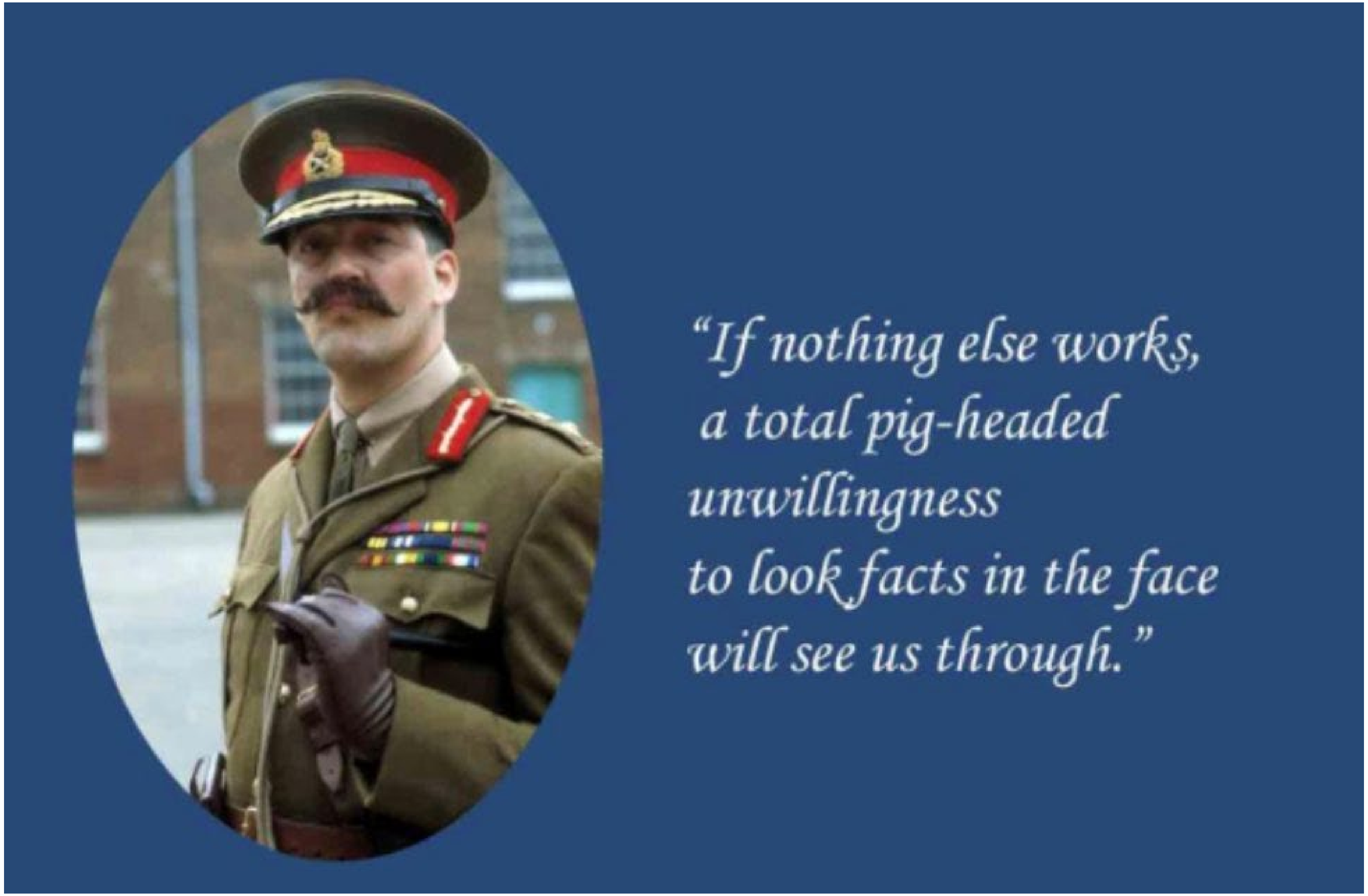
Avoiding an Energy Blunder Downunder

Mr Robert Parker, B Eng Civil, M Eng Sci Nuclear
Nuclear For Climate Australia



Content

1. Restatement of the Big Issue
2. Sustainability of Nuclear Energy
3. Improbability of close to 100% Renewables solution
4. Superior Economics and Emissions reductions of Nuclear Energy on the NEM
5. Nuclear Energy Options
6. Conclusions

