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Small Modular Reactors Infographics

Sydney-based nuclear energy consultancy SMR Nuclear Technology Pty Ltd (SMR-NT) has issued a set of infographics to provide policymakers and the Australian community with a better understanding of the real differences between SMRs, solar, wind and fossil fuels for electricity generation.

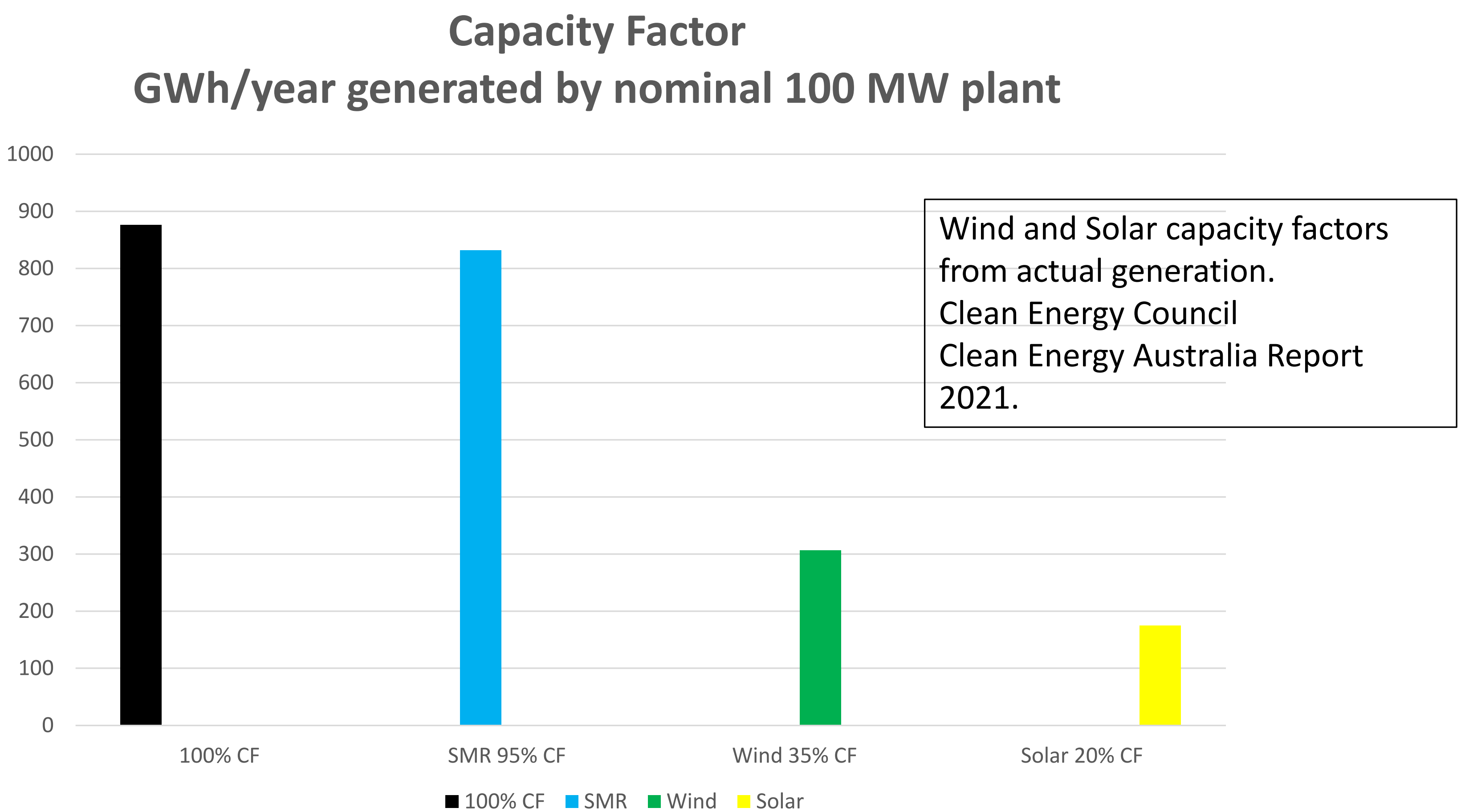
Australians cannot afford a short-term view of generation costs. They need to take a measured approach which weighs up the costs of the different technologies over their lifetimes. Planners can then work out the real costs to the overall power system.

