



RENEWABLE ENERGY IN AUSTRALIA - IMPLICATIONS FOR ELECTRICITY PRICES

GRAHAM BARCLAY
BE, MEngSc



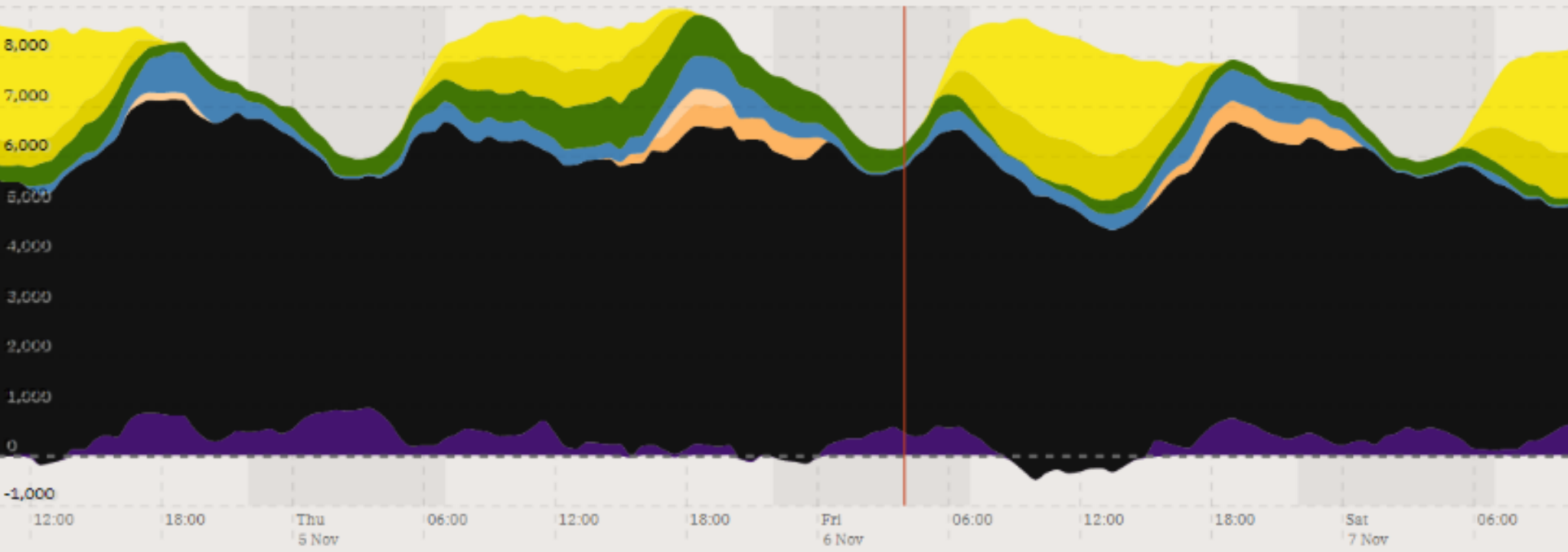
Energy

New South Wales

1D 3D 7D 30D 1Y ALL 5m 30m

Generation MW

6 Nov, 4:00 AM Coal (Black) 5,307 MW Total 6,224 MW



Price \$/MWh

6 Nov, 4:00 AM \$58.56



Default

Sources

- Solar (Rooftop)
- Solar (Utility)
- Wind
- Hydro
- Gas (OCGT)
- Gas (CCGT)
- Distillate
- Coal (Black)
- Imports

Loads

- Exports
- Pumps

Net

Renewables







Kernkraftwerk Philippsburg Block 2
Dampf-Wasserringkondensator (DWK)
Spindelpumpe - Kondensationsfunktions

Technische Daten:

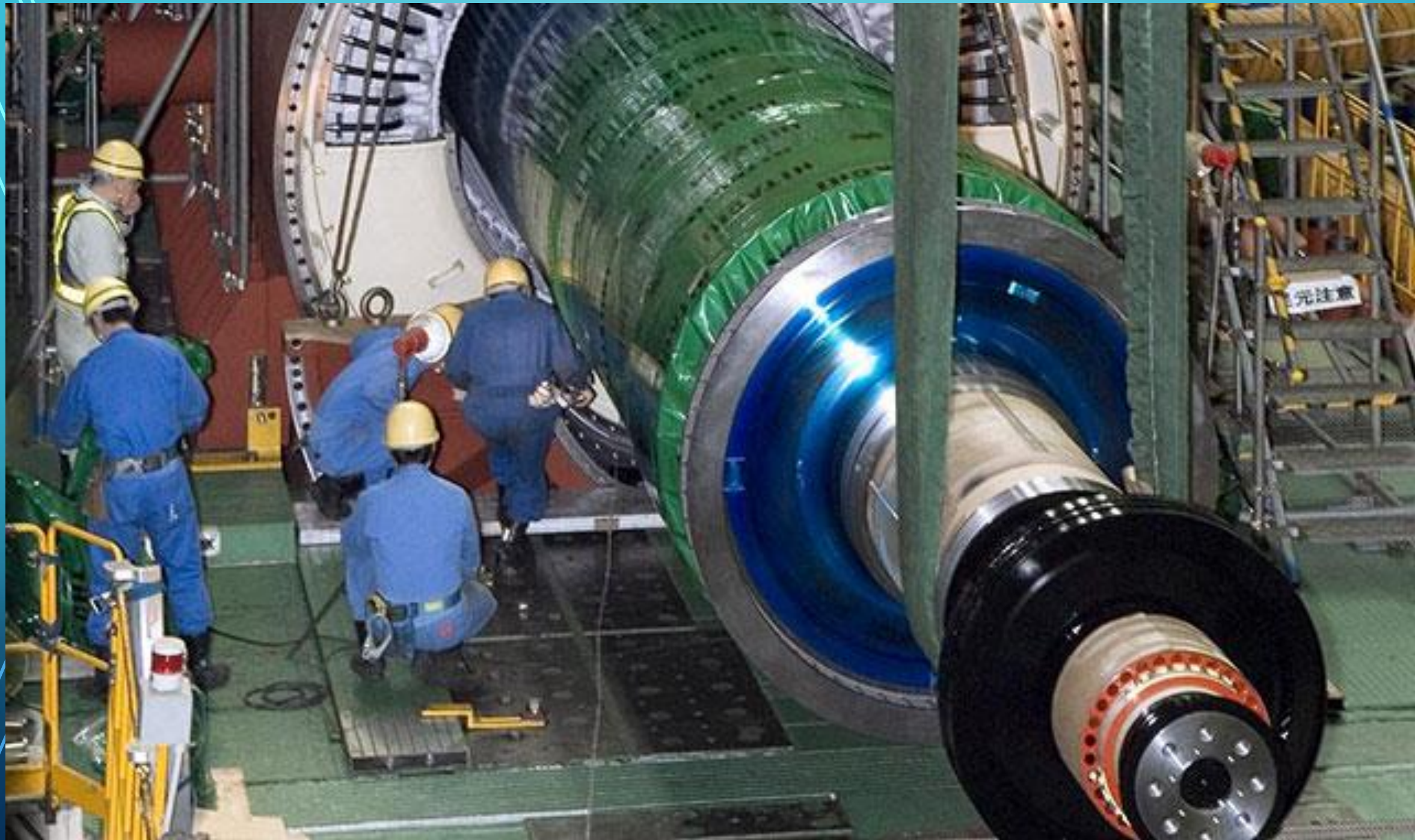
Parameter	Wert
Hersteller	Siemens AG, Berlin (Eingetragene Marke: DWK)
Spezialanwendung	2. Stufe des Dampferkondensators (DWK) im Block 2 des Kernkraftwerks Philippsburg
Material	Stahl (S235JR)
Werkstoffgruppe	Stahl
Herstellungsjahr	1985
Hersteller	Siemens AG

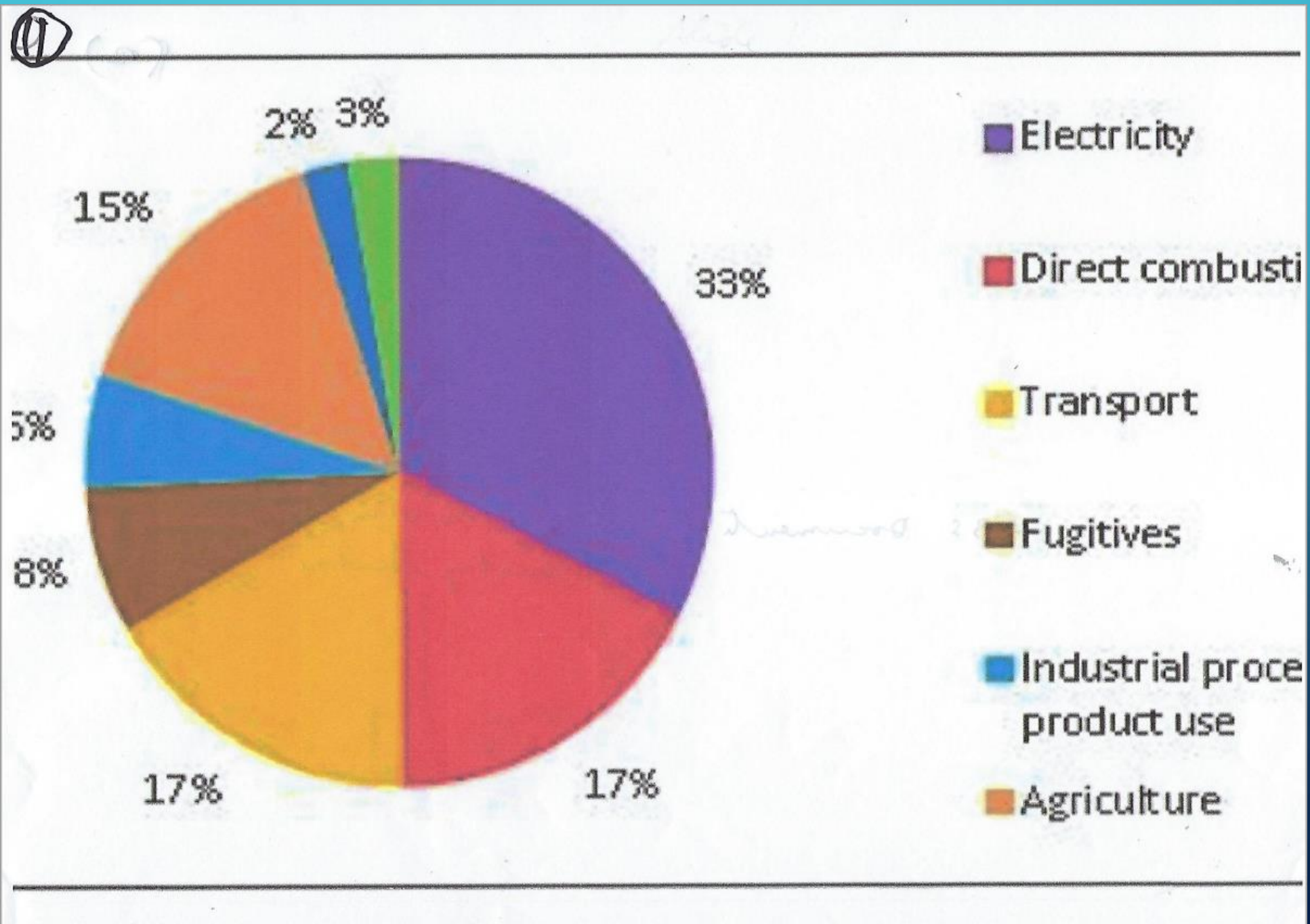
Daten der 1985 ausgebauten Niederdruckturbinen (1):

Parameter	Wert
Druckstufe	1. Stufe
Druckstufe	2. Stufe
Druckstufe	3. Stufe

Historische Informationen:

Die Spindelpumpe ist ein Teil des Dampferkondensators (DWK) im Block 2 des Kernkraftwerks Philippsburg. Sie wurde im Jahr 1985 von der Siemens AG in Berlin hergestellt. Die Spindelpumpe ist ein Teil des Dampferkondensators (DWK) im Block 2 des Kernkraftwerks Philippsburg. Sie wurde im Jahr 1985 von der Siemens AG in Berlin hergestellt.