From James Hansen
13th October, 2023

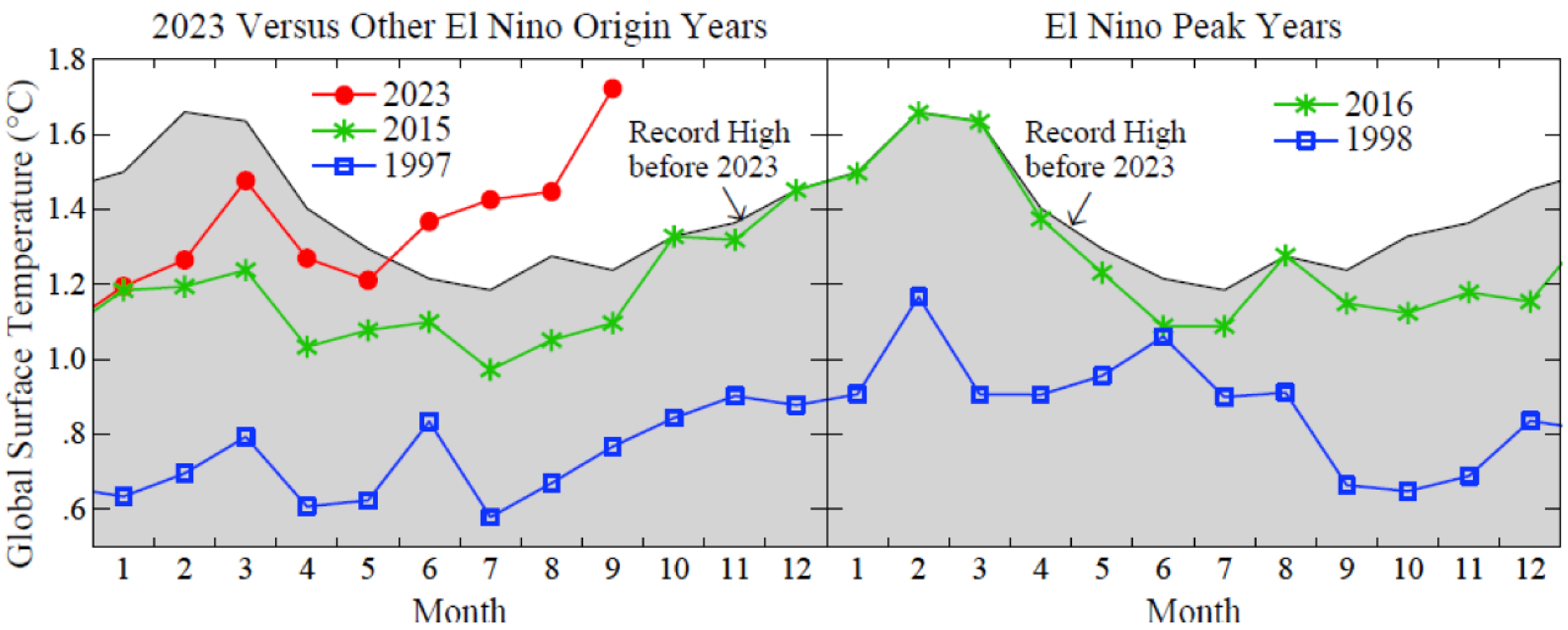


Fig. 1. Global temperature (relative to 1880-1920 mean for each month) for the 1997-98, 2015-16 and 2023-24 El Ninos. The impact of El Nino on global temperature usually peaks early in the year (El Nino Peak Year) following the year in which the El Nino originated.

From James Hansen 13th October, 2023

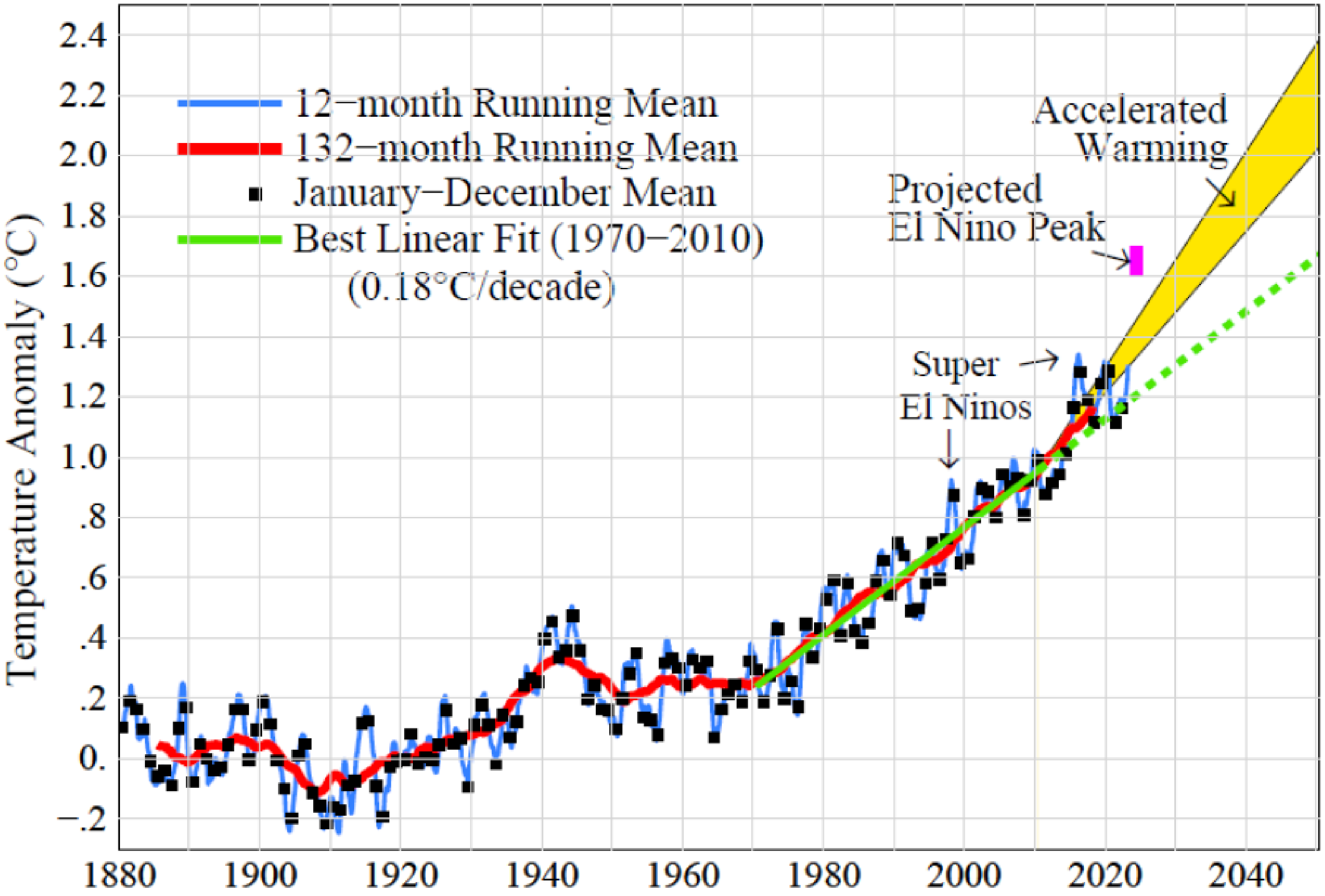
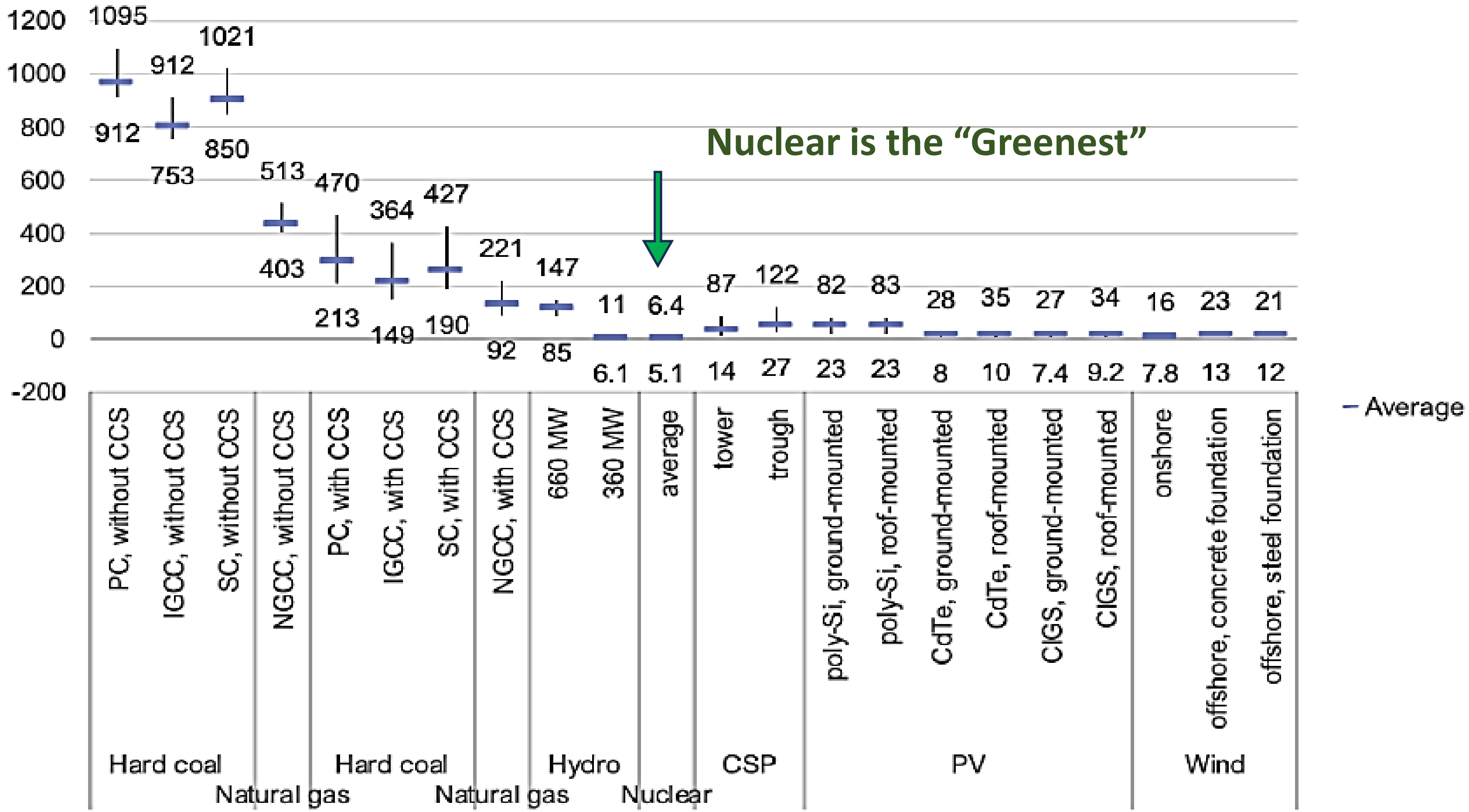