The cost of transmitting bulk electricity would be dramatically increased by the number of small solar and wind generators that needed to be connected to the grid.

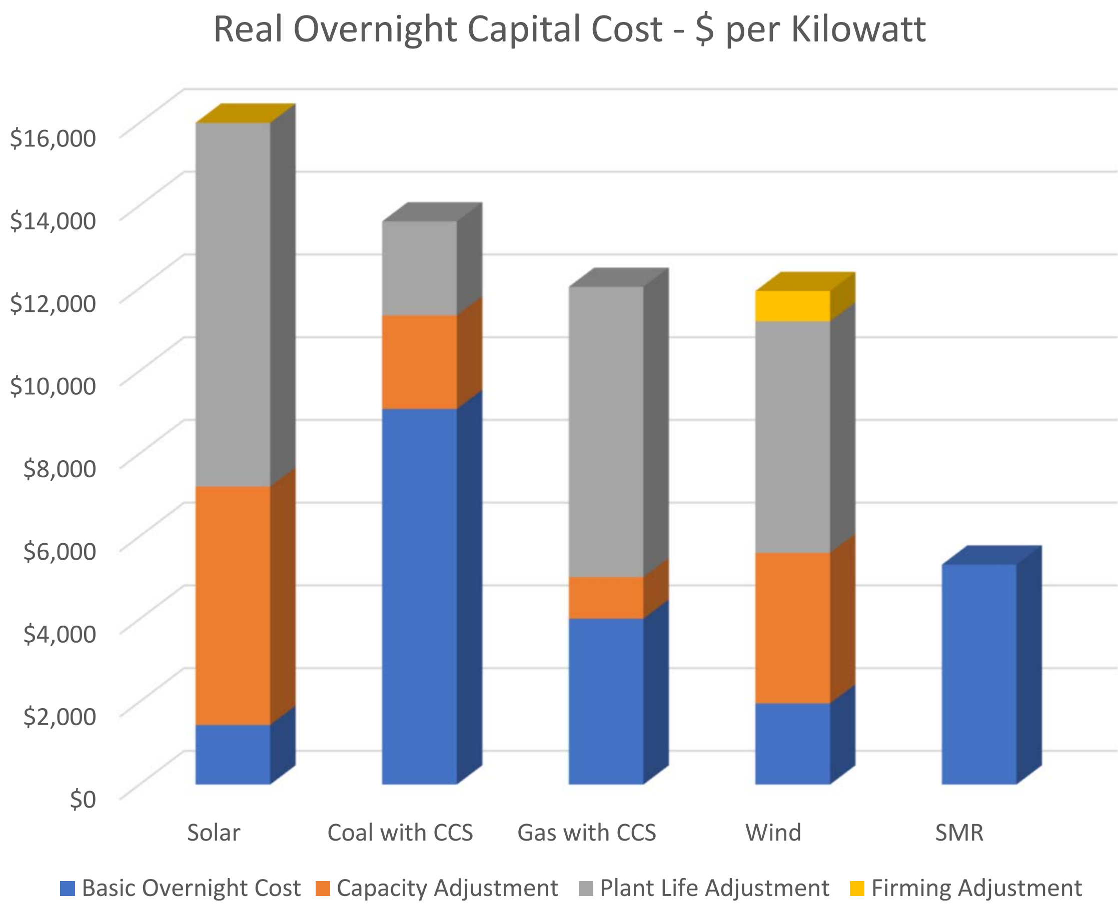
A major advantage with nuclear generation in pursuing Australia's 2050 net zero goals, especially with the modern Small Modular Reactors (SMRs), is that they can be connected to the existing power grid and avoid much of the cost of new transmission infrastructure. This could generate national savings of billions of dollars.