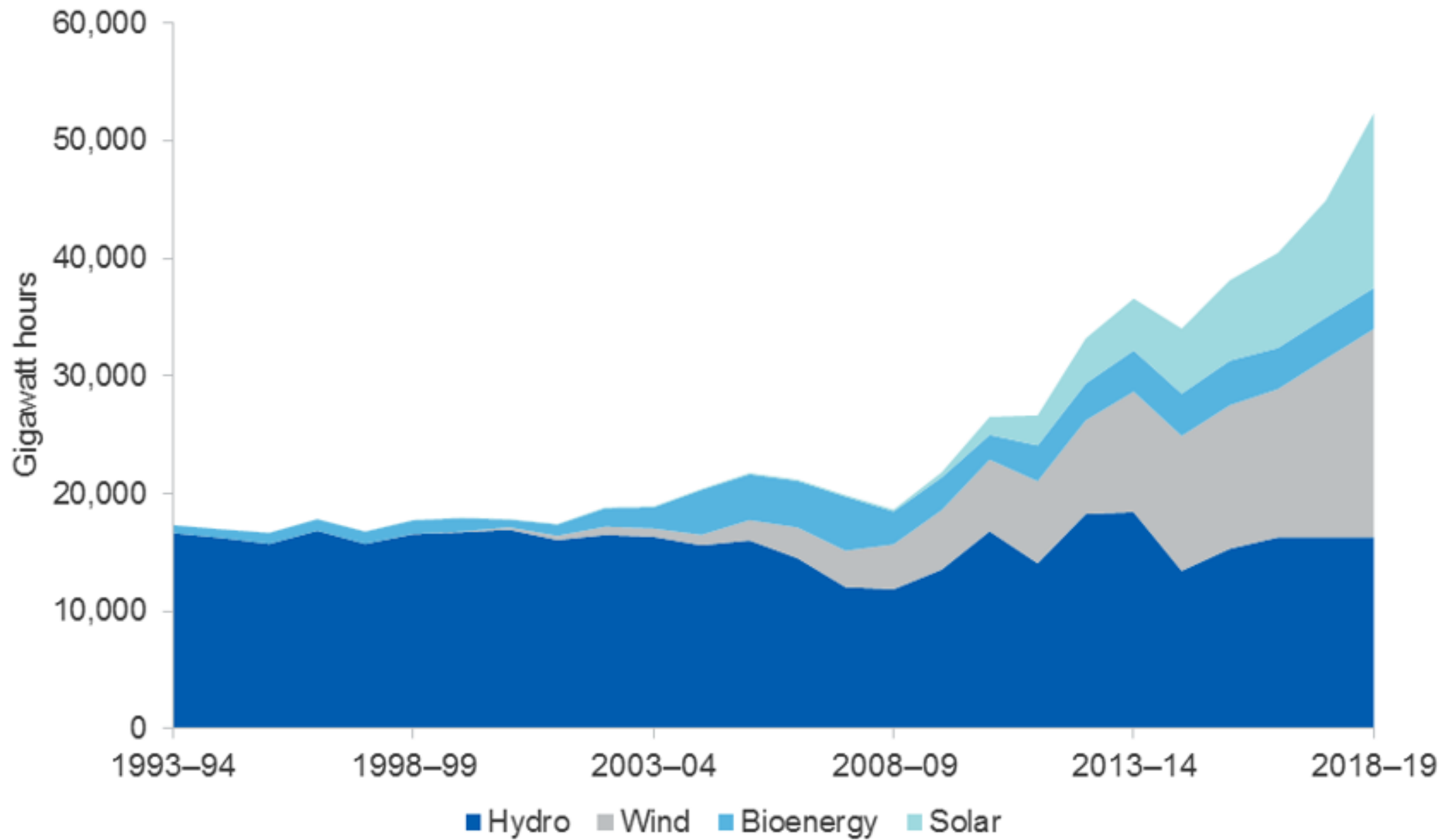
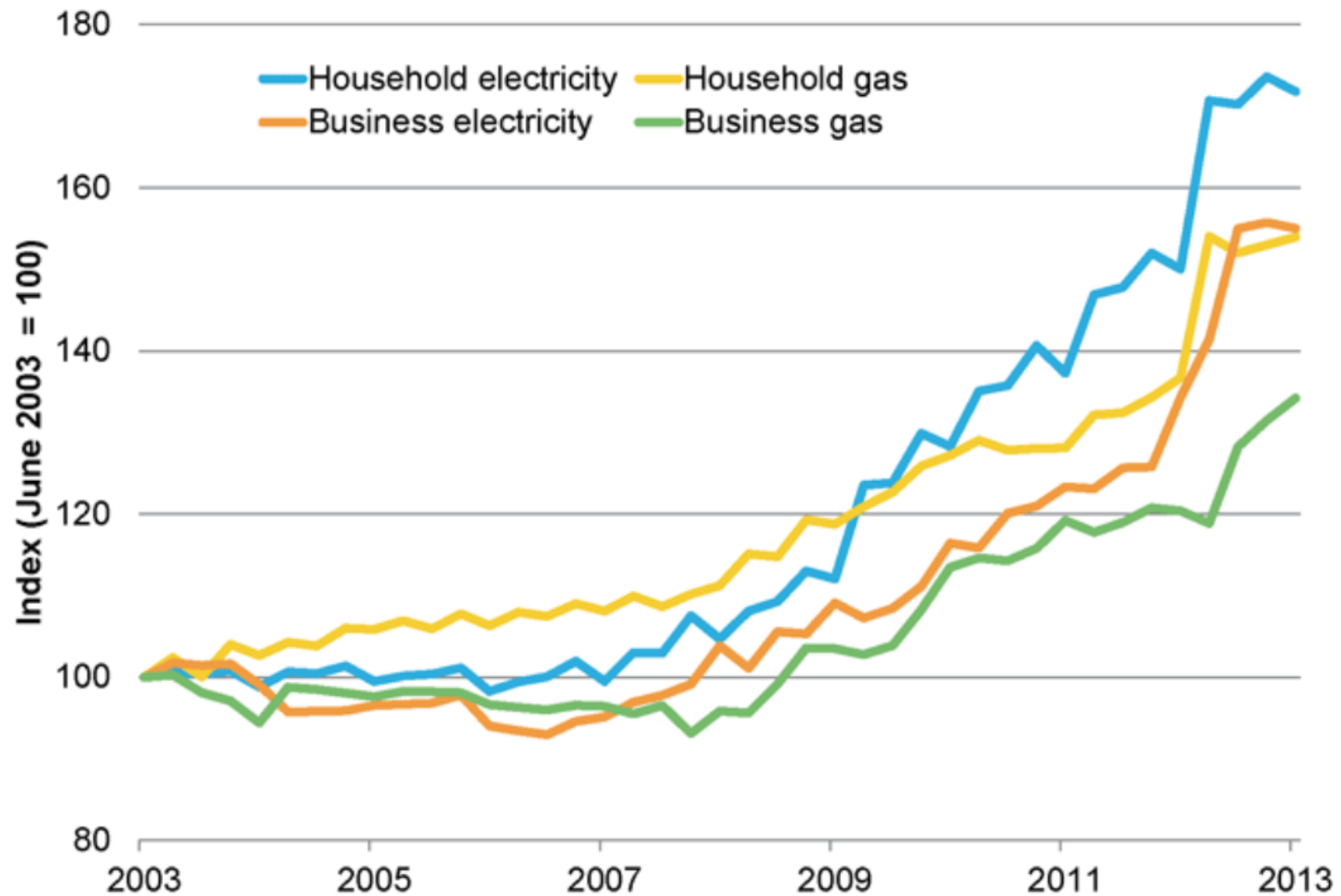


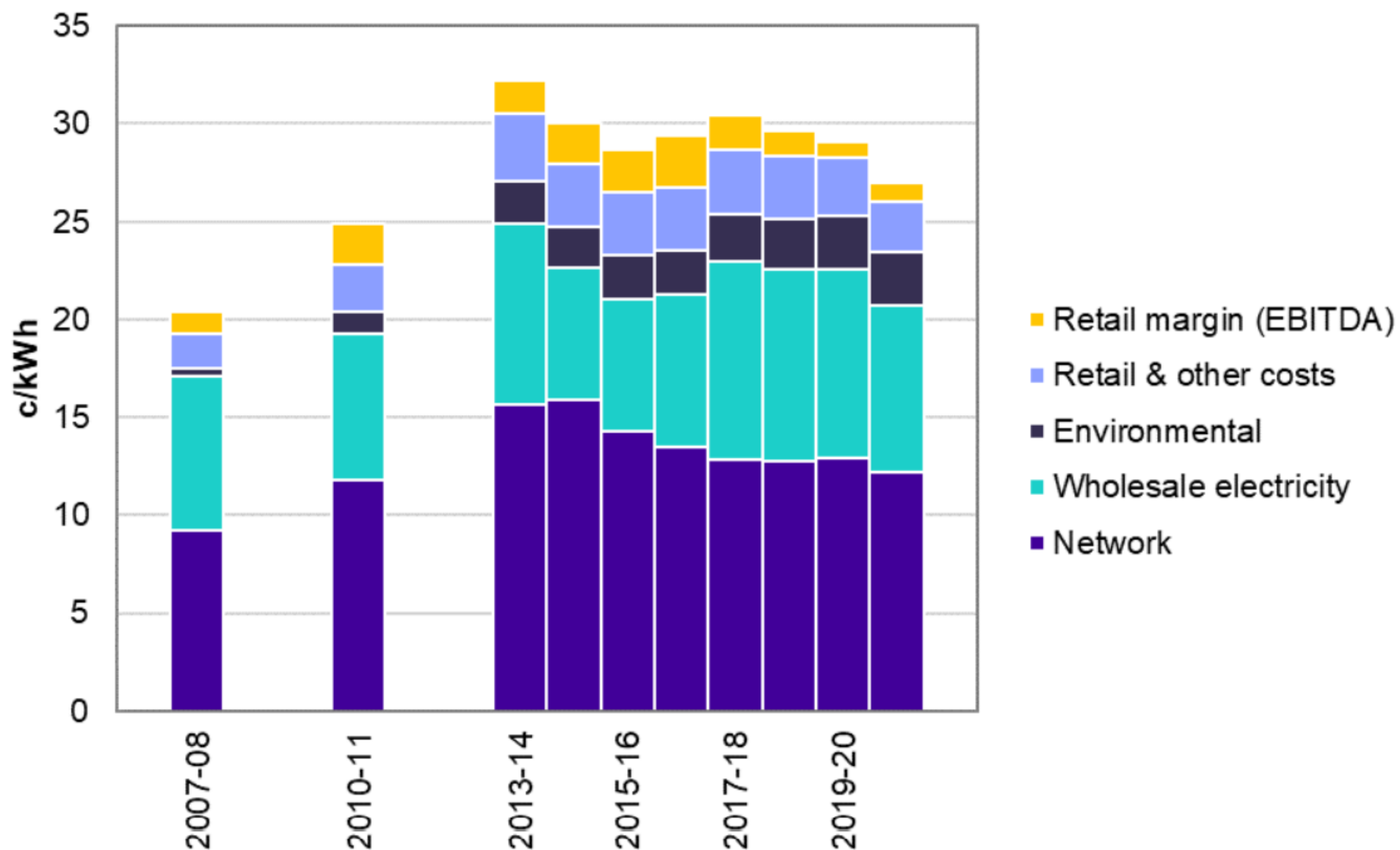
Figure 1: Real electricity and gas price increases, 2003 to 2013



Source: Australian Bureau of Statistics.

