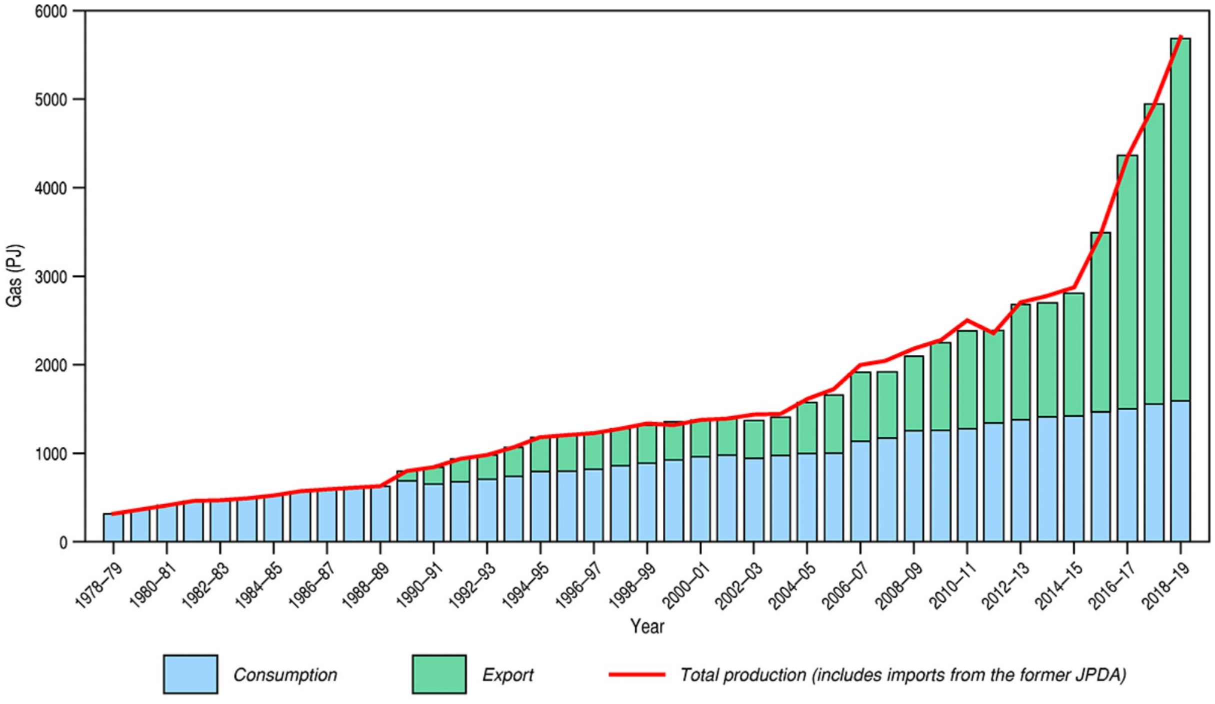
NOTE: PETAJOULE FIGURES ARE BASED ON LOWER HEATING VALUE (LHV) OF HYDROGEN
SOURCE: ACIL ALLEN ANALYSIS

TABLE ES 3 AUSTRALIA'S POTENTIAL EXPORTS OF HYDROGEN (PJ)

Country	2025			2030			2040		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
Japan	2.1	12.7	33.0	21.9	44.2	96.4	47.1	102.3	237.7
Republic of Korea	1.0	2.9	6.4	4.8	9.4	20.1	12.9	28.1	68.4
Singapore	0.04	0.2	0.5	0.5	0.9	1.8	1.5	2.7	7.5
China	0.1	0.3	0.9	1.4	4.5	9.5	10.7	23.7	55.7
Rest of the World	0.05	0.2	0.6	0.5	1.3	2.8	2.4	5.4	12.7
Total	**3.2**	**16.4**	**41.4**	**29.1**	**60.3**	**130.7**	**74.6**	**162.2**	**382.0**