Fig. 2. Global temperature relative to 1880-1920 based on the GISS analysis.[1,2]

Emissions from Energy Generators

Figure 1 Lifecycle greenhouse gas emission ranges for the assessed technologies

Lifecycle GHG emissions, in g CO_2 eq. per kWh, regional variation, 2020

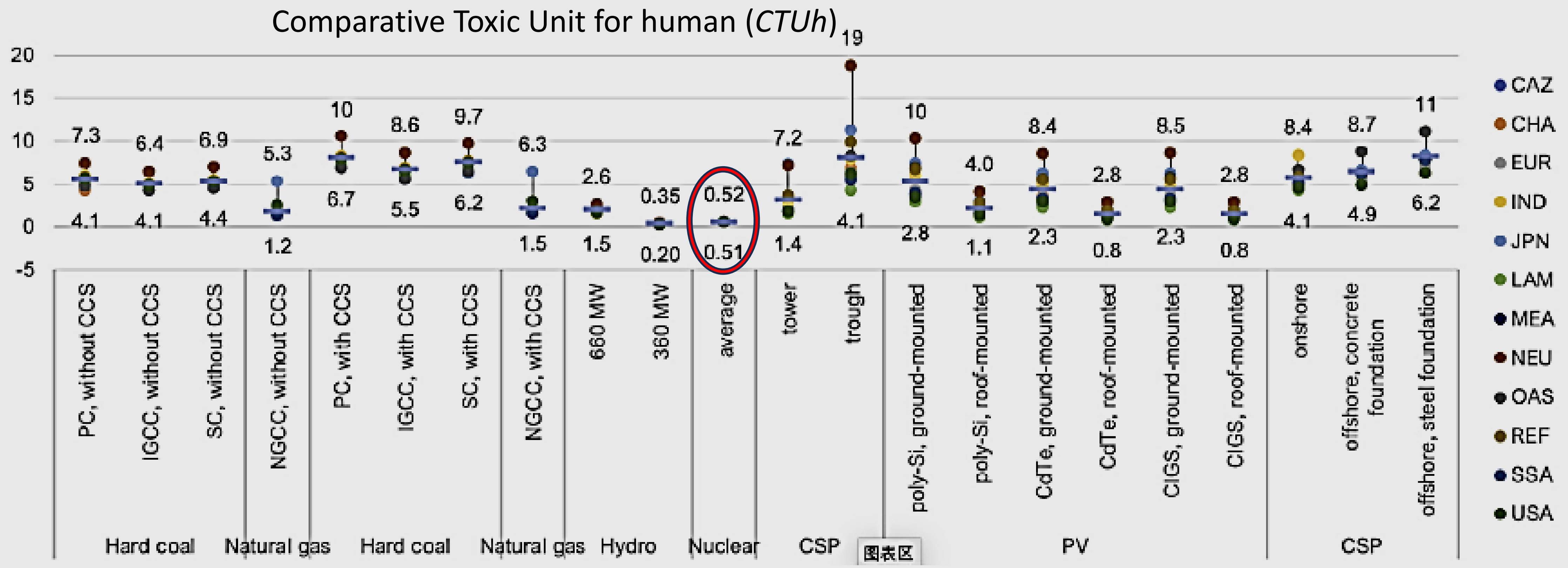


Life Cycle Assessment of Electricity Generation Options. United Nations Economic Commissions for Europe 2021

Lifecycle human toxicity – carcinogenic

Figure 42 Lifecycle human toxicity (carcinogenic)' regional variations for year 2020. Variability is explained by several factors: electricity mix (all regions), region of extraction (fossil fuels), load factors (renewables). Nuclear power is modelled as a global average except for front-end.