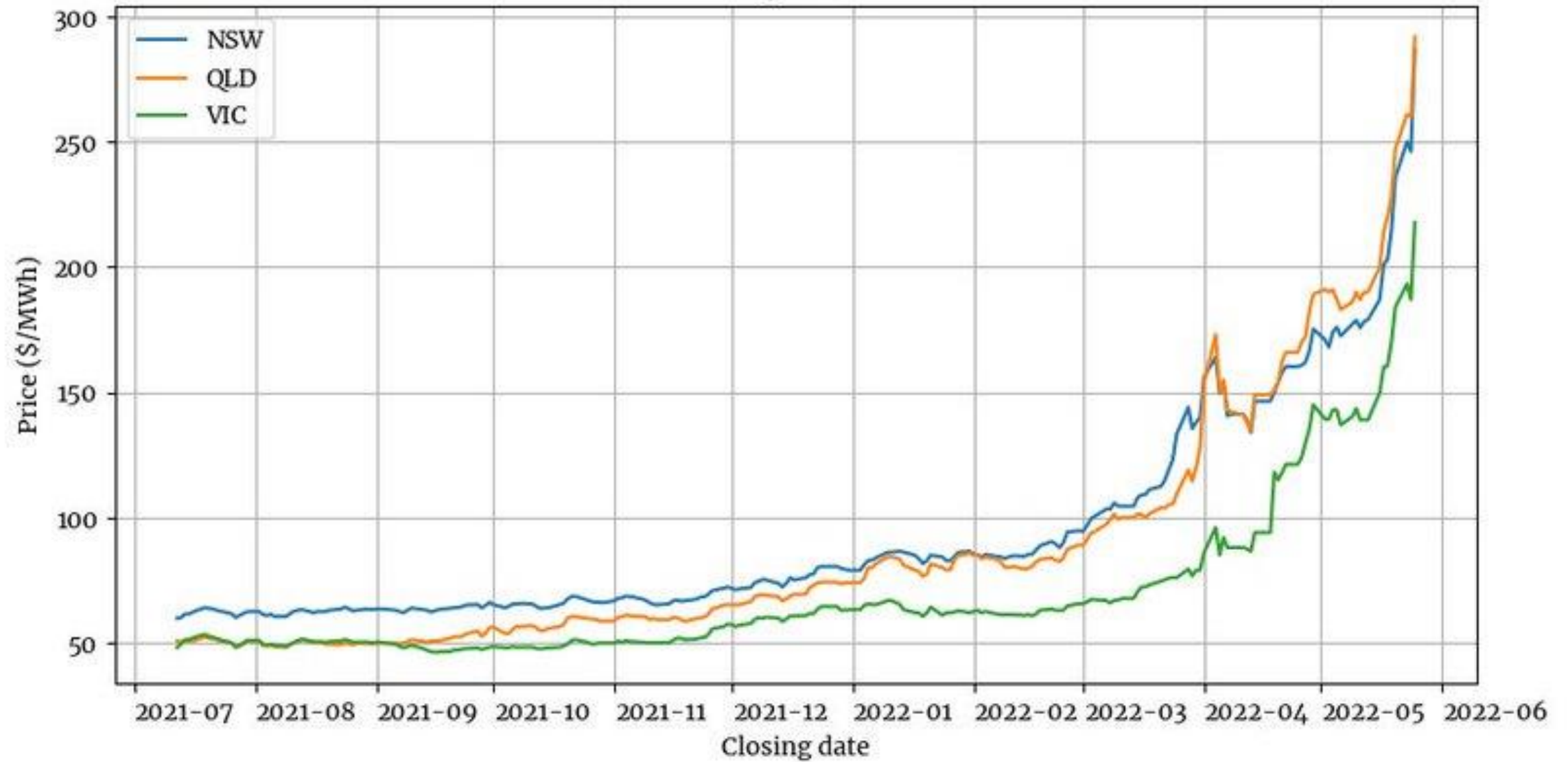
Figure 2.2: Effective price of residential electricity is the cheapest in 8 years

Average residential customer effective price across the NEM from 2007–08 to 2020–21, real \$2020–21, excluding GST



Source: ACCC analysis based on retailers' data.

Baseload contract Q3 2022



NEW SOUTH WALES	
RESIDENTIAL POWER PRICE BREAKDOWN - 2022	
Price Component	Percentage (%)
Poles and Wires	44
Wholesale (generation)	34
Retail Margin	16
Environmental Costs	6
TOTAL	100

WORLD RENEWABLE ENERGY and POWER PRICES

Country	Fraction of National Electrical Energy Produced by Renewables in 2021 (%)	Fraction of National Electrical Energy Planned to be Produced by Renewables in 2030 (%)	Relative Electrical Energy Prices in 2021 - Australia - Index 1
Australia	29	Est. 50	1.00
USA	25	100 ⁸	0.73
Japan	20	38	1.02
China	30	33 ²	0.36
UK	43 ⁶	95 ¹	1.51
France	16 ³		0.86
Germany	45 ⁴	80 ⁵	1.56
South Korea			0.45
Canada	67 ⁷	90 ⁷	0.51
Norway			0.63
Russia			0.39

Note 1. Includes biomass and nuclear

Note 2. By 2025

Note 3. 46% if nuclear included

Note 4. Includes biomass and hydro, 57% if nuclear included

Note 5. Includes nuclear

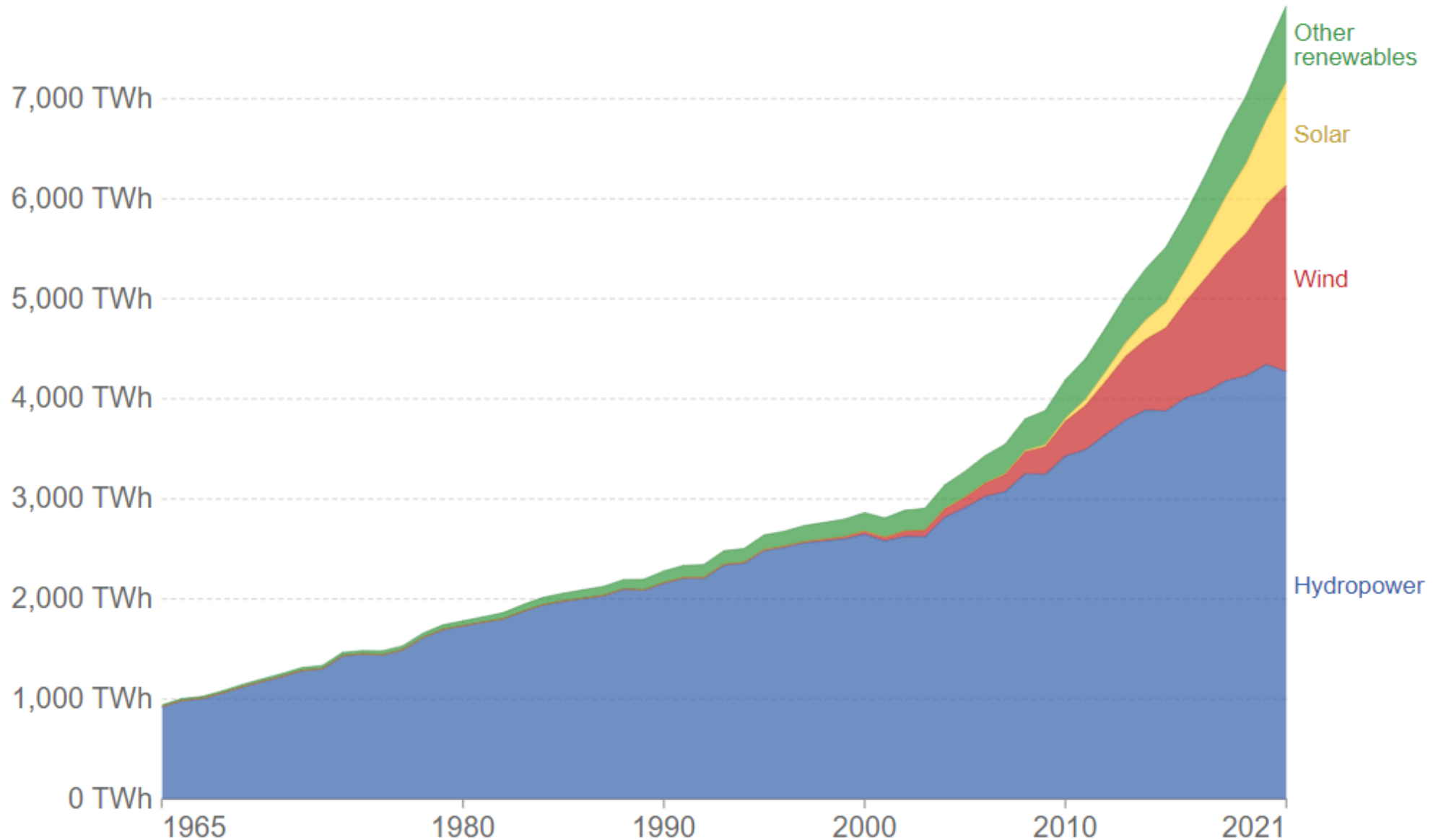
Note 6. Includes biomass

Note 7. Includes hydro, nuclear

Note 8. By 2035, includes nuclear

Renewable energy generation, World

Our World
in Data



Source: BP Statistical Review of Global Energy

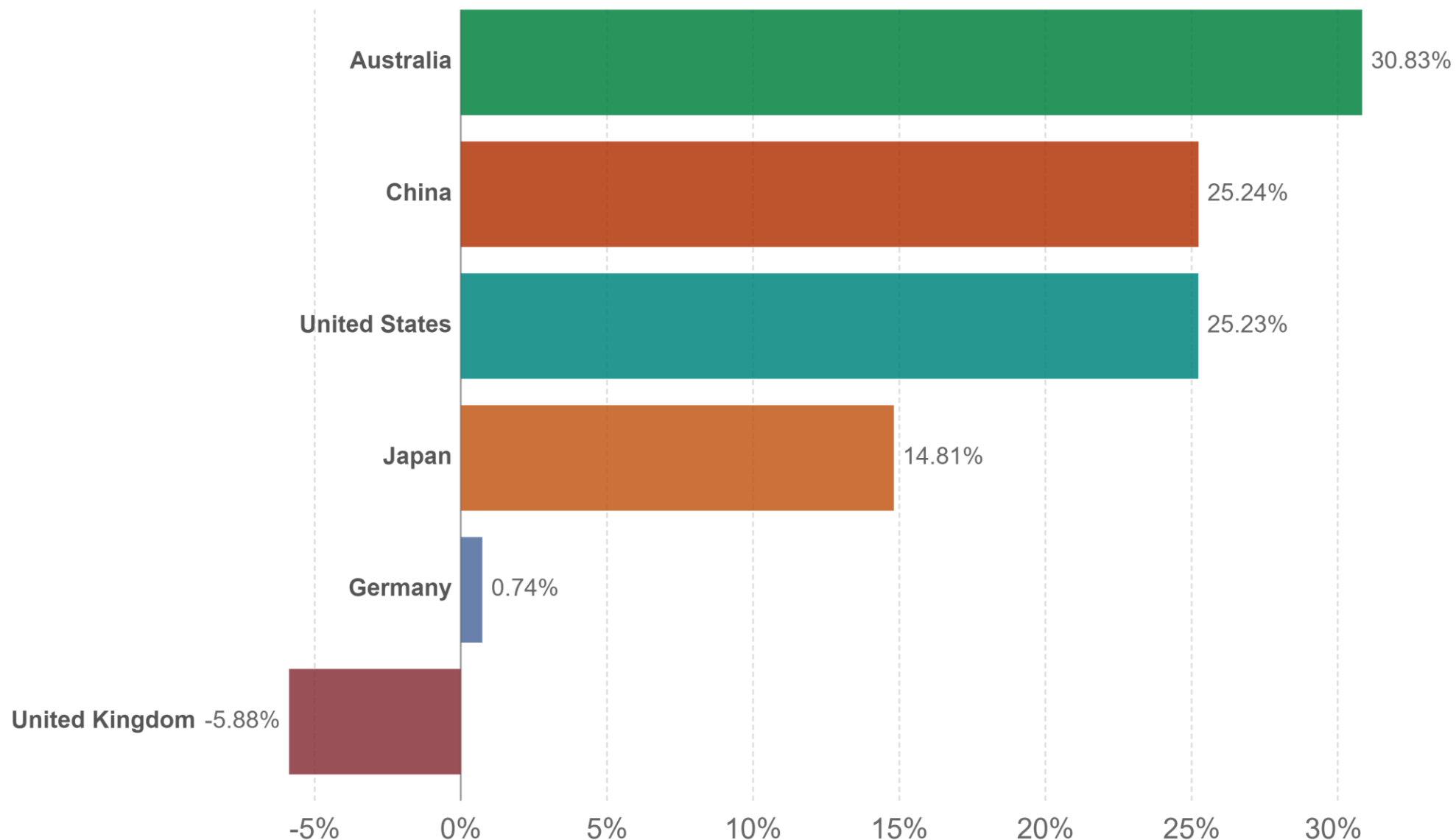
OurWorldInData.org/renewable-energy • CC BY