SOURCE: ACIL ALLEN ANALYSIS

Comparison – gas production 1978-2019



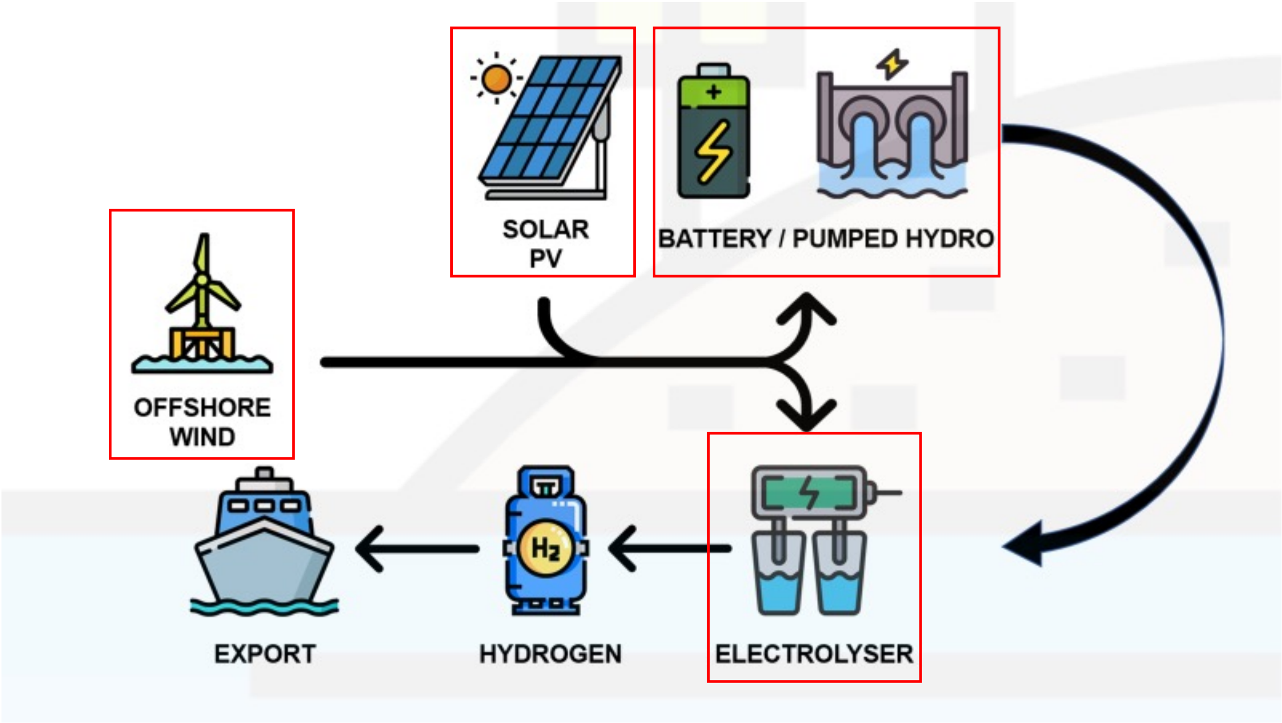
Source: Department of Industry, Science, Energy and Resources, Australian Energy Statistics 2020, Tables D1 and J.
Note: Consumption data includes statistical discrepancies. JPDA = former Joint Petroleum Development Area. PJ = petajoules.

AECR 2.6

Figure 5. Historical trends in Australia's gas production, consumption and LNG exports