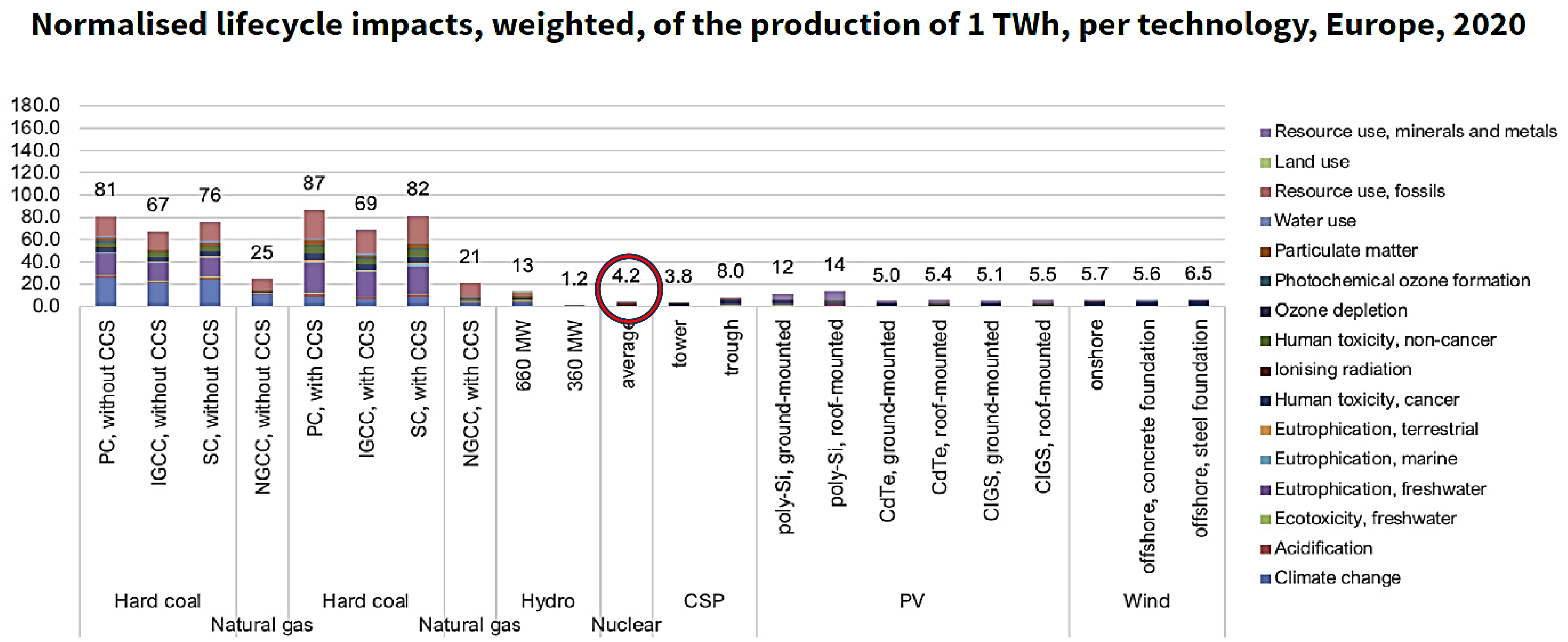
Lifecycle human toxicity potential, carcinogenic, in CTUh per TWh, regional variation, 2020



Life Cycle Assessment of Electricity Generation Options. United Nations Economic Commissions for Europe 2021

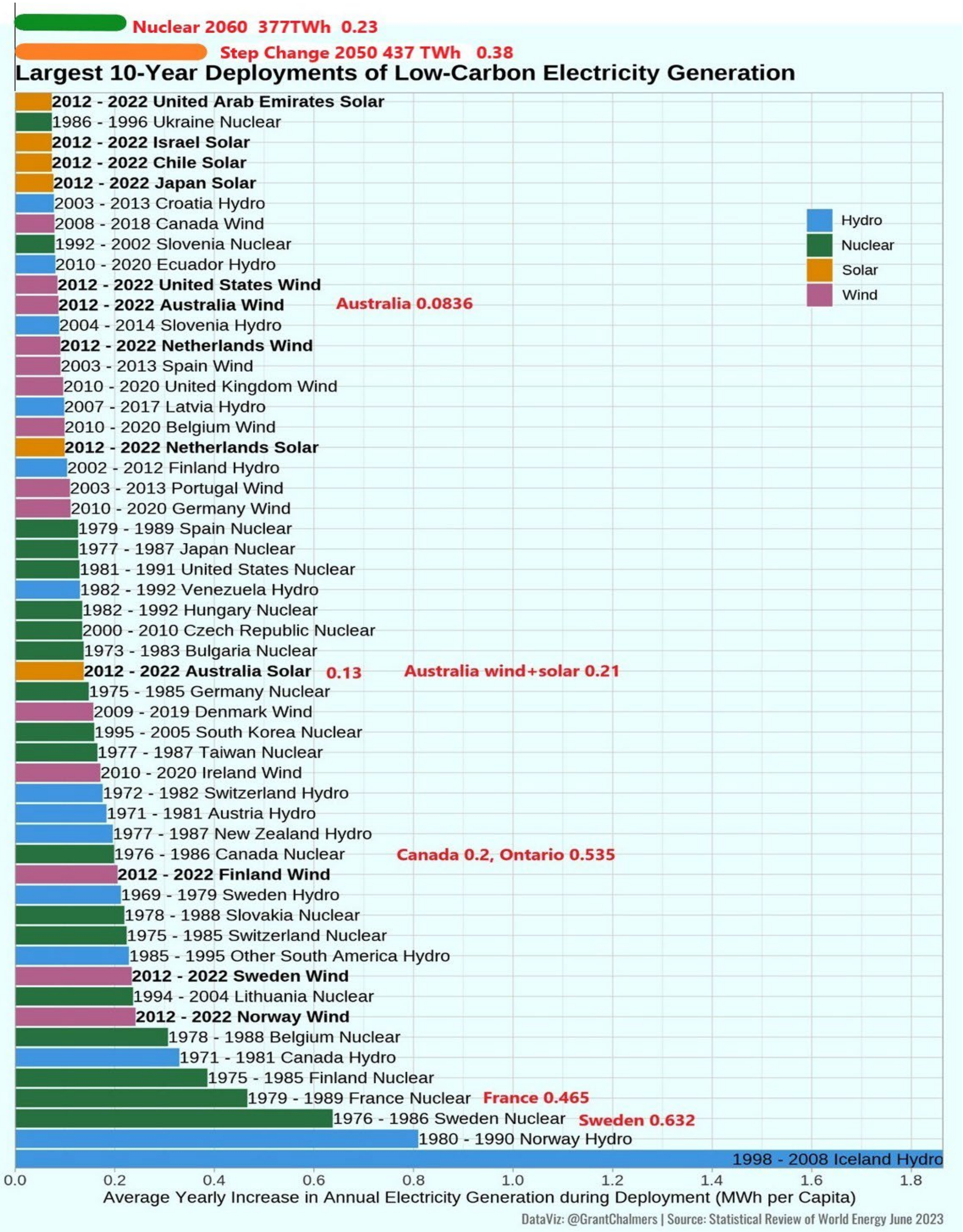
Conclusions summarised
The United Nations Economic Commission for Europe