Note: 'Other renewables' refers to renewable sources including geothermal, biomass, waste, wave and tidal. Traditional biomass is not included.

Annual percentage change in solar energy generation, 2021

Our World
in Data

Shown is the percentage change in solar energy generation relative to the previous year.



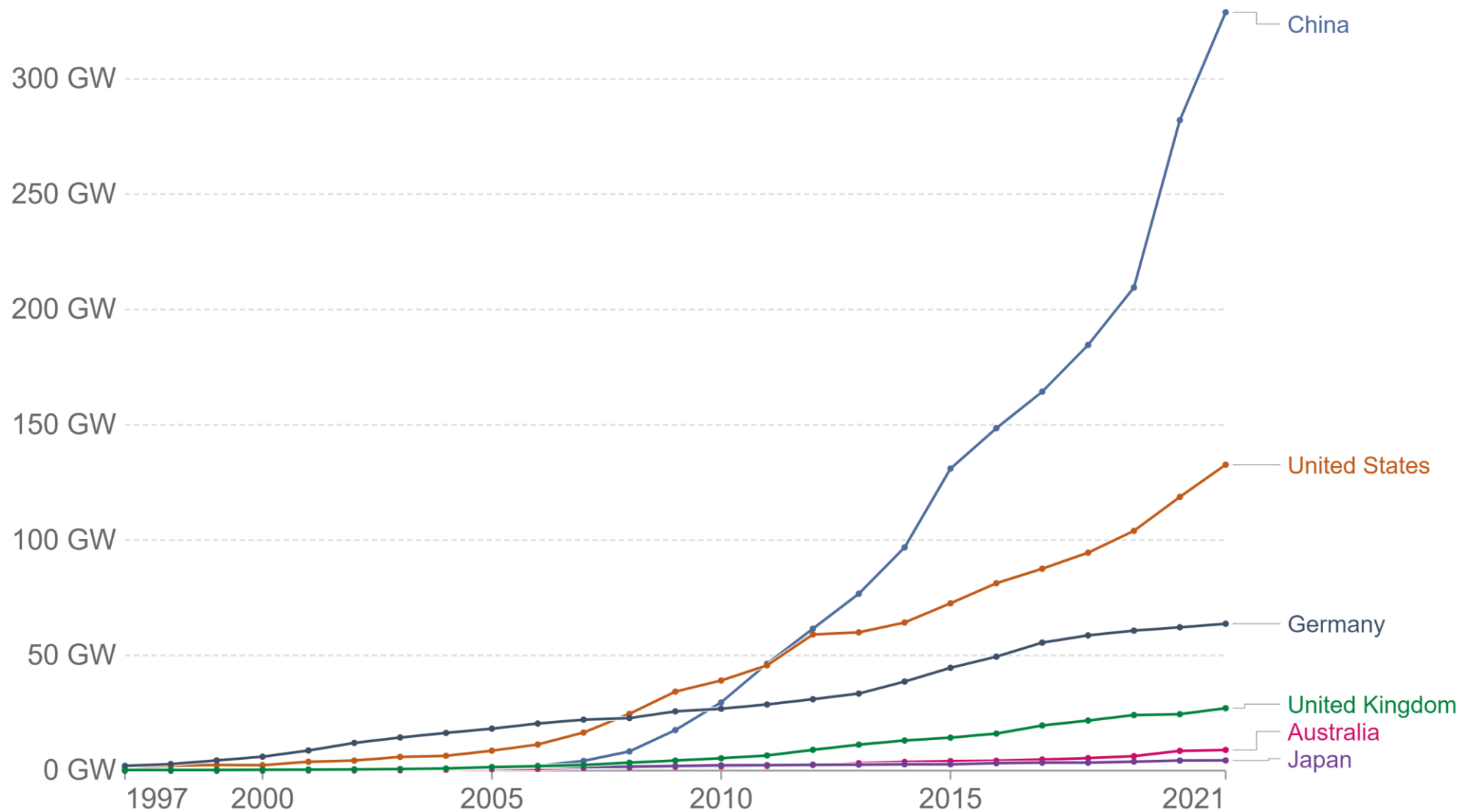
Source: Our World in Data based on BP Statistical Review of World Energy

OurWorldInData.org/energy • CC BY

Installed wind energy capacity

Cumulative installed wind energy capacity including both onshore and offshore wind sources, measured in gigawatts (GW).

Our World
in Data



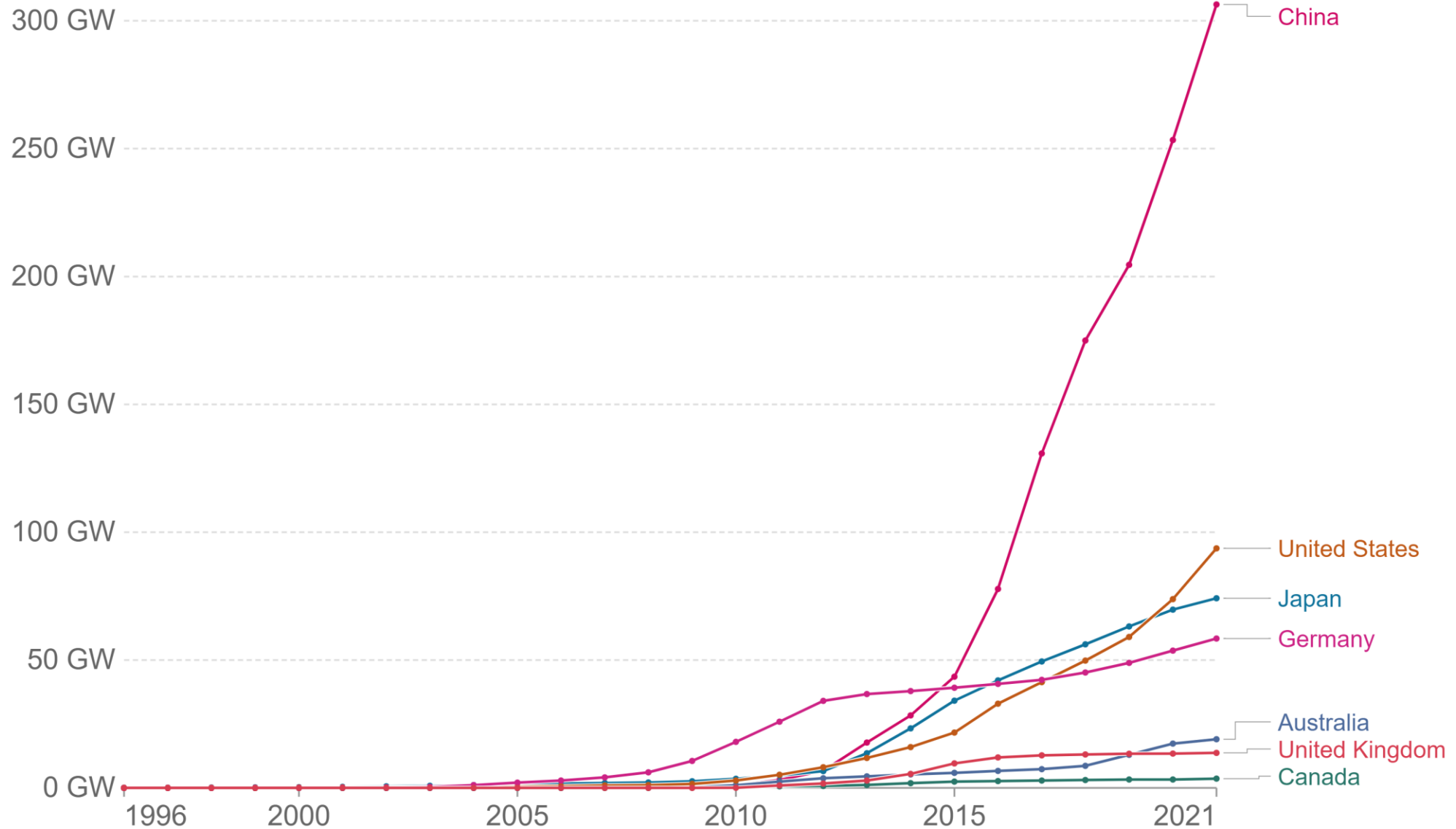
Source: Statistical Review of World Energy - BP (2022)

OurWorldInData.org/renewable-energy • CC BY

Installed solar energy capacity

Cumulative installed solar capacity, measured in gigawatts (GW).