All low emissions technologies will be needed to achieve Australia's net zero goals: Each low emissions technology brings different advantages - the big challenge is determining the right technology mix for the minimum long-term system cost. In this respect, SMRNT's infographics will be of value to both policymakers and the general public.

Further information: *tony.irwin@smrnuclear.com.au*



When you contract for a 100 MW power plant you actually get the generated output of 95 MW for an SMR (832.2 GWh/y) or 35 MW for a wind farm (306.6 GWh/y) or 20 MW for a solar plant (175.2 GWh/y)



Solar > $17,732/kW*
Wind > $11,932/kW*
SMR $5,596/kW
Gas with CCS $12,033
Coal with CCS $13,616

*Solar and wind have connection and interstate transmission costs in addition to these costs.

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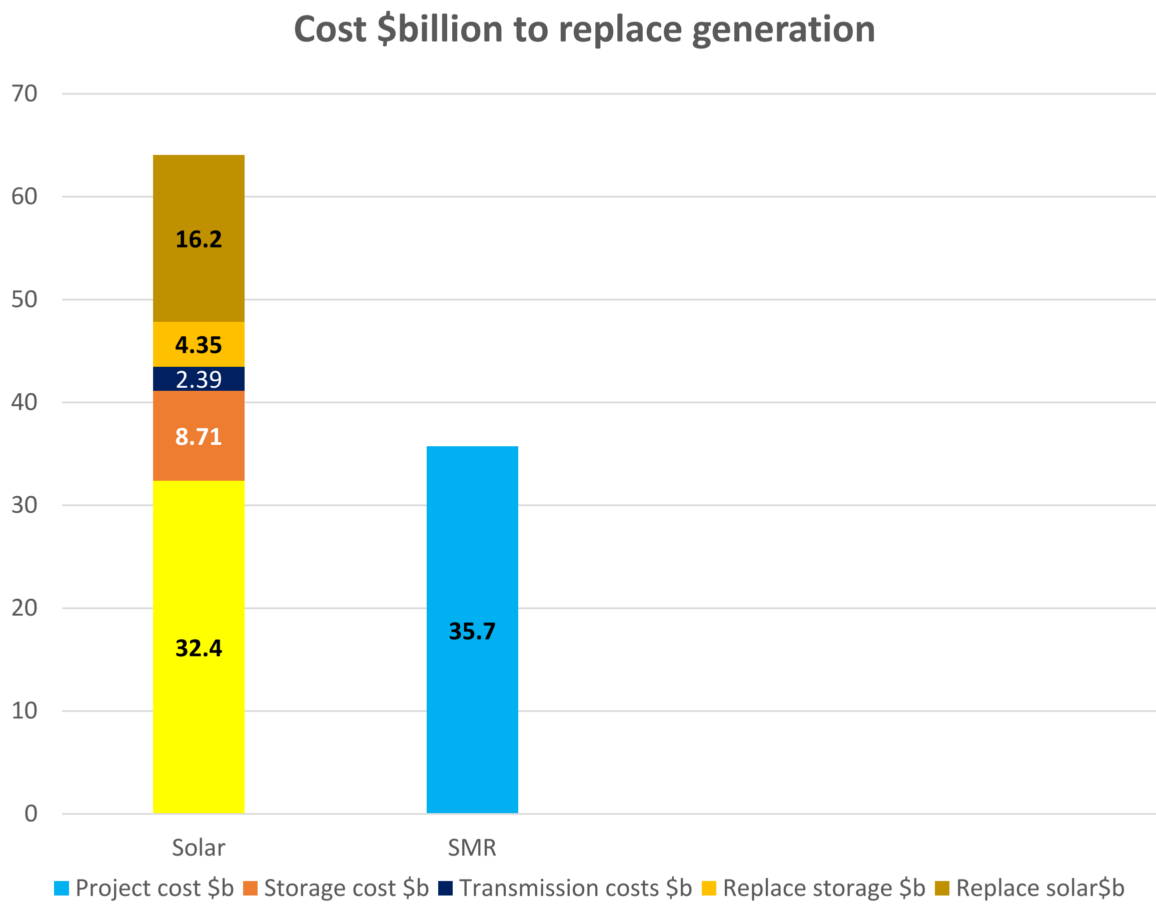
SMR cost – NuScale estimate for 12 module 884 MWeN FOAK in Australia , other overnight costs – CSIRO GenCost 2021-22
SMR Capacity factors 95%, VRE capacity factors – Clean Energy Council report 2021
Firming costs CSIRO GenCost 2020-21 with average firming factor 0.27

Coal-fired power stations in NSW generated 49,110 GWh in 2021. What would be the cost of replacing this generation with utility scale solar or SMRs?