Figure 53 Normalised, weighted, environmental impacts of the generation of 1 TWh of electricity



Life Cycle Assessment of Electricity Generation Options. United Nations Economic Commissions for Europe 2021

Speed of low carbon energy deployment



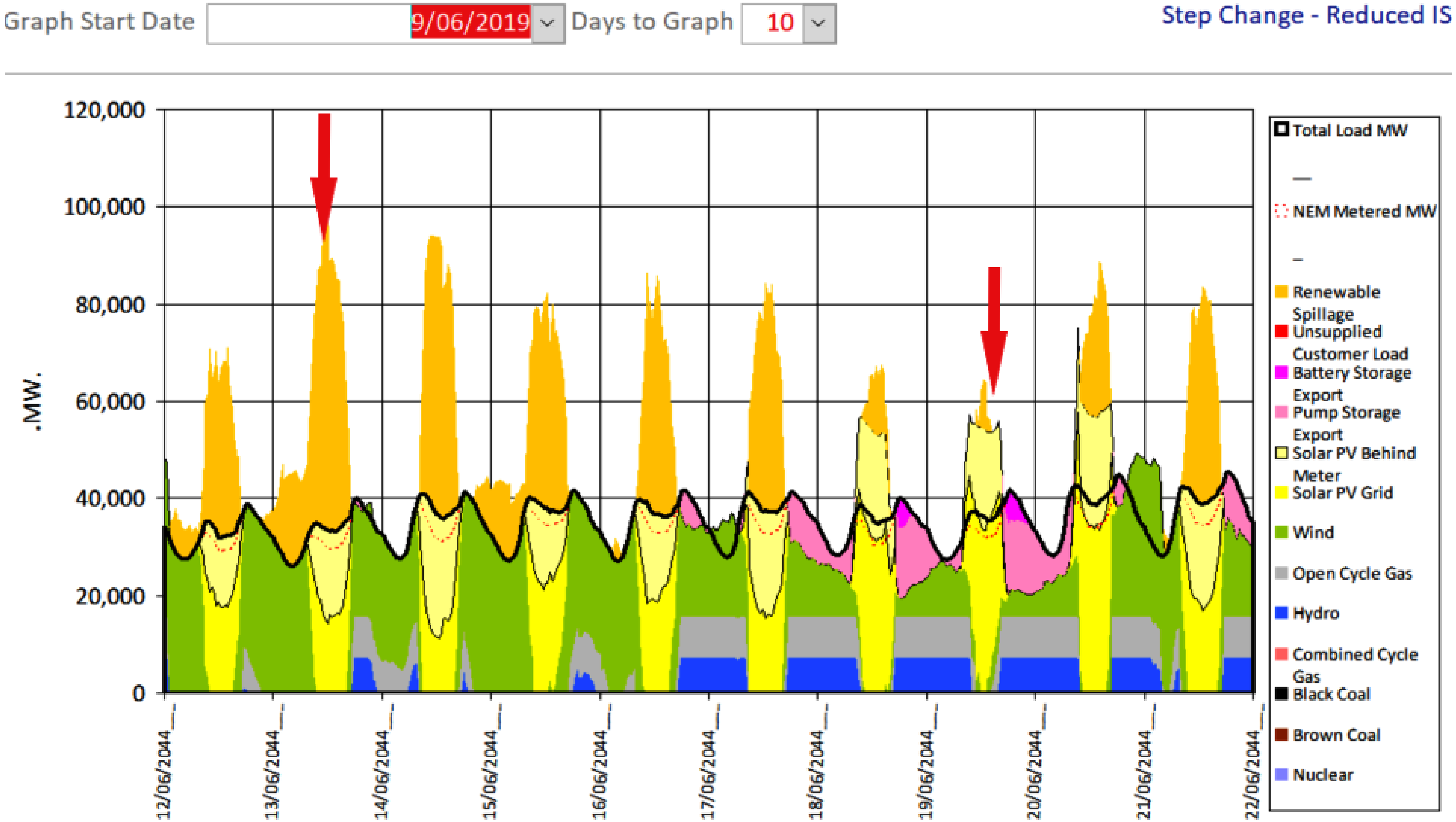
1. Seven of the ten fastest non-hydro low carbon programmes were all nuclear

2. AEMO's Step Change scenario requires deployment of renewable energy twice as fast as has been achieved by any location globally and still contains 139 gr CO2/kWh

3. A nuclear based programme would be conservatively achievable at 0.28MWh/cap/yr & similar to that of Belgium's programme and has 9 times lower emissions intensity at only 19 gr CO2/kWh

AEMO Step Change Scenario – in 2050

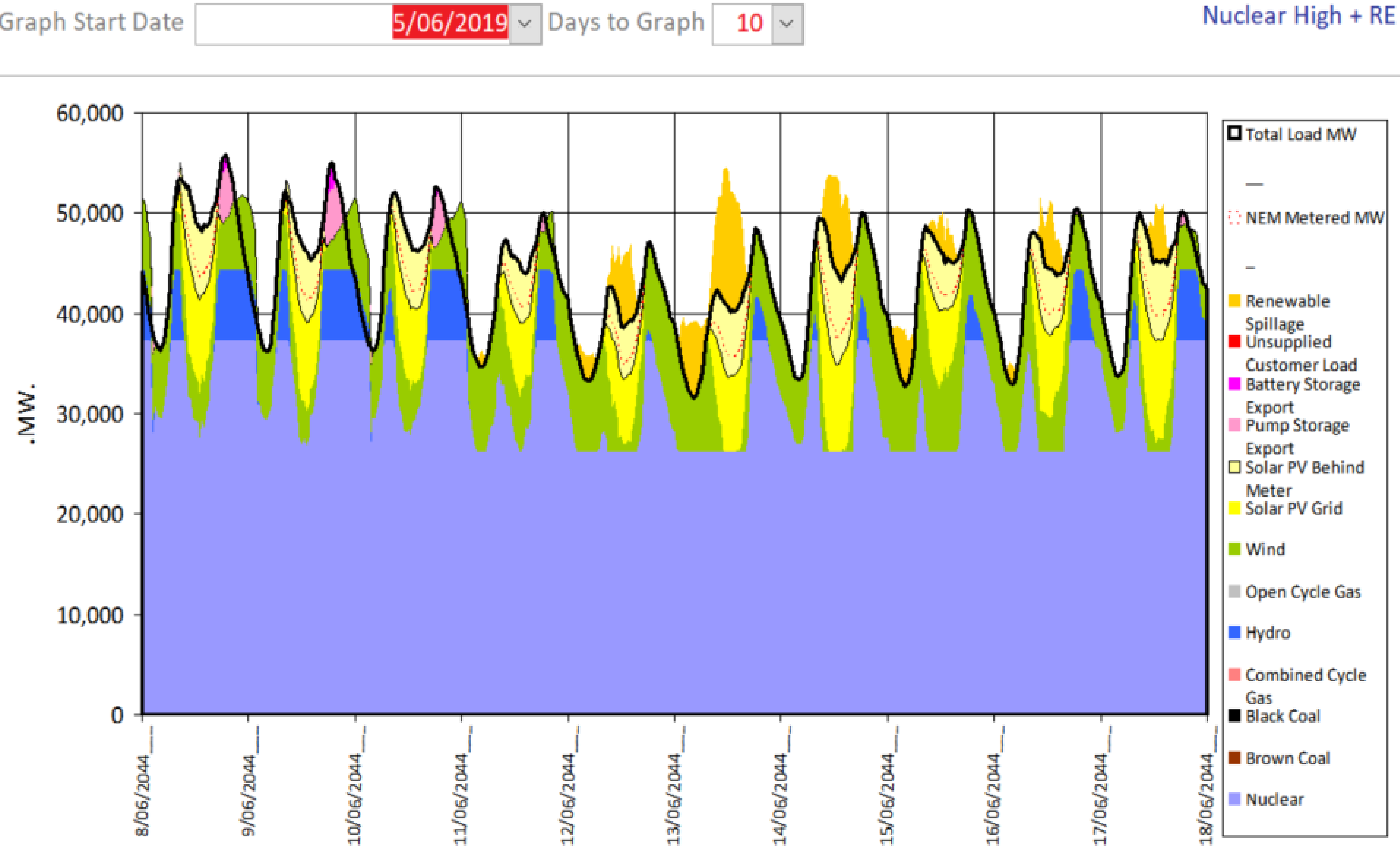
AEMO's Step Change scenario - 283 GW of capacity with 138GW solar, 70GW wind, 14.5GW P/Store, 45.2 GW batteries & 9.4 GW gas. Can't be built in a sensible time frame & will only produce 311TWh/yr