Our World
in Data



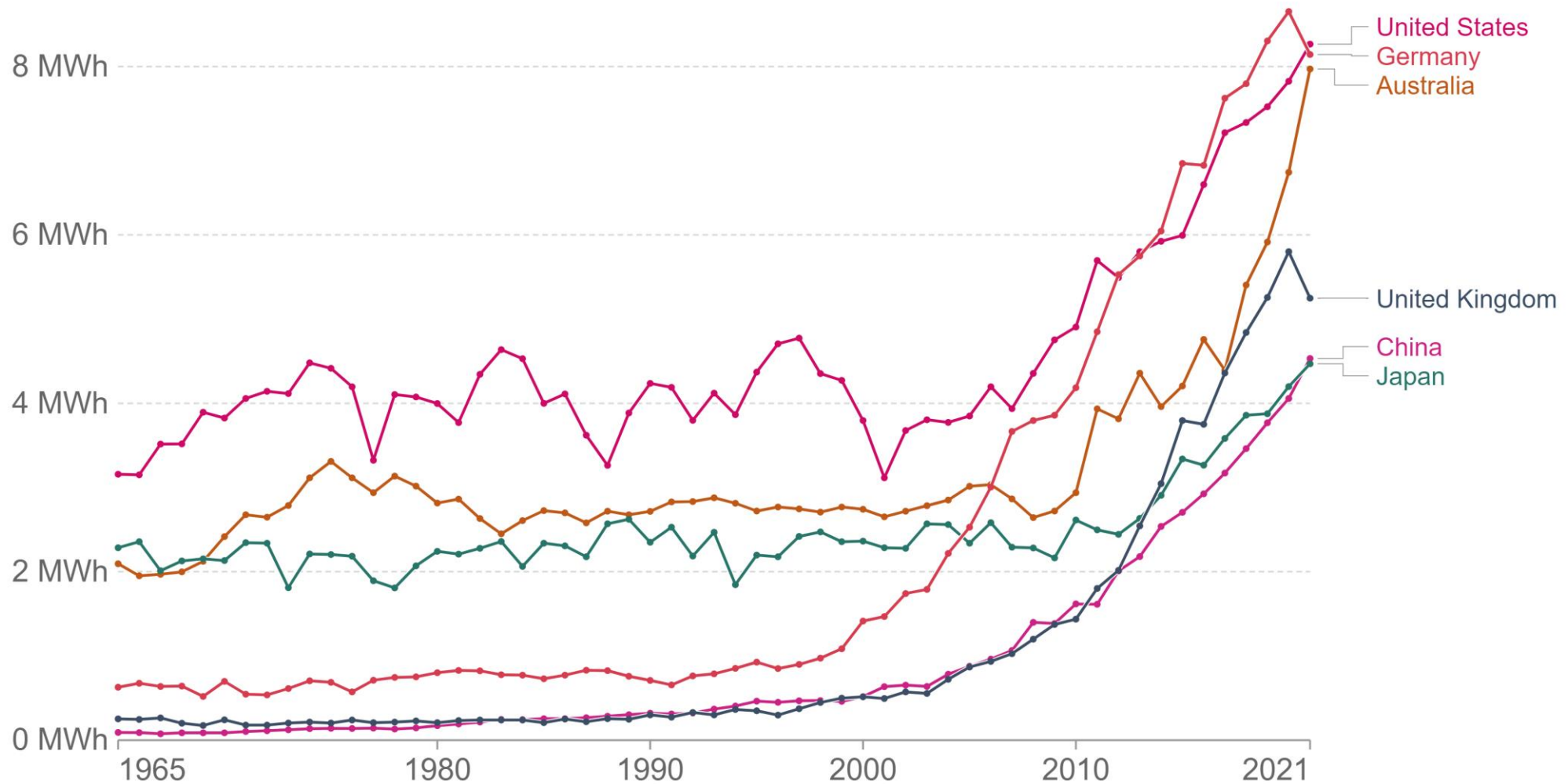
Source: Statistical Review of World Energy - BP (2022)

OurWorldInData.org/renewable-energy • CC BY

Per capita energy consumption from renewables, 1965 to 2021

Our World
in Data

Renewables is the sum of energy from hydropower, wind, solar, geothermal, wave and tidal, and bioenergy. Traditional biofuels are not included.



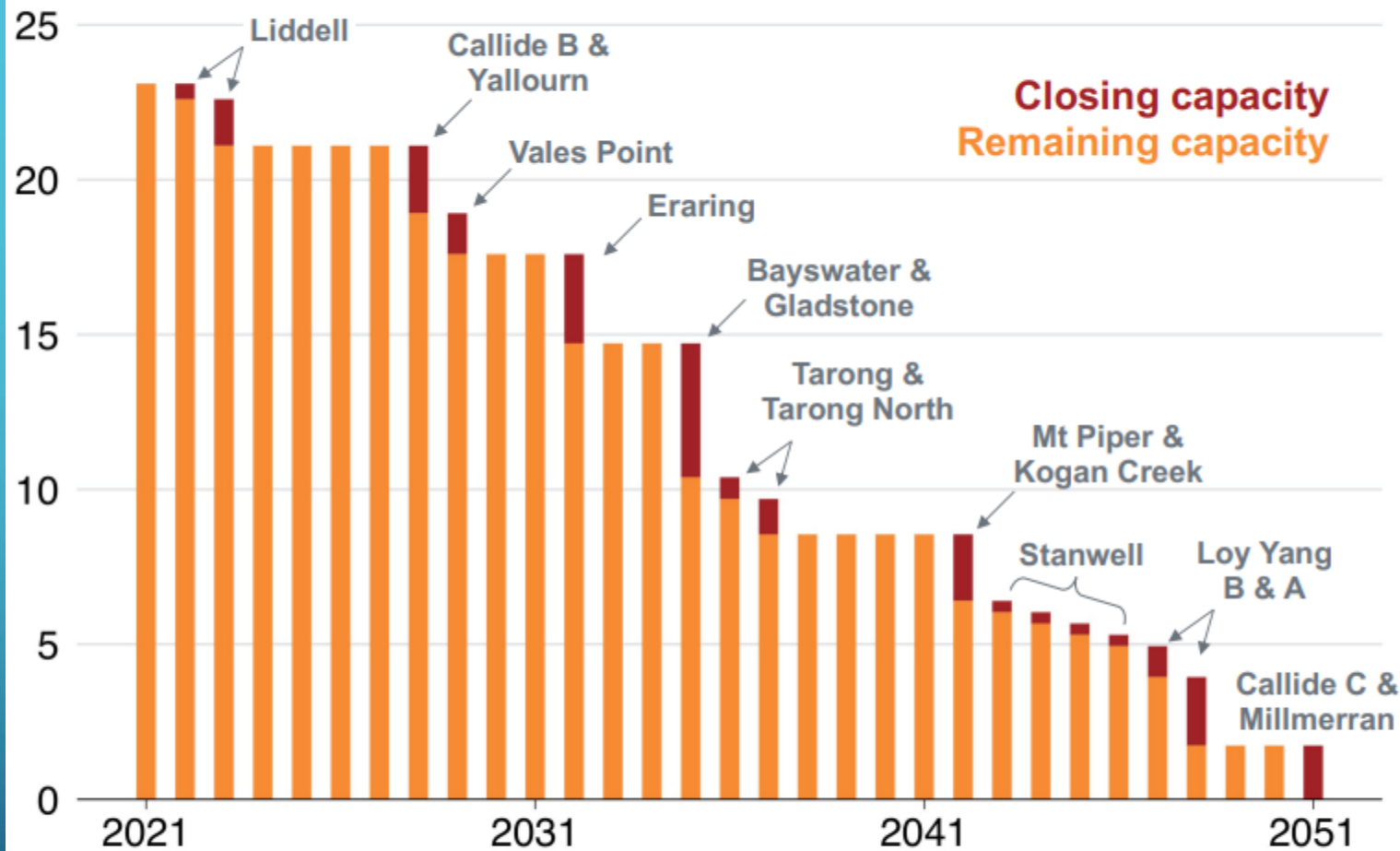
Source: Our World in Data based on BP Statistical Review of World Energy & UN Population Division

OurWorldInData.org/energy • CC BY

Note: 'Primary energy' refers to energy in its raw form, before conversion into electricity, heat or transport fuels. It is here measured in terms of 'input equivalents' via the substitution method: the amount of primary energy that would be required from fossil fuels to generate the same amount of electricity from renewables.

Figure 1.1: Most of Australia's coal-fired power stations are scheduled to be retired over the next few decades

Scheduled capacity, gigawatts



Note: No closure date has been announced for Callide C, but the Australian Energy Market Operator (AEMO) estimates it will close in 2051, based on the technical life of the plant: AEMO (2020a).

Sources: Grattan analysis of AEMO (2021a), AEMO (2021b) and EnergyAustralia (2021).

Figure 20 Forecast coal retirements, *Step Change* technology and regional outlook