To 2050
Total solar cost = 64.05 billion
(Solar cost includes storage cost (4hr battery), additional transmission cost and solar/storage replacement during lifetime at half cost

Total SMR cost = $35.7 billion
(No additional storage or transmission required)

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SMR Based on NuScale 12 module 884 MWeN, 7 plants would be required at cost of $5.1 billion each.

Solar based on Darlington Point 275 MWac SAT solar, 72 plants would be required at a cost of $0.45 billion each. Solar plant replaced during lifetime to 2050 at half cost.

Storage required based on CSIRO GenCost 2021-22 – average utility scale storage required for VRE = 0.27 (range 0.2 – 0.34). Battery Storage replaced during plant lifetime at half cost.

Additional transmission required based on a proportion of AEMO ISP 2022 (2050) - 10,000 km required for VRE.

Advantages of SMR option:

- **SMRs are dispatchable, independent of the weather, do not require storage and can load follow**
- **SMRs have lower lifecycle emissions than solar and require less critical materials**
- **SMRs have a 60 year life**

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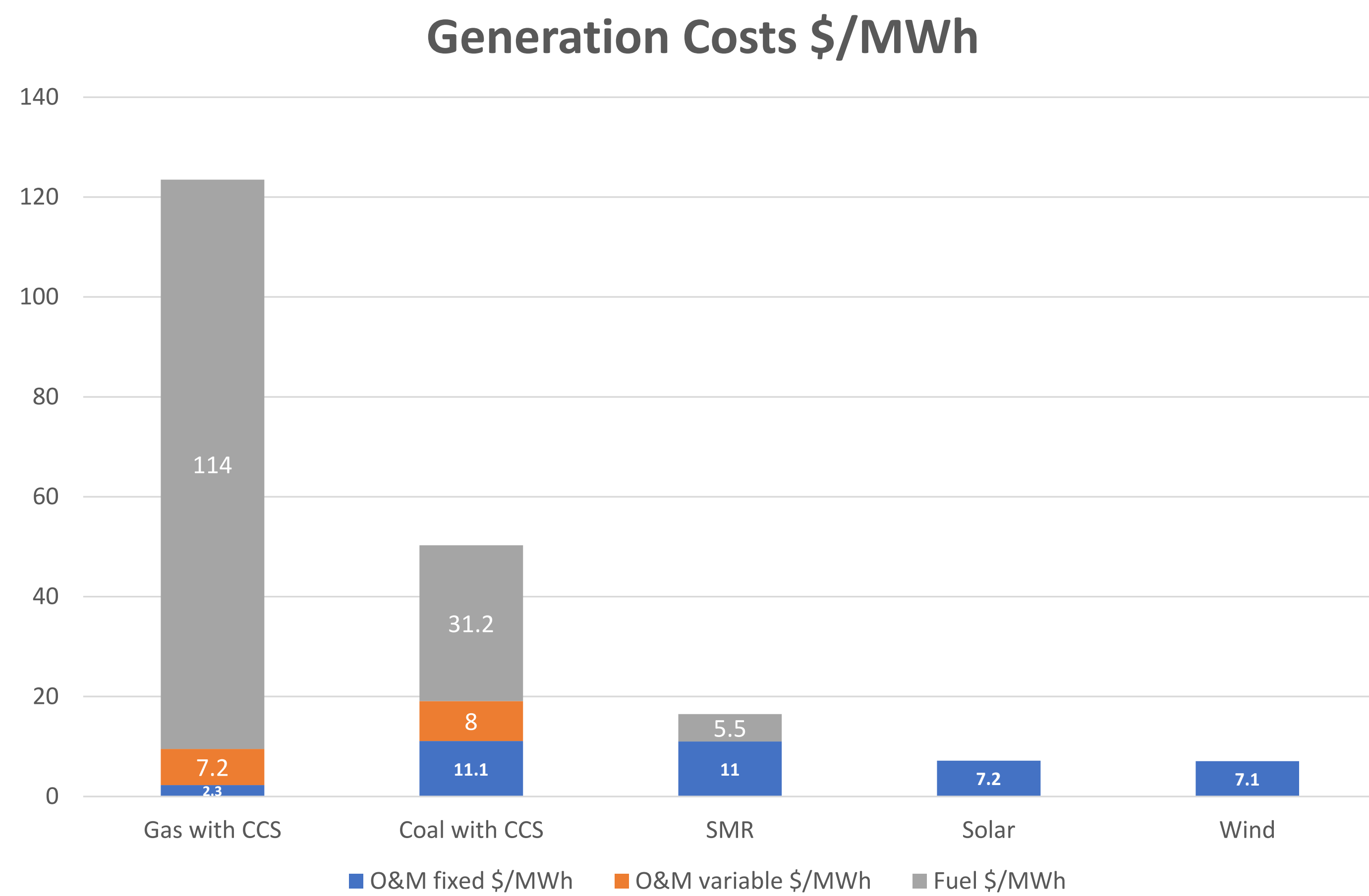