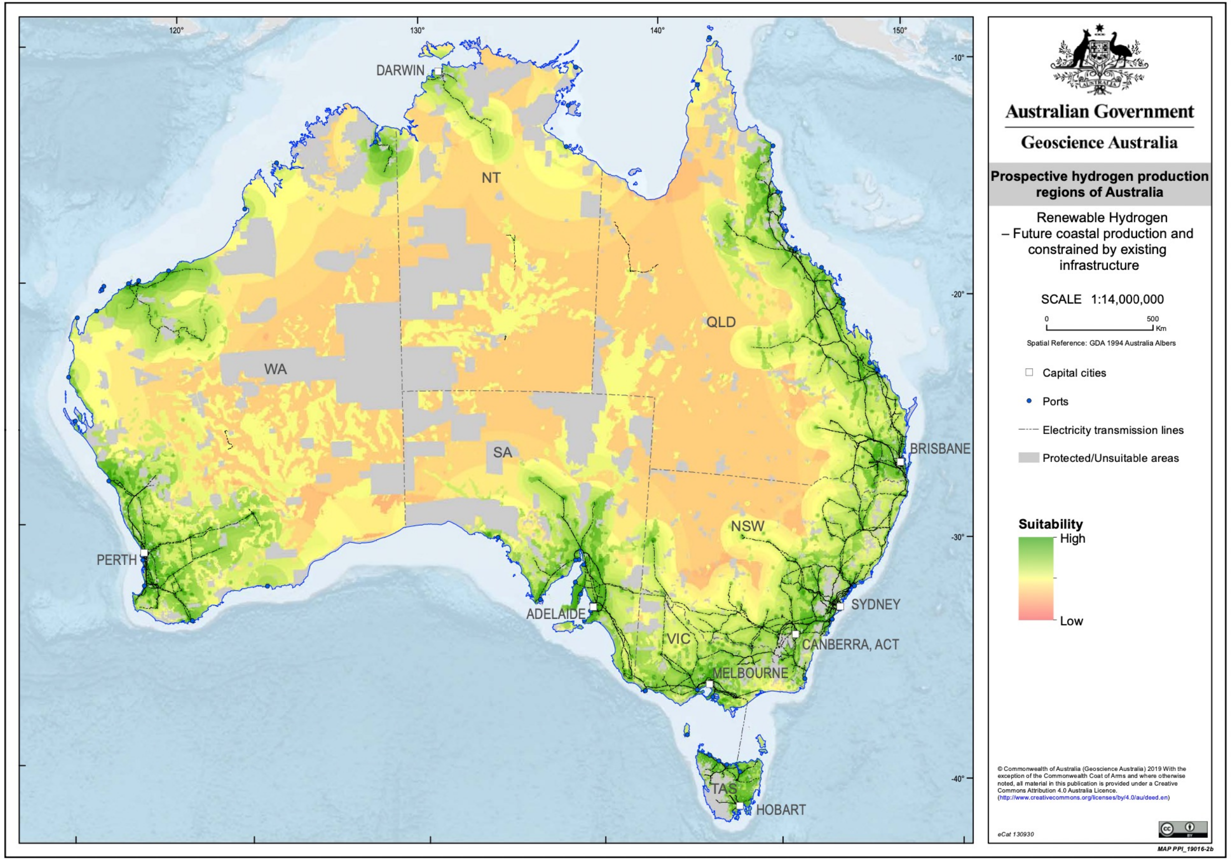
Source: Geosciences Australia. Available at: https://www.ga.gov.au/digital-publication/aecr2021/gas#production-section