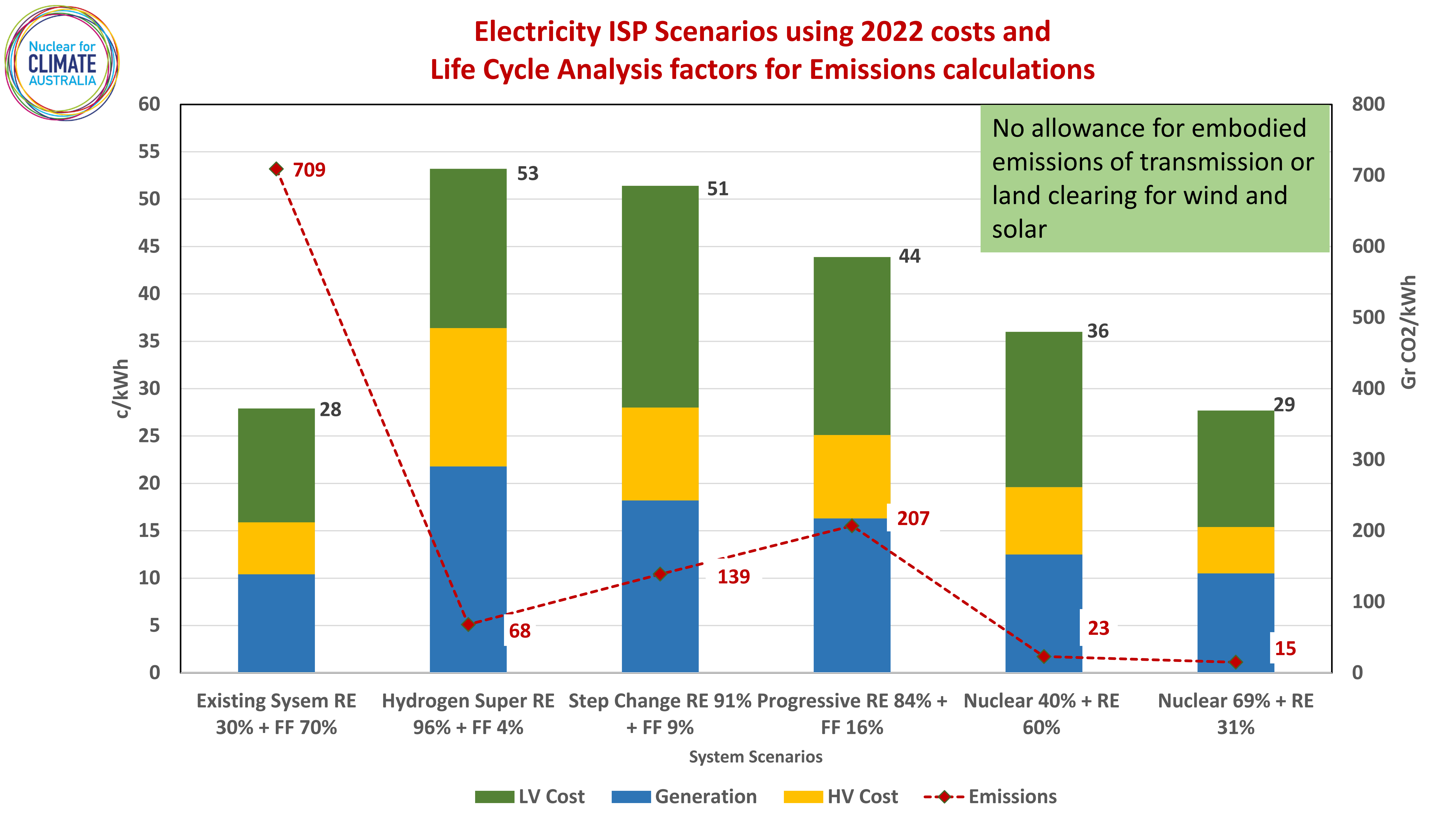
1. Using Nuclear with RE to produce the same 311 TWh/yr has 1/3rd of Step Change capacity Only 98 GW and 0 GW of gas.
2. Nuclear supports a fully decarbonised electricity system Emissions are only 15 gr CO2/kWh cf 139 in Step Change Scenario
3. Abating carbon with a nuclear based system costs $29/tonne while AEMO's Step Change costs $340/tonne
4. 40% spilled energy

Optimum Nuclear based energy mix –in 2060

Delivered Electrical Energy in 2060 – 377 TWh/yr assumes demand matches population growth + 75TWh/yr for transport electrification