SMR costs : NuScale estimates for Australia
Other technologies costs: CSIRO GenCost 2021-22 report table B.8 for 2021

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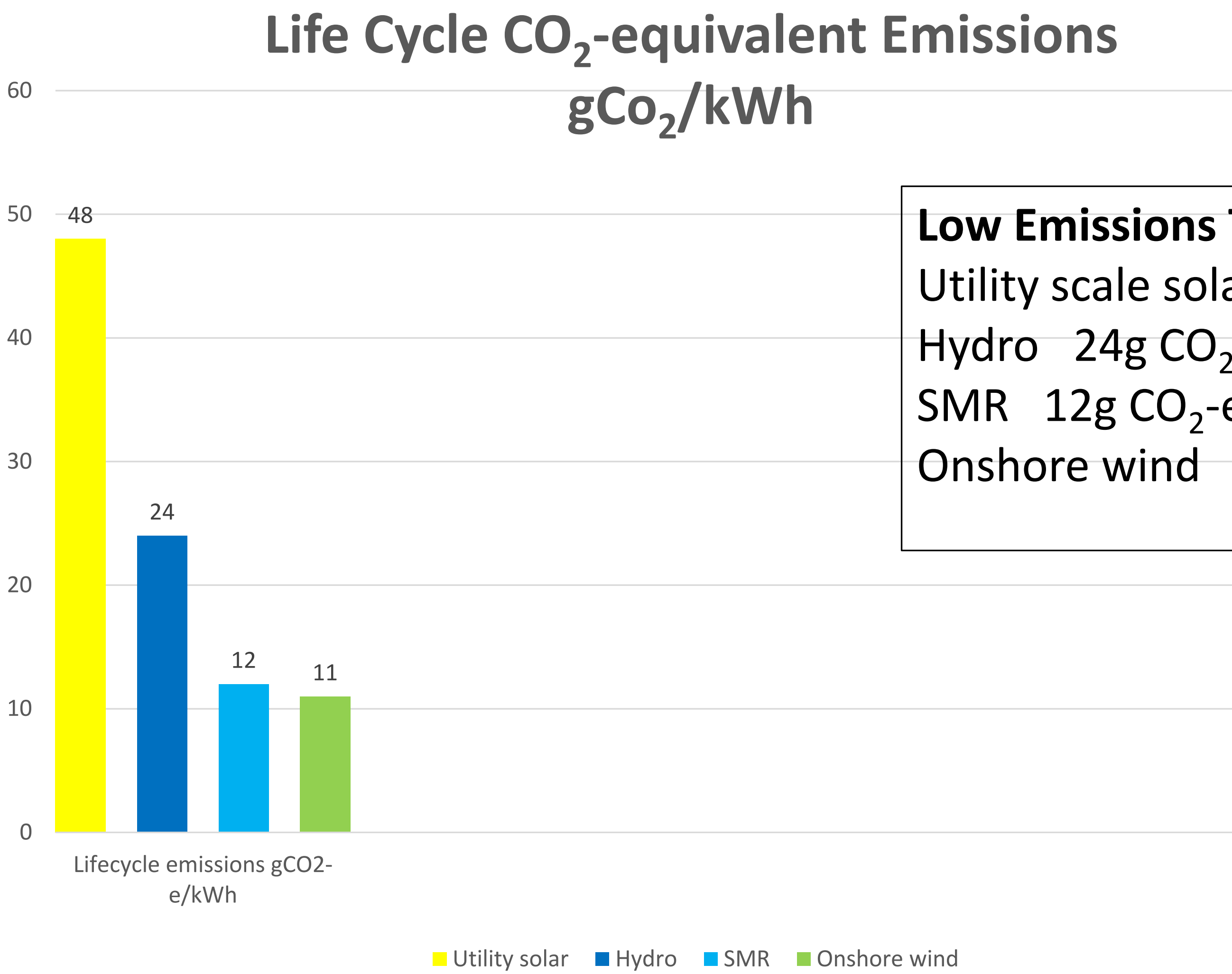