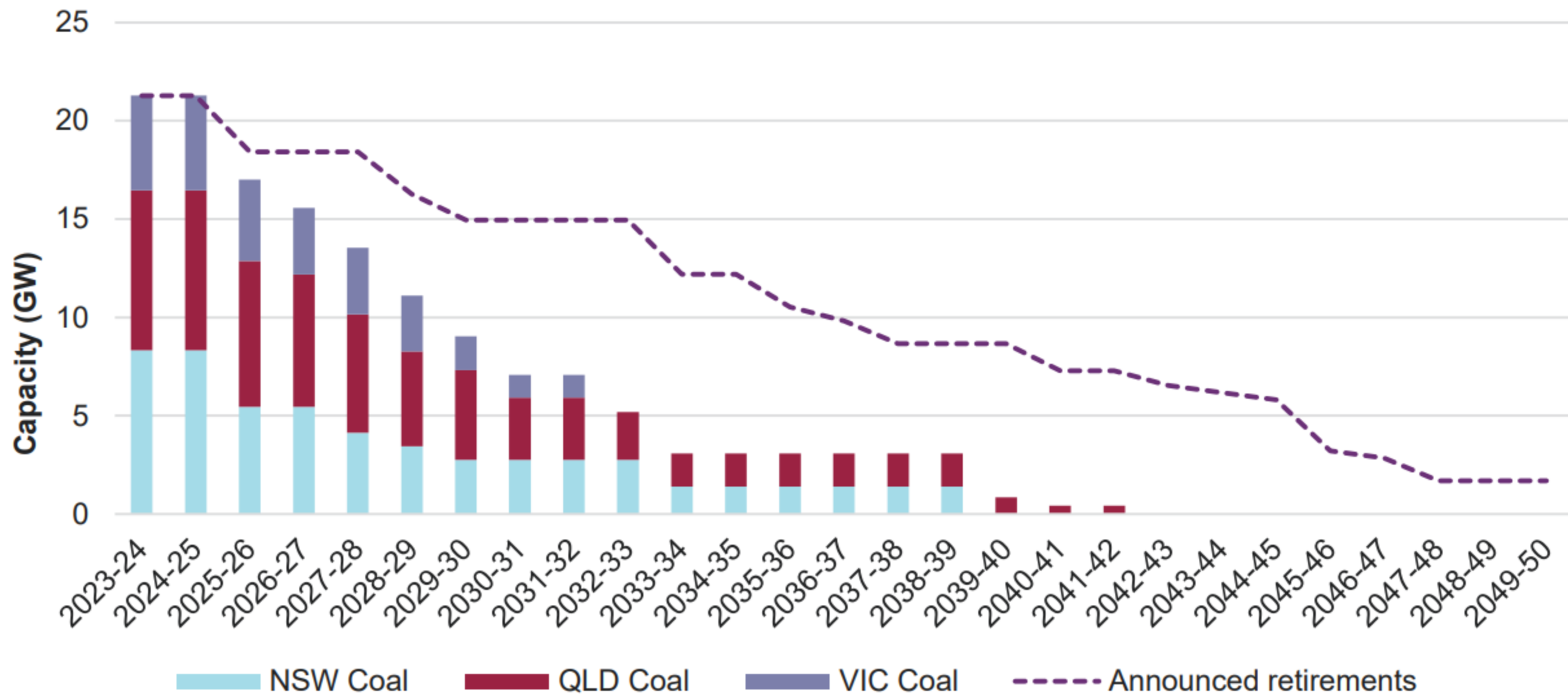


Figure 8 NEM carbon budgets and the resulting emission trajectories

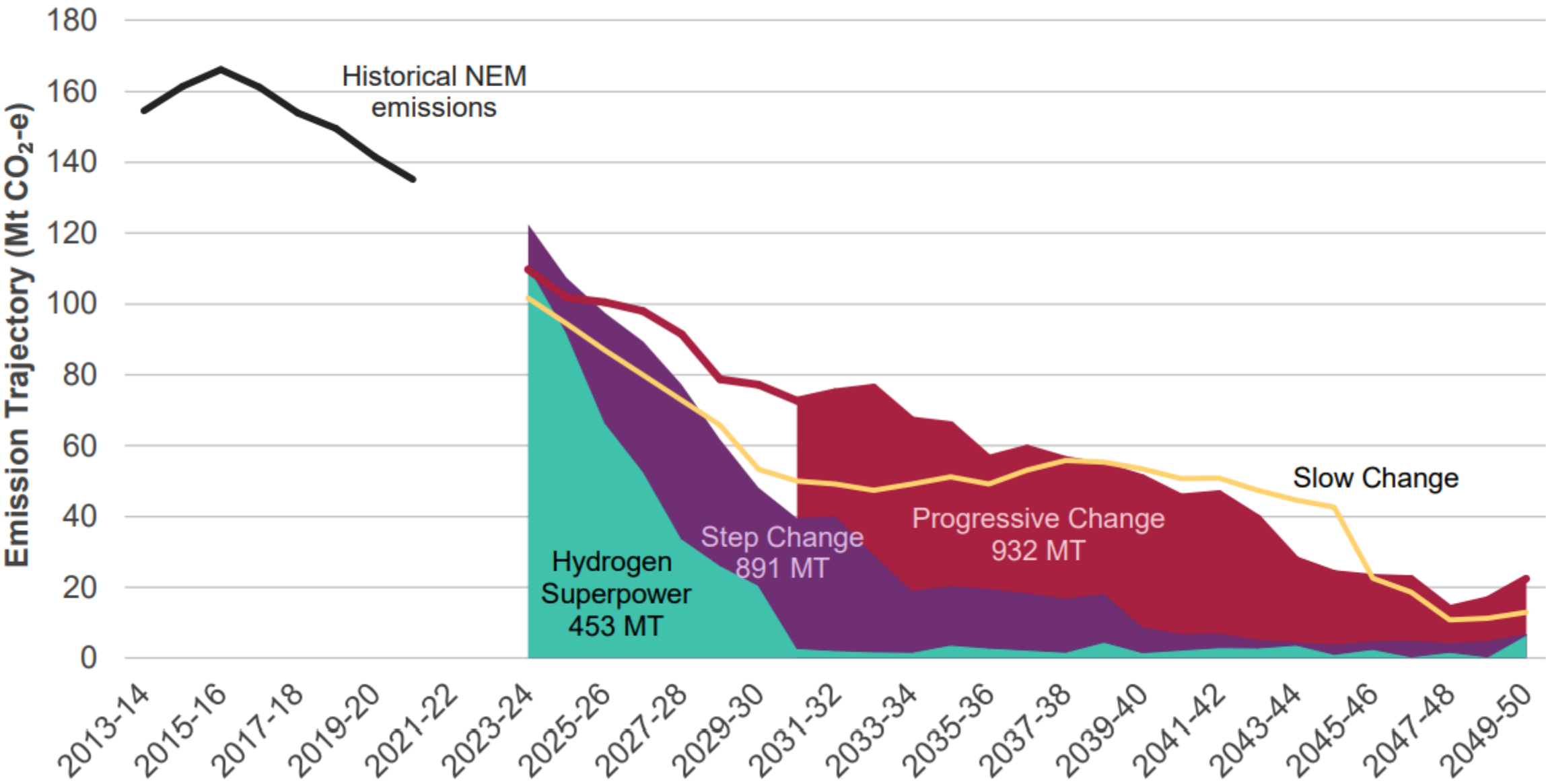


Figure 14 Daily NEM-wide actual and projected VRE availability

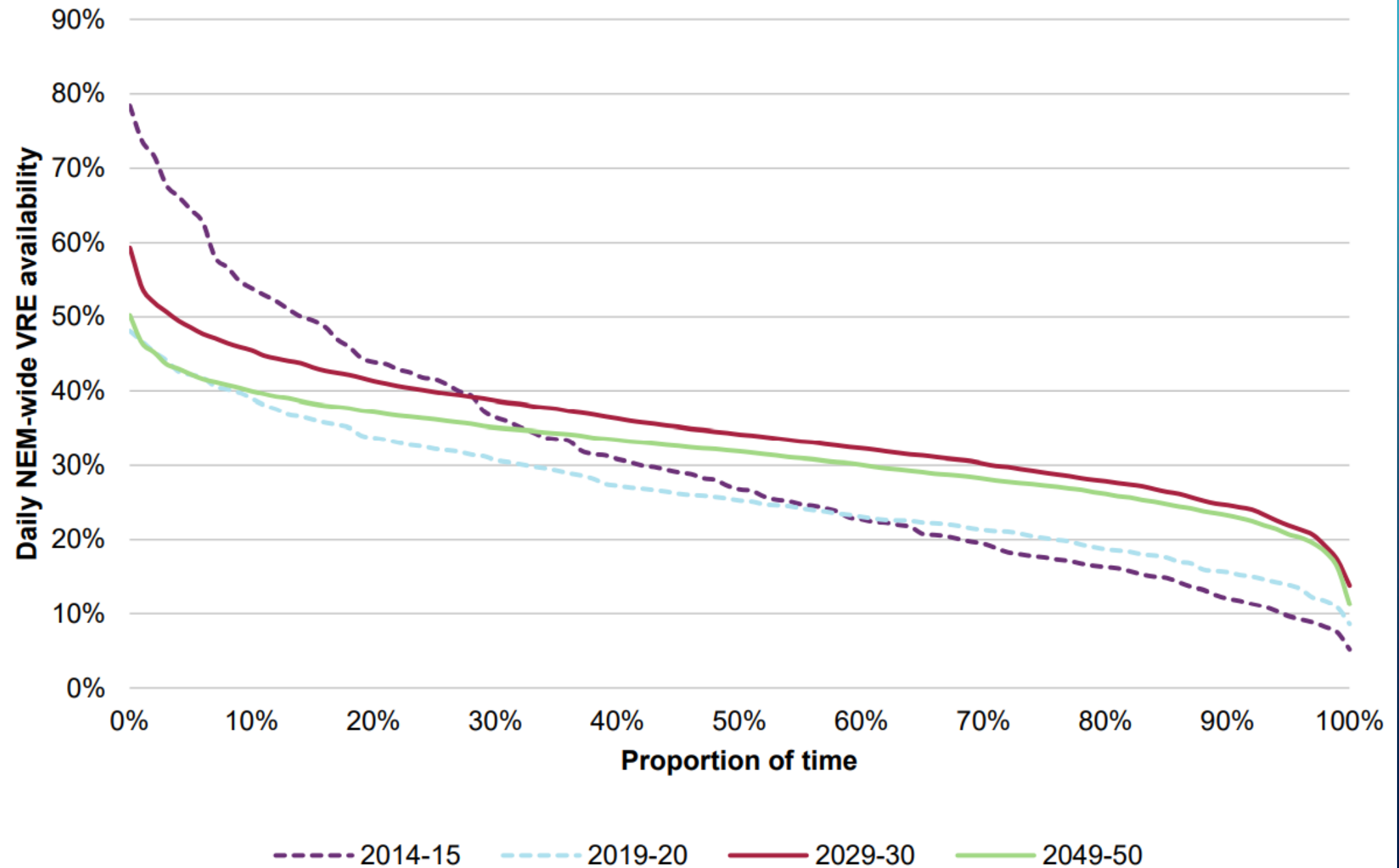
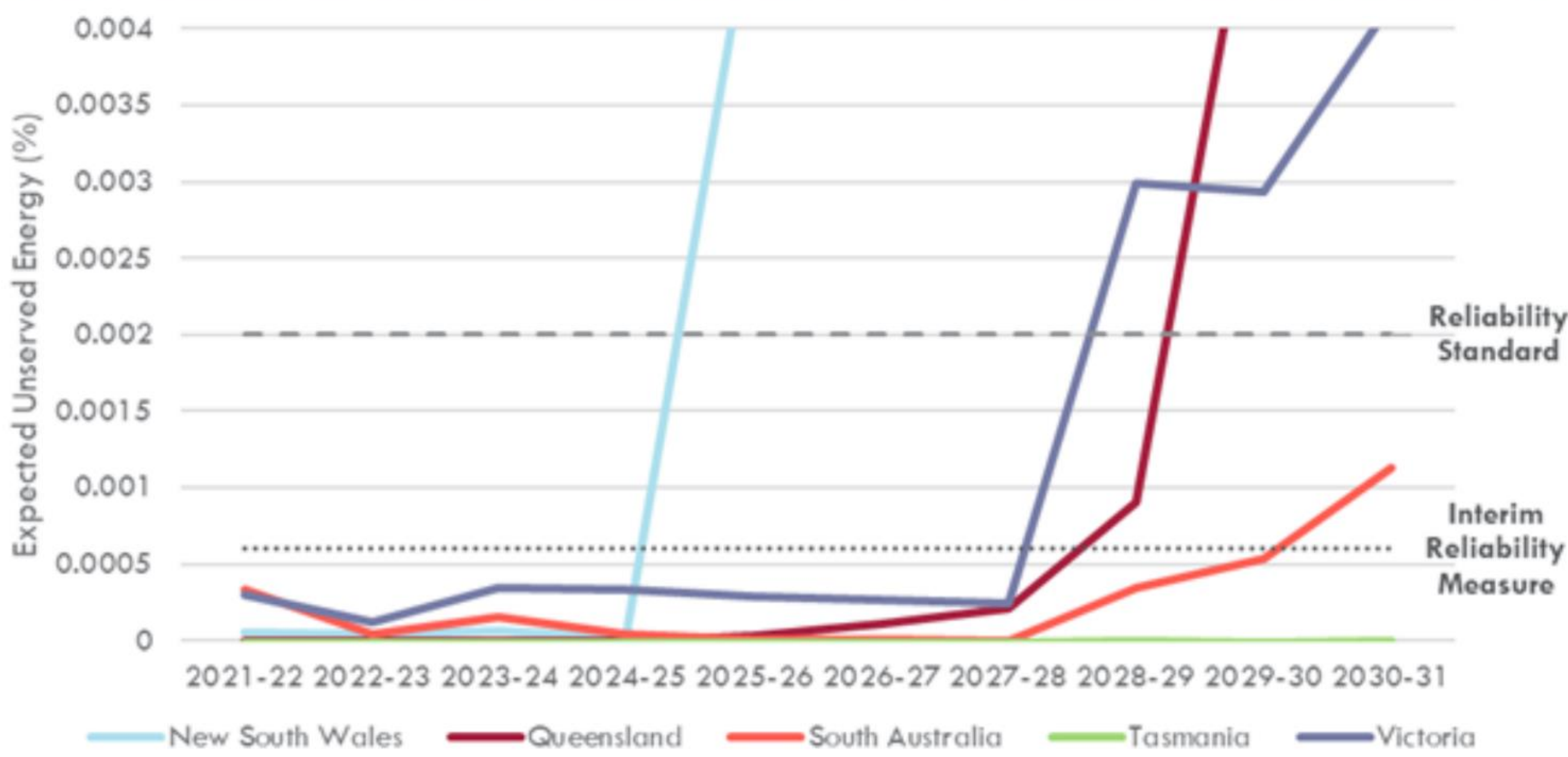


Figure 3 Reliability and indicative reliability forecasts, all regions, Committed case, 2021-22 to 2030-31



WORLD - NUCLEAR POWER CAPACITY			
Country	Presently Installed (& Operational) Capacity (MW)	Under Construction (MW)	Planned Fraction of Electrical Energy by 2030 (%)
Australia	0	0	0
USA	96,000	2,000	20
Russia	29,000		
Japan	32,000	3,000	20
France	61,000		Est. 65 -70
China	50,000	17,000	20
UK	7,000	3,000	25
South Korea	26,000		
Canada	13,500	0	
India	7,000	8,000	
World	400,000		