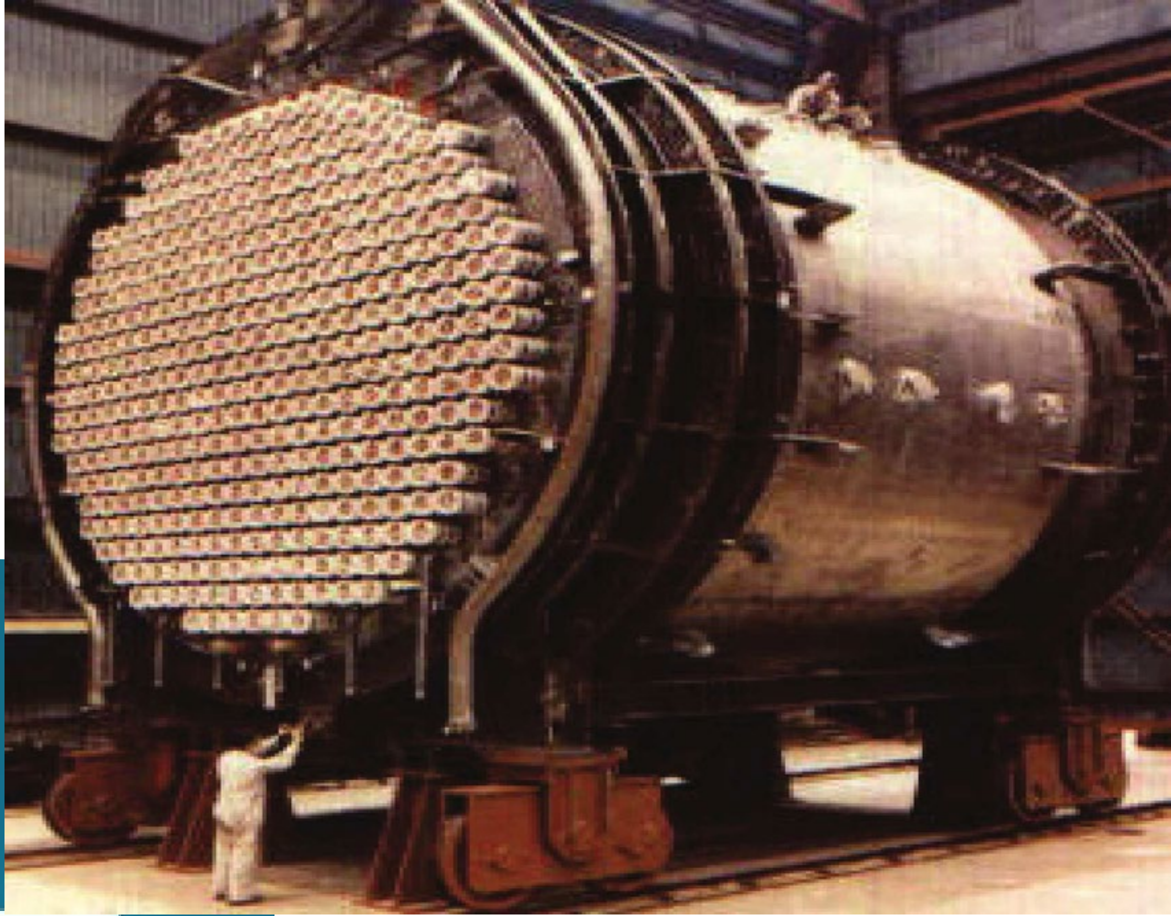
- Peak Load – 70.9 GW Gross, 64.9GW Metered
- Nuclear Plants 40.1GW Hybrid mix large & small
- $7,402/kW installed
- 9.4GW nuclear /100TWh of gross system demand
- Roof Top solar 25GW
- Utility solar 18GW
- Wind 20GW
- Storage of 12 GW and 51 GWh – batteries plus thermal or
- 468 GWh pumped storage including Snowy Hydro 2.0