Low Emissions Technologies

Utility scale solar 48g CO_2-e/kWh

Hydro 24g CO_2-e/kWh

SMR 12g CO_2-e/kWh

Onshore wind 11g CO_2-e/kWh

Ref: WNA and IPCC

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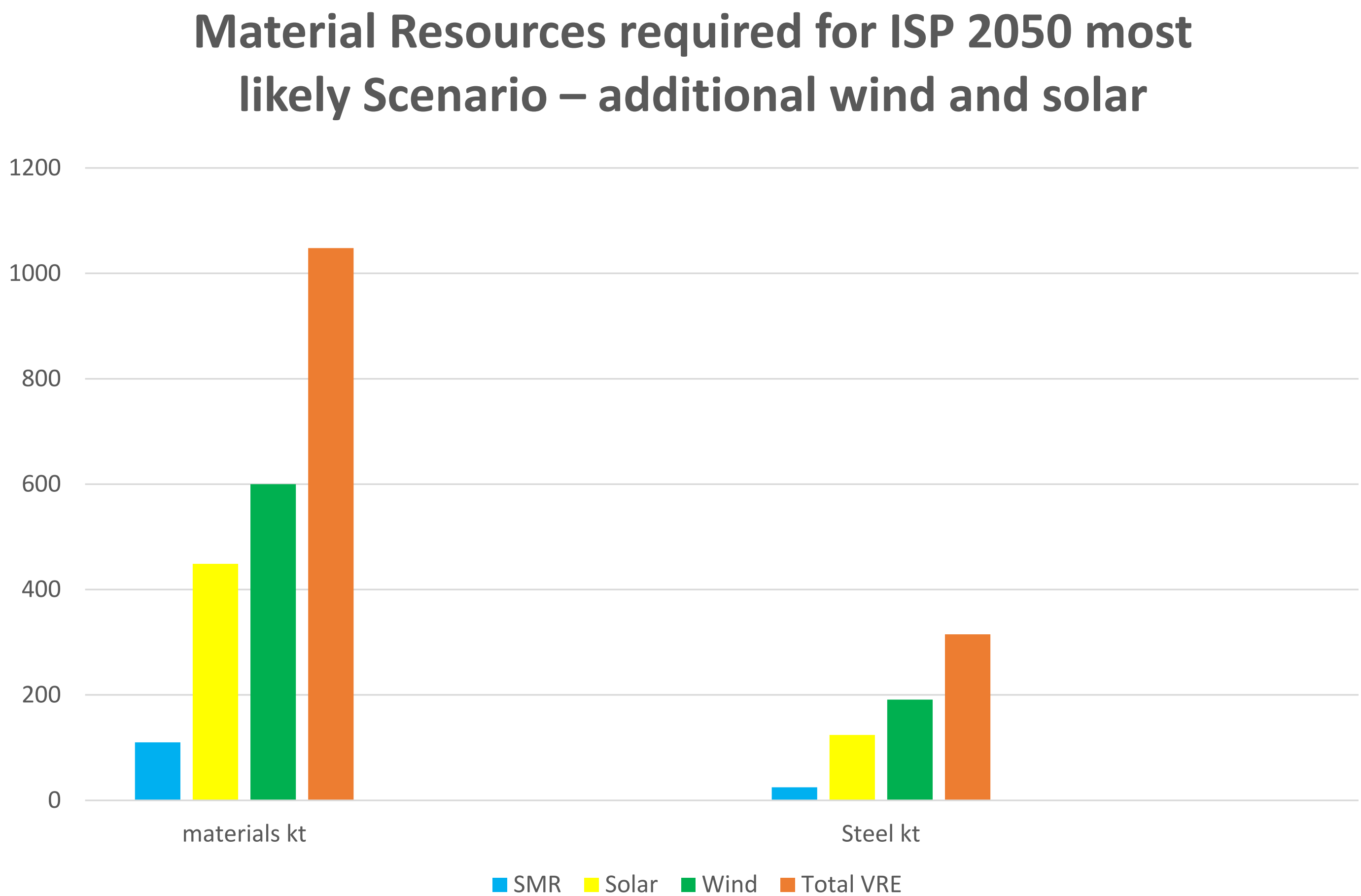