The Hydrogen production system

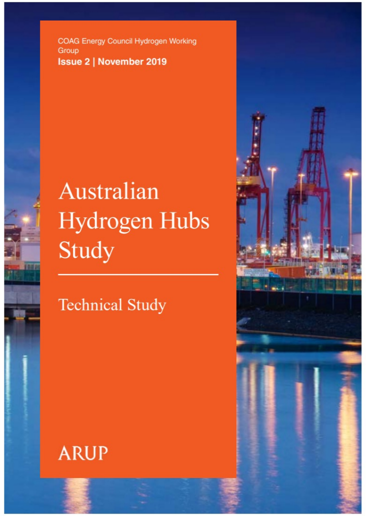


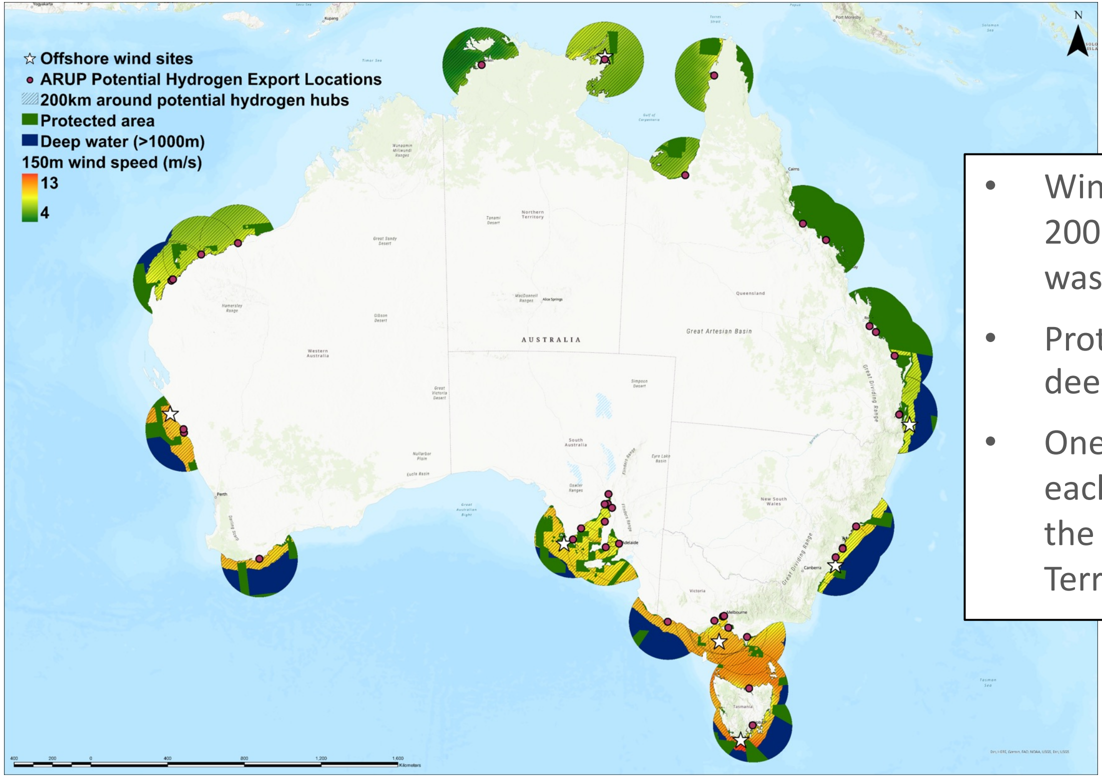
- Off-grid system
- Offshore wind and onshore solar PV supply electricity
- Battery / pumped hydro as electrical storage
- Located near ports for export purpose
- Optimizes offshore wind, solar PV, storage and electrolyser capacity for least-cost hydrogen production