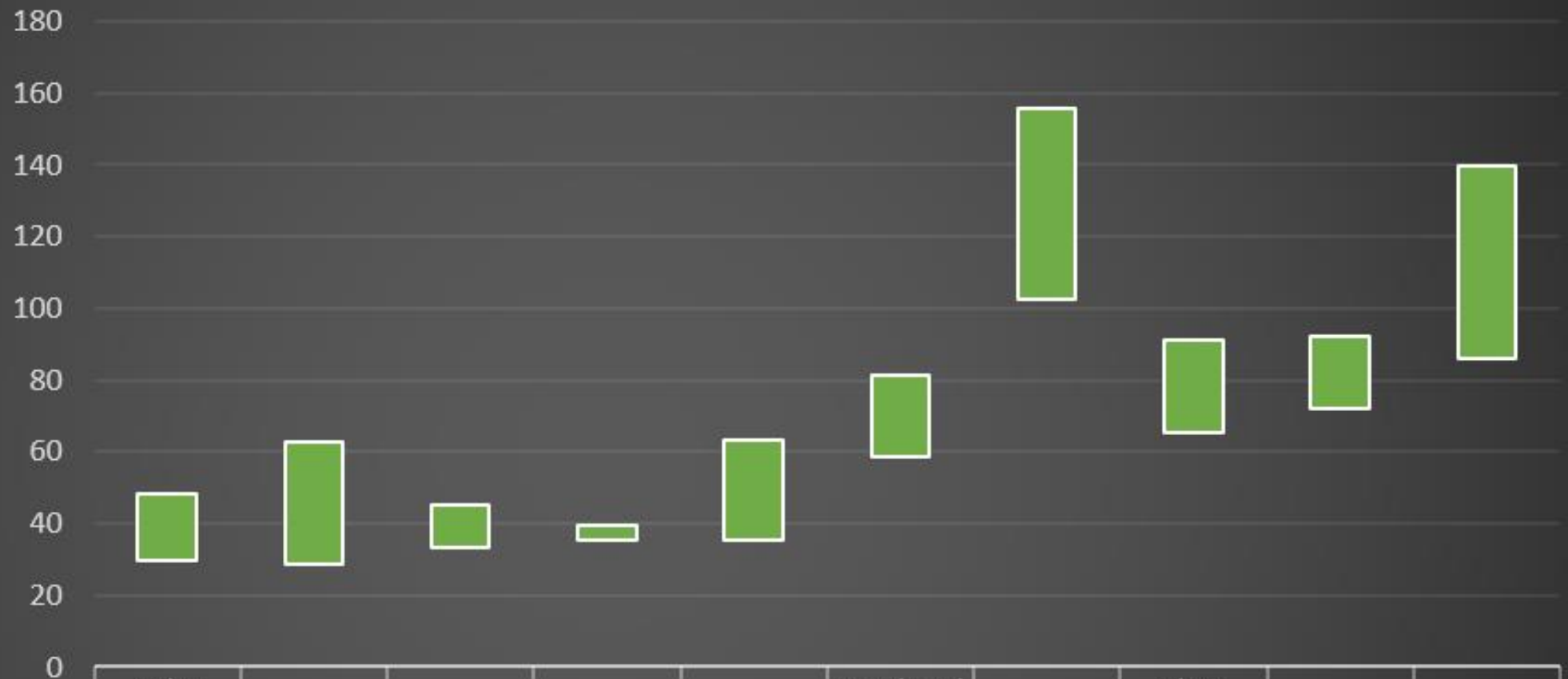








Projected LCOE USA by 2025 (as of 2020)



	Solar photovoltaic (PV)	Wind, onshore	Combined cycle	Geothermal	Hydroelectric	Combustion Turbine	Wind, offshore	Ultra-supercritical coal	Advanced Nuclear	Biomass
Min	29.75	28.72	33.35	35.13	35.37	58.48	102.68	65.1	71.9	86.19
Simple Average	35.74	39.95	38.07	37.47	52.79	66.62	122.25	76.44	81.65	94.83
Capacity weighted average	32.8	34.1	36.61	37.47	39.54	68.71	115.04			
Max	48.09	62.72	45.31	39.6	63.24	81.37	155.55	91.27	92.04	139.96