AEMO 2022 ISP

2050 most likely scenario additional wind = 60 GW, additional utility solar = 64.1 GW.

SMR nuclear to generate the same TWH/y = 22.1 GW

Note: all wind and solar will have to be replaced before 2050 – these VRE materials figures will be doubled.

Quantities of materials from IEA "The Role of Critical Materials in Clean Energy Transitions" May 2021. Steel BNW June 2021
Wind average 10,000kg/MW, critical minerals copper, zinc, manganese, chromium, nickel, molybdenum, rare earths.
Solar PV average 7,000 kg/MW, critical materials silicon, copper , silver.
Nuclear average 5,000 kg/MW, critical materials chromium, copper, nickel.

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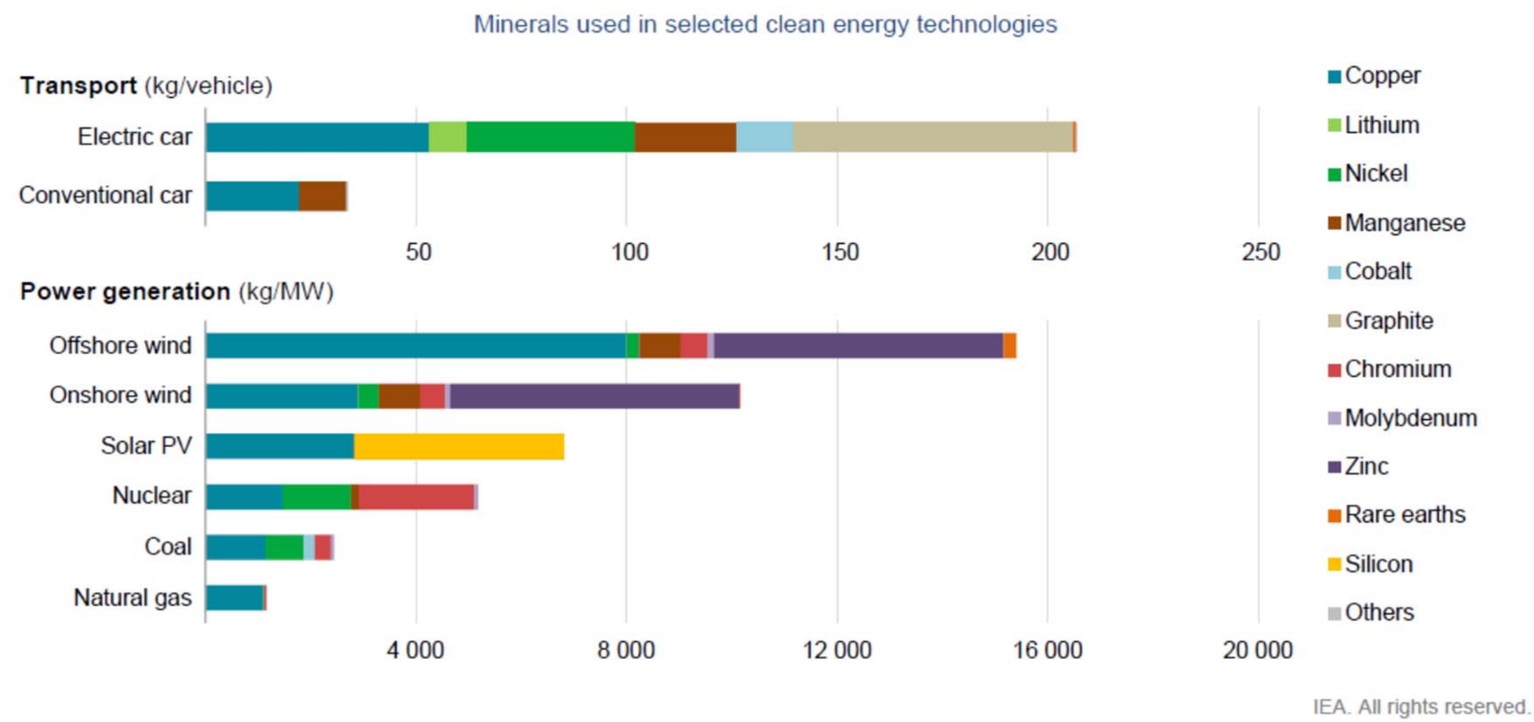
Sustainability of Energy Systems



Notes: kg = kilogramme; MW = megawatt. Steel and aluminium not included. See Chapter 1 and Annex for details on the assumptions and methodologies.

	Nuclear	Solar	Wind
Concrete t/TWh	947	1,702	4,466
Steel t/TWh	120	1,313	1,447

Steel: BNW June 2021 Materials use in a Clean Energy Future

Small Modular Reactors (SMRs), Solar and Wind
Which technology has more clear advantages (shown in green)?

Parameter	SMR	Utility Scale Solar	Onshore Wind
Reliability of generation	reliable	variable	variable
Independent of the weather	independent	dependent	dependent