Prospective renewable hydrogen production regions in Australia

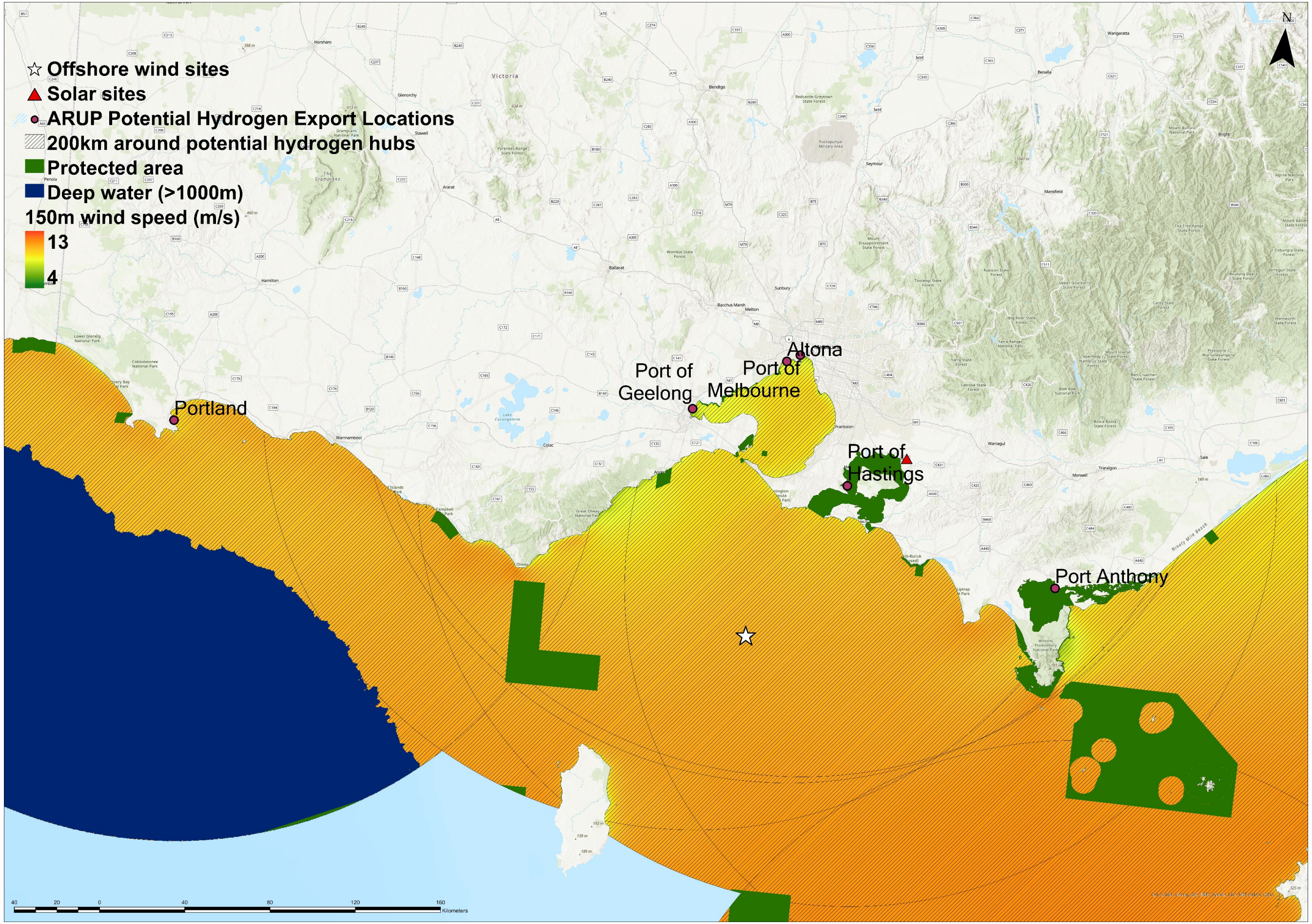


Site Selection





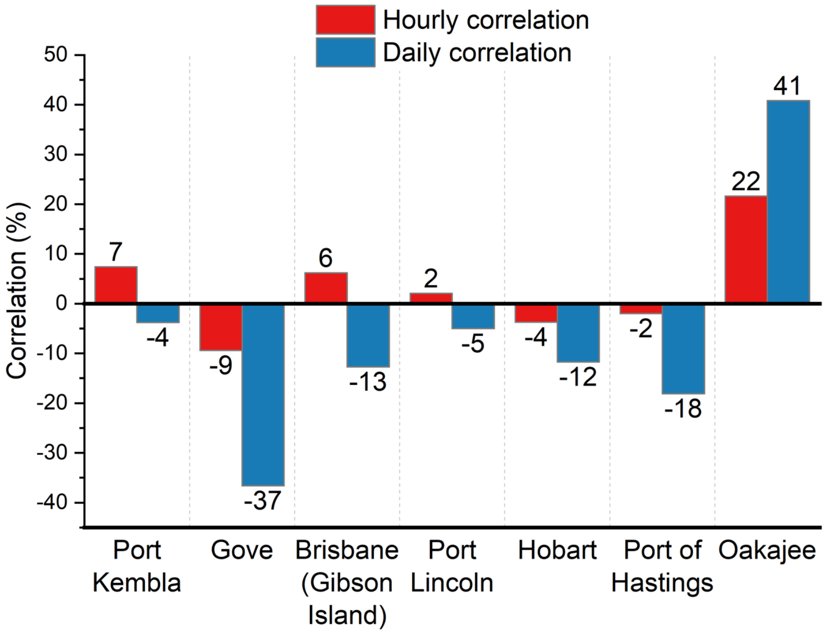
- Wind resource within 200km of each port was assessed
- Protected areas and deep water removed
- One site selected for each state excluding the Australian Capital Territory