Chart 4.1: NOAK Projects commissioning in 2025, in real 2018 prices²³

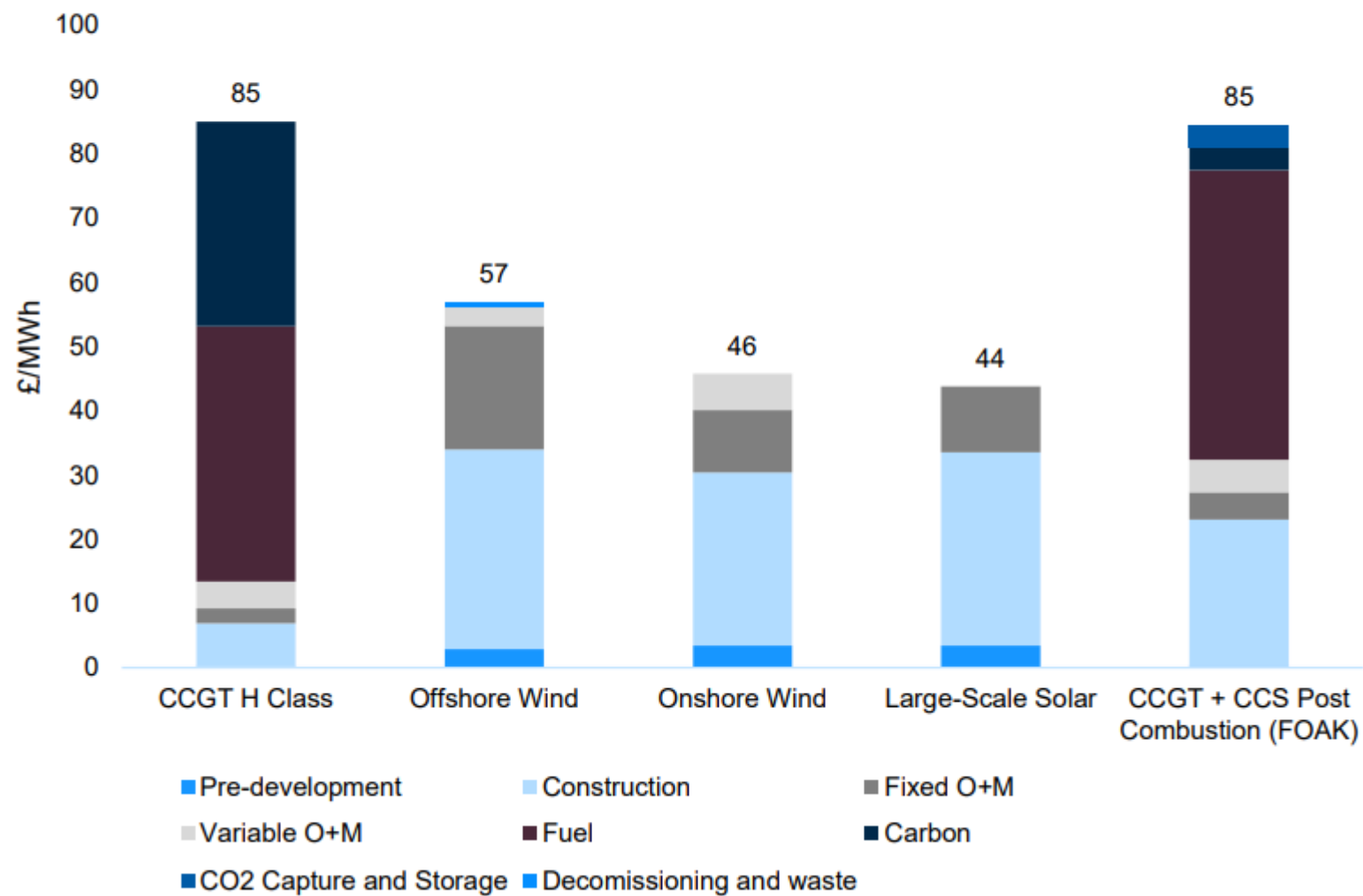


Figure 1 Forecast NEM capacity to 2050, Step Change scenario

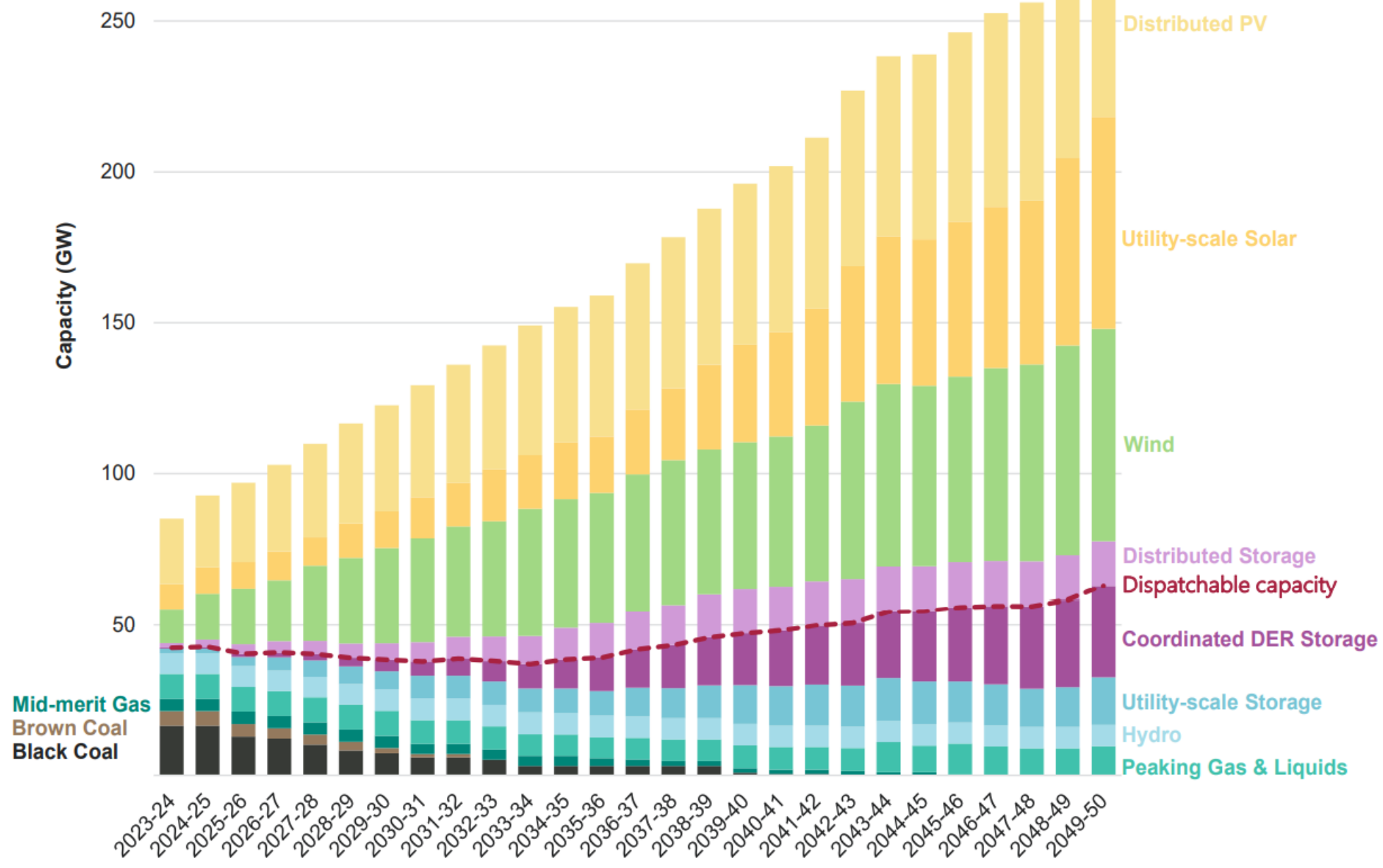
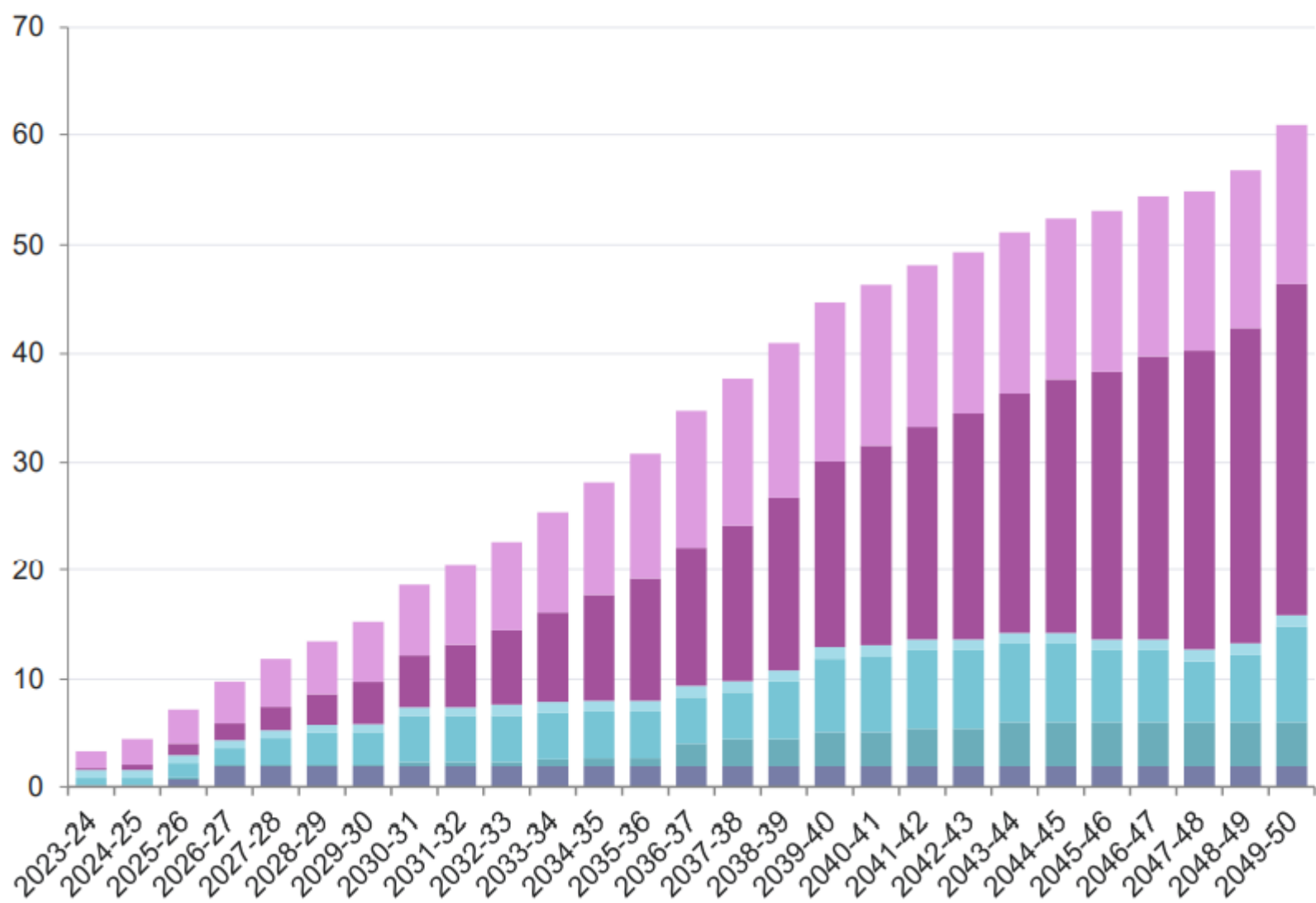
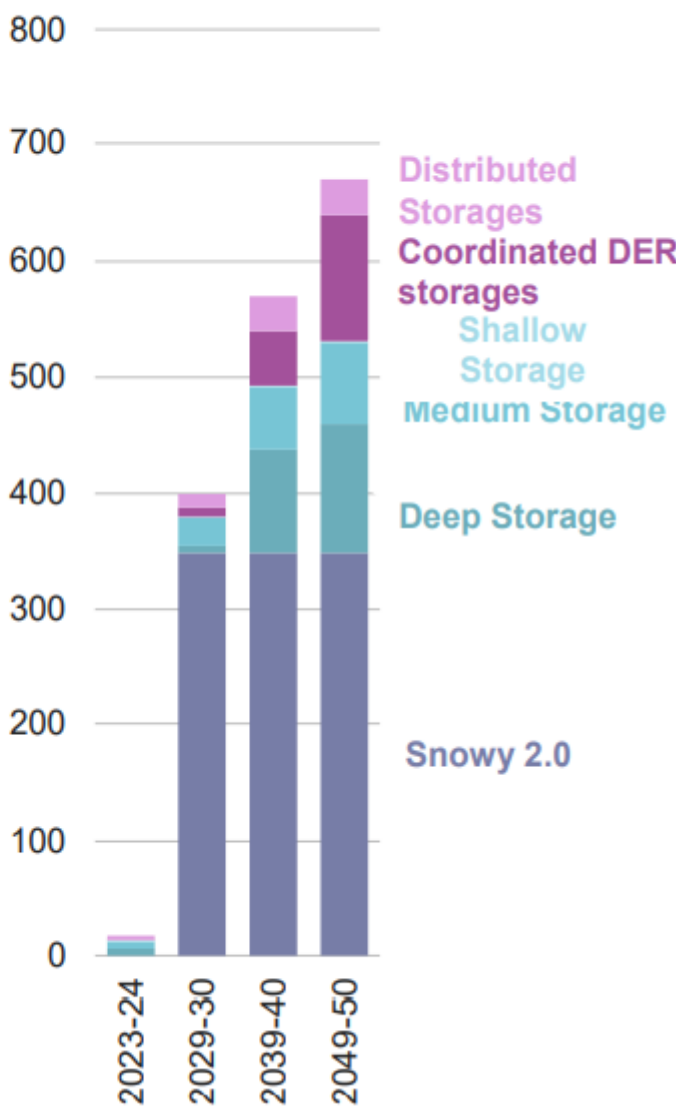


Figure 23 Forecast of MW storage capacity (left) and energy storage capacity (right), Step Change

Installed Capacity,
GW



Storage Depth, GWh



AUSTRALIA - NATIONAL ELECTRICITY MARKET

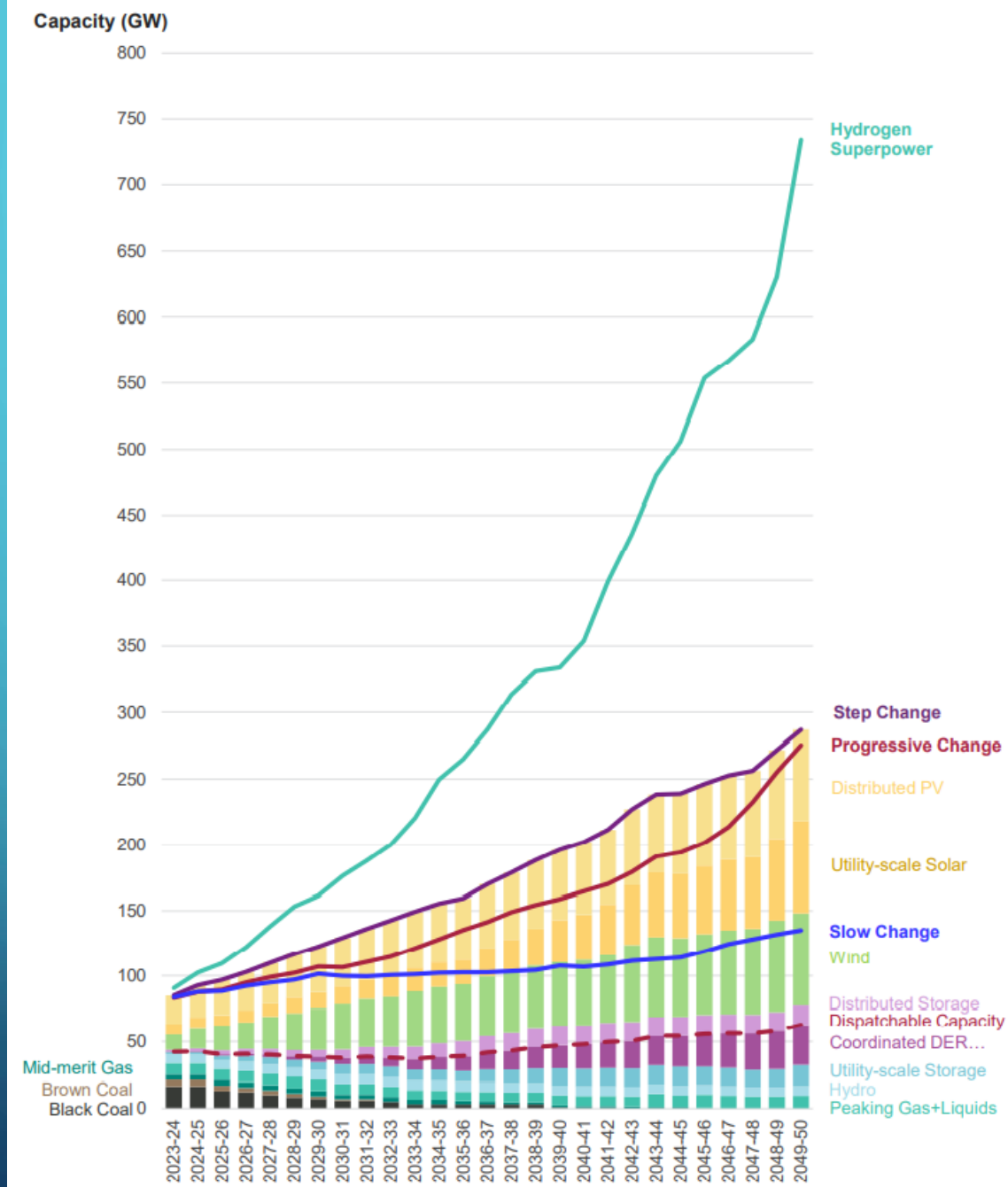
CAPITAL EXPENDITURE REQUIRED TO PROVIDE RENEWABLES SUFFICIENT TO ACHIEVE NET ZERO CO₂ BY 2050

Generation or Energy Storage Type	Capacity (MW)	Unit Cost to Install \$/MW	Total Cost (\$ billions)
1. Rooftop Solar	70,000	1,400 (no batteries)	98
2. Utility Scale Solar	70,000	700	49
3. Wind	75,000	1,500	112
4. Distributed Storage (home batteries)	15,000	500	7
5. Coordinated DER Storage (vehicle batteries).	30,000	1,000	30
6. Utility Scale Storage	15,000	1,000	15
7. Hydro	6,000	3,000	18
8. Gas Fired Thermal	8,000	1,600	13
9. Transmission (km)	10,000	1,000/km	10
TOTAL	289,000		352

HYDROGEN vs BATTERIES

	HYDROGEN		BATTERIES	
Energy Conversion Option	Electrolysis / fuel cell / electric motor		Li-ion / electric motor	
Transport to consumer	Road/rail to retail point of sale		Transmission line to retail charging station	
Energy efficiency	Electrolysis	70%	Transmission	95%
	Compression	85%	Battery charge	99%
	Transport to consumer	80%	Engine Conversion	90%
	Fuel cell conversion to electricity	60%	Battery leakage	90%
	DC to AC conversion	90%		
	Engine conversion	90%		
	TOTAL	23%		76%
Cost per kilometre (index)	8.0		1.0	
Time to refill	5 minutes		3 hours	

Figure 11 Development opportunities to 2050 in *Step Change*, and compared to total capacity required in *Progressive Change* and *Hydrogen Superpower*



An abstract graphic on the left side of the slide, consisting of a network of white lines and small circles on a dark blue background, resembling a circuit board or a neural network. The lines are of varying thickness and connect to small white circles of different sizes.

THE END