Capacity factor	95%	22% - 32%	35% - 44%
Load following capability	yes	no	no
Provides frequency control	yes	no	no
Provides system inertia	yes	no	no
Black start capability	yes	no	no
Direct process heat for industry	yes	no	no
Plant lifetime years	60	<25	<30
Land area required hectares/TWh	2.4	1,295	7,203
Visual impact	low	medium	high
Noise impact	low	low	high
Wildlife impact	low	medium	high
Major material required t/TWh	1,190	2,516	5,976
Critical minerals required t/TWh	12	124	130
Materials – concrete t/TWh	1,058	1,216	4,466
Materials – steel t/TWh	134	938	1,447
Lifecycle emissions g/kWh	12	48	11
Firming required	None	Typical Battery 4 hrs/ PHES 12 hrs	
Cost of firming $/kW	$0	$1,629 battery/kW $2,711/kW PHES	
Additional transmission	none	>$12.7 billion	
Life waste included in cost	yes	no	no
O&M cost $/MWh	11	9.7	8.2
Fuel cost $/GJ	0.5	Free	Free
Construction time years	3	0.5	1.0

SMR parameters: NuScale (USA) 12 module 924 MW plant estimate for Australia
Wind and solar: CSIRO GenCost 2021-22 Final report July 2022, transmission AEMO 2022 ISP
Pumped Hydro Energy Storage (PHES) and battery costs – CSIRO GenCost 2021-22 Table B.7.
Material requirements: Bright New World and IEA "the Role of Critical Materials in Clean Energy Transitions"
Land use: NEI April 2022
Lifecycle emissions: WNA and IPCC

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