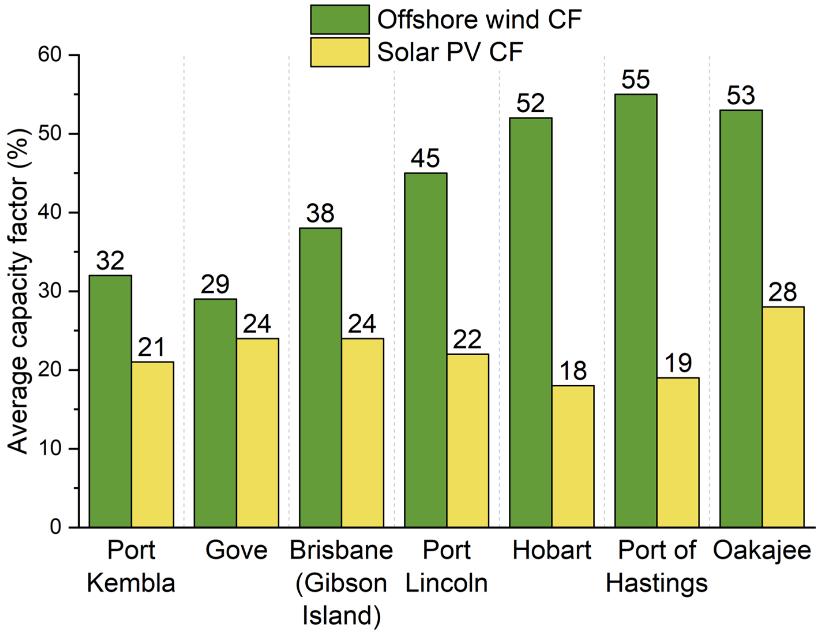


Offshore wind sites
Solar sites
ARUP Potential Hydrogen Export Locations
200km around potential hydrogen hubs
Protected area
Deep water (>1000m)
150m wind speed (m/s)
13
4
Portland
Port of Geelong
Port of Melbourne
Altona
Port of Hastings
Port Anthony
N
Kilometers

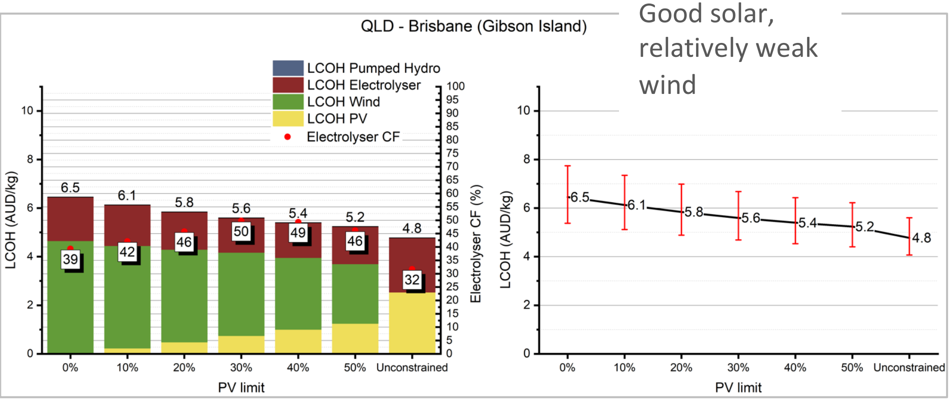
State	Port name	Offshore wind				Solar PV	
		Lat	Lon	Water depth (m)	Port distance (km)	Lat	Lon
NSW	Port Kembla	-34.82	150.95	98	41	-34.47	150.89
NT	Gove (near town of Nhulunbuy)	-12.05	136.69	24	16	-12.23	136.51
QLD	Brisbane (Gibson Island)	-27.81	153.76	95	76	-27.43	153.14
SA	Port Lincoln	-34.91	135.37	88	50	-34.72	135.83
TAS	Hobart	-43.65	146.72	29	98	-42.88	147.30
VIC	Port of Hastings	-39.05	144.77	70	85	-38.23	145.52
WA	Oakajee	-27.81	114.01	46	106	-28.60	114.61

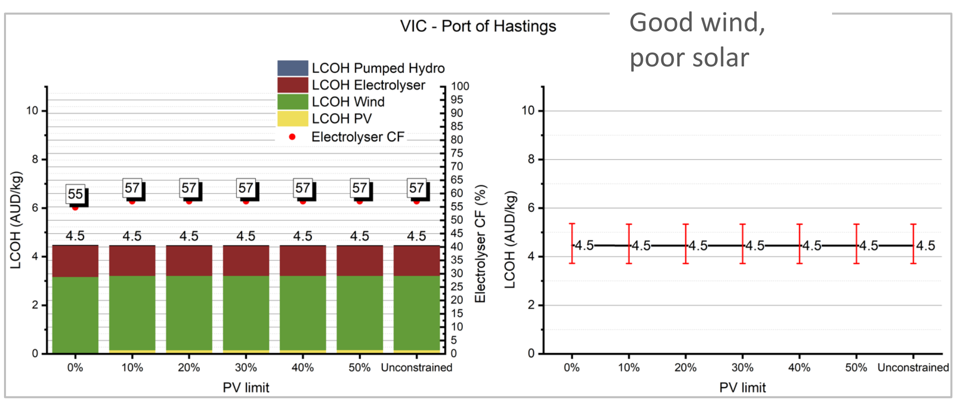
Site Selection

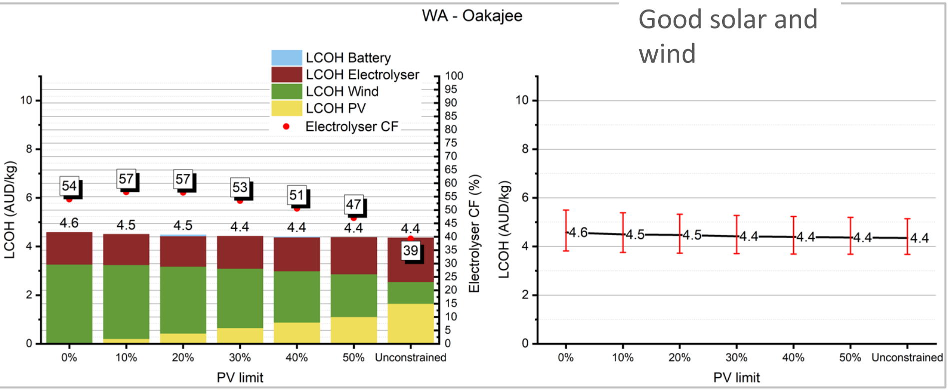




Annex: 2030 PV-Constrained scenarios



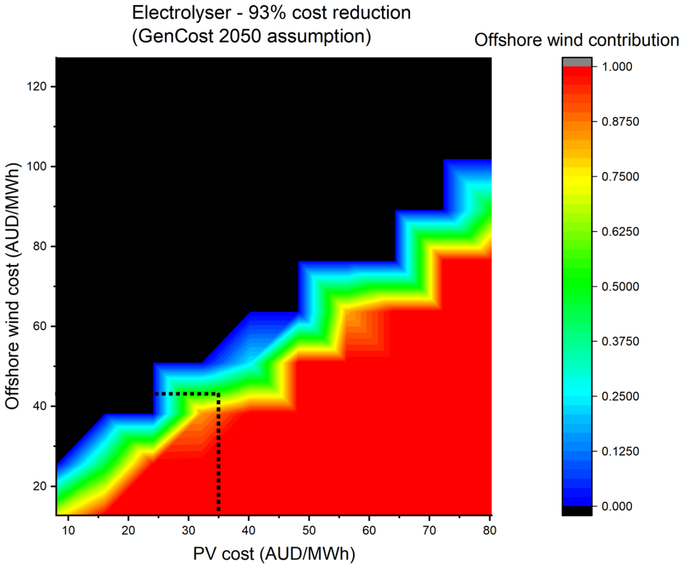


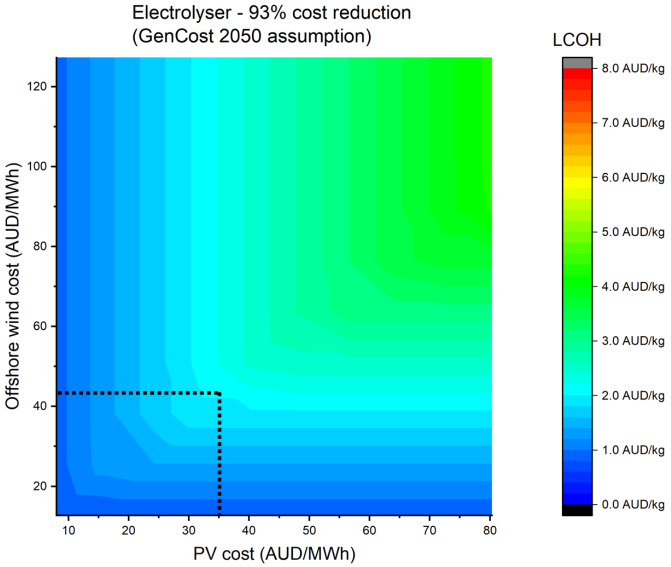


- Offshore wind has an useful role to play in regions with good offshore wind resources (CF > 45%).
- Challenging for offshore wind in regions with poor to moderate offshore wind resources (CF < 40%).
- LCOH in the unconstrained systems ranges between AUD4.4–5.5/kg across sites

Varying-costs scenario

- Assumption-free analysis covering a wide range of future cost reduction scenarios
- Electrolyser cost reduction: 20%, 40%, 60%, 80%, 93% from 2020 level
- Solar PV and offshore wind cost reduction: 10% - 90% from 2020 level, in 10% intervals
- AUD2/kg can be achieved with solar PV costing AUD35/MWh and offshore wind costing AUD43/MWh





Conclusions

- Offshore wind has a potentially useful role to play in supporting hydrogen production.
  - Potential land use or other above ground factors that limit solar PV (or onshore wind) deployment.
  - Offshore wind can smooth out variable generation from solar PV because they are usually negatively correlated.
- Reaching AUD$2/kg is possible under low electrolyser cost assumptions if offshore wind costs fall substantially.

- Paper available here for free download: https://www.sciencedirect.com/science/article/pii/S0959652623003815

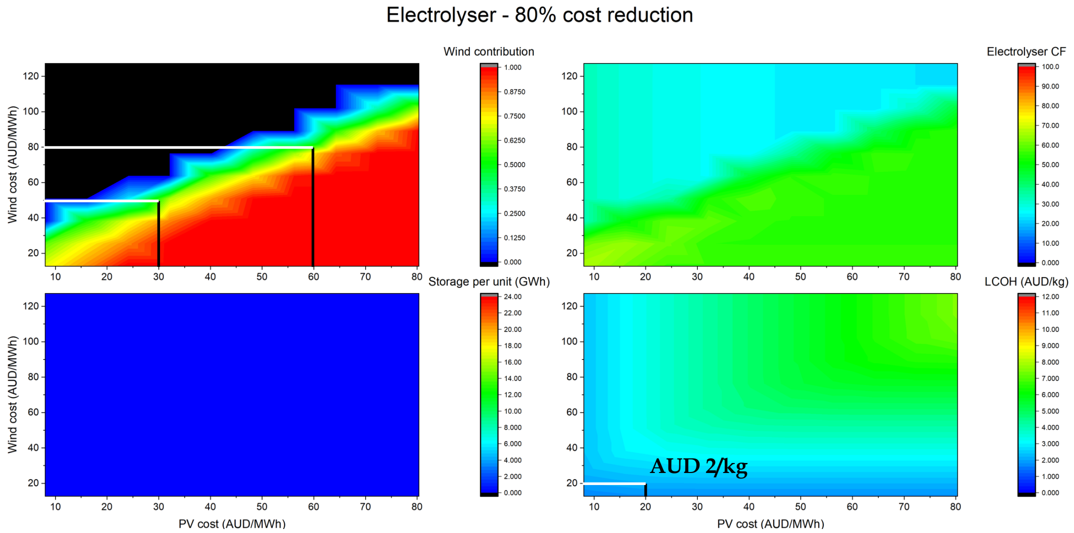
Annex: Modelling assumptions

GenCost Assumptions:

	Capital (AUD/kW)	Fixed O&M (AUD/kW p.a.)	Variable O&M (AUD/MWh p.a.)	Economic life (years)
2020				
Large scale solar PV	1,505	17	-	25
Offshore wind	5,771	158	-	25
PEM electrolyser	3,510	105	-	25
2030				
Large scale solar PV	824	17	-	25
Offshore wind	2,336	64	-	25
PEM electrolyser	923	28	-	25
Real discount rate: 6%				

- Electrolyser efficiency: 62kWh/kg in 2030
- (linearly increasing from 70kWh/kg in 2020 to 45kWh/kg in 2050)

Annex: Varying-costs scenarios



- The role for offshore wind falls with lower electrolyser costs
- In the 'worst-case' for offshore wind: it need to reach AUD50-80/MWh to achieve 40%-60% contribution, for a solar PV cost ranging between AUD30-60/MWh
- Both offshore wind and solar PV need to reach AUD20/MWh to achieve AUD2/kg

Annex: Simulation