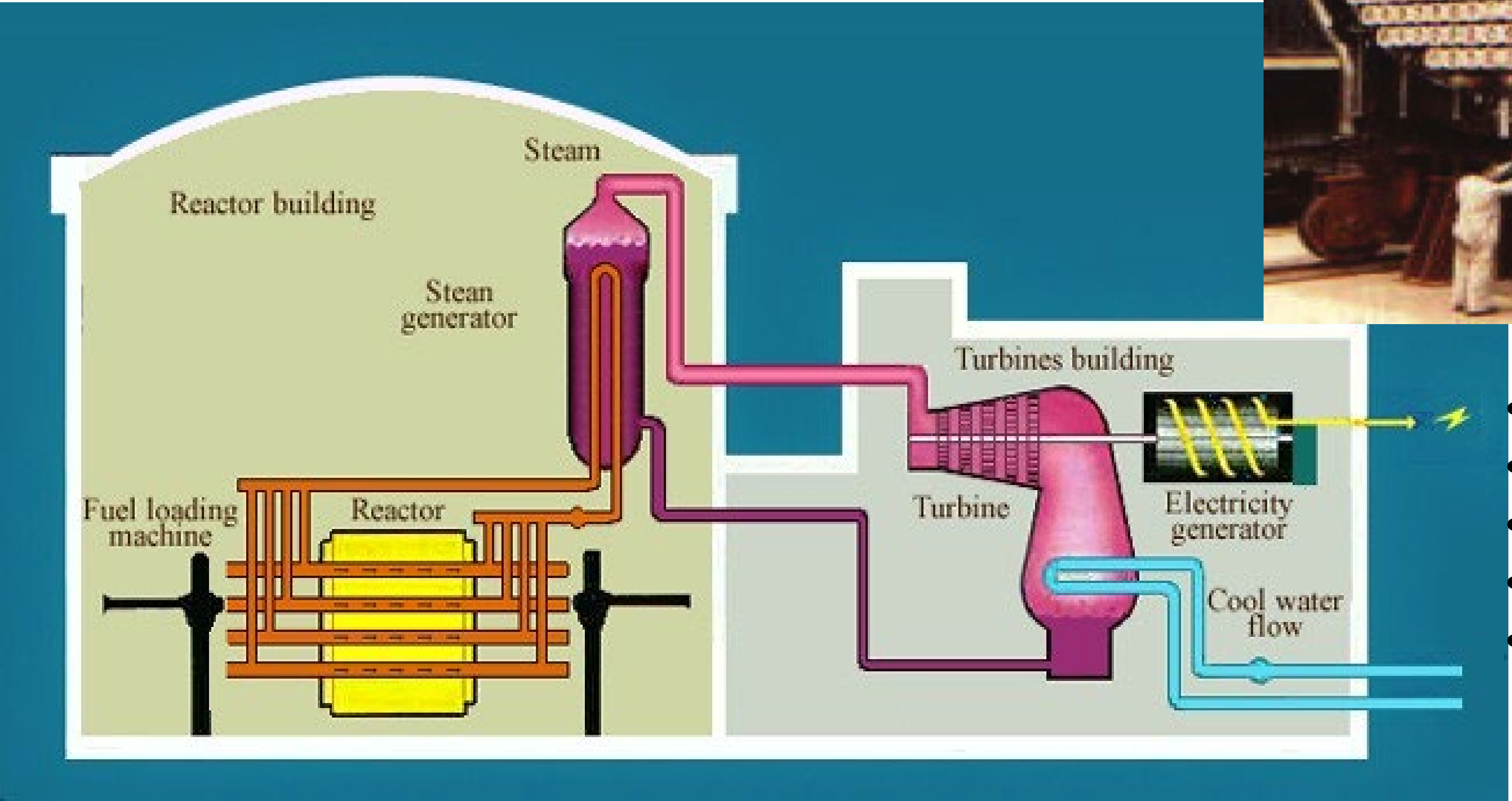


Nuclear for CLIMATE AUSTRALIA
Electricity ISP Scenarios using 2022 costs and
Life Cycle Analysis factors for Emissions calculations
No allowance for embodied emissions of transmission or land clearing for wind and solar
c/kWh
Gr CO2/kWh
0
5
10
15
20
25
30
35
40
45
50
55
60
0
100
200
300
400
500
600
700
800
28
53
51
44
36
29
709
68
139
207
23
15
Existing Sysem RE 30% + FF 70%
Hydrogen Super RE 96% + FF 4%
Step Change RE 91% + FF 9%
Progressive RE 84% + FF 16%
Nuclear 40% + RE 60%
Nuclear 69% + RE 31%
System Scenarios
LV Cost
Generation
HV Cost
Emissions

Westinghouse AP1000, Vogtle 3 and 4
1,117MW Gen III+ NPP

CANDU EC6 Reactor 700MW





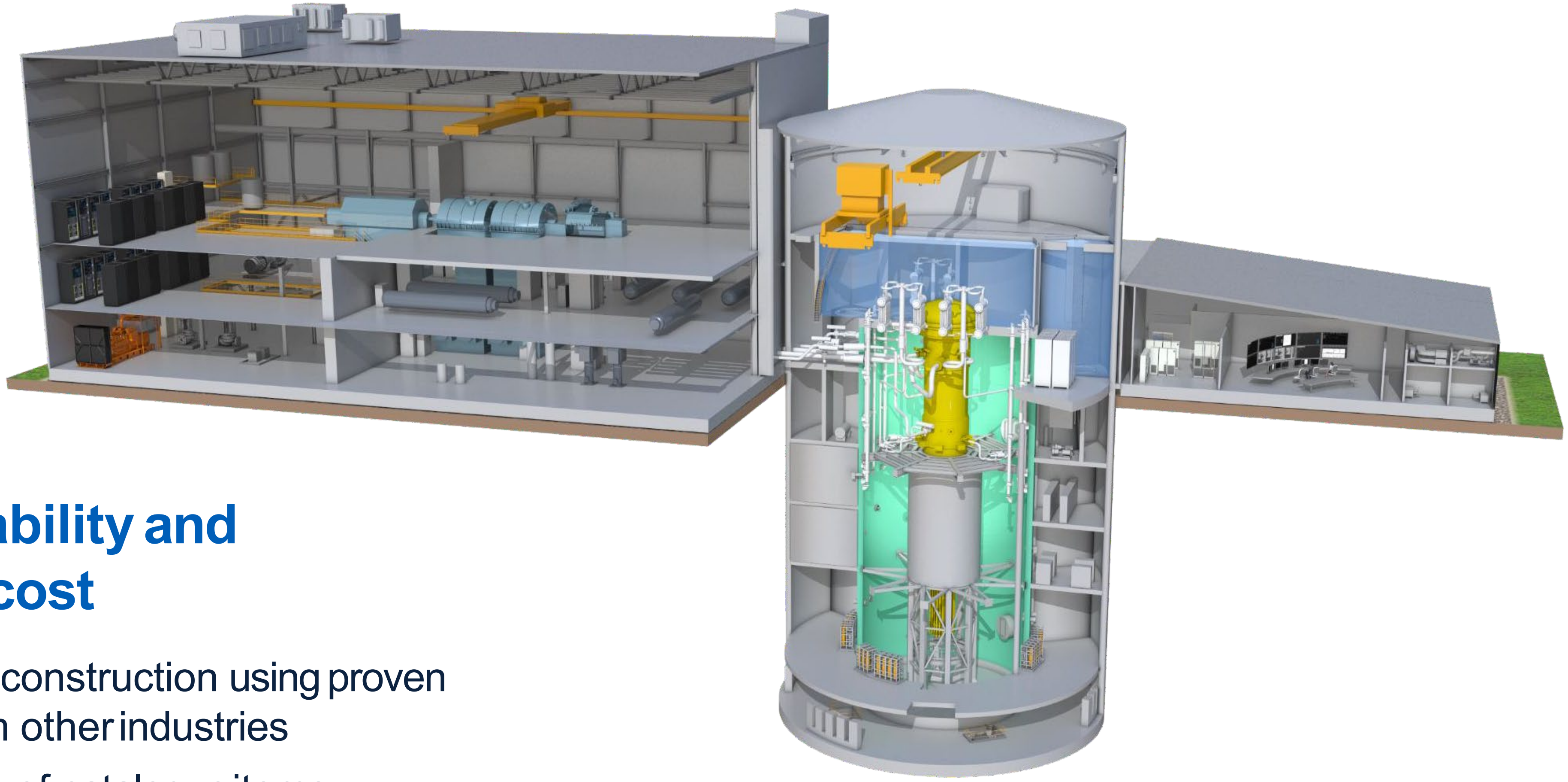
- Uses natural Unenriched uranium
- Available tomorrow
- Made in Canada
- Needs heavy water moderator
- Huge heat sink resists meltdown

Small footprint and simple plant layout

Power Block dimensions: 140m x 70m
Secure or Protected Area: 2.7 Ha
Owner's Area: 13.8 Ha
EPZ: Expected to be site boundary

Interest in GE-Hitachi BWRX 300	
1	Ontario Power Generation
2	Sask Power in Saskatchewan
3	Tennessee Valley Authority at Clinch River
4	Synthos Green in Poland
5	Sweden and Karnfull Energy
6	Czech Republic and CEZ
7	Estonia

Optimized for cost and ease of construction



Constructability and Design-to-cost

- Underground construction using proven methods from other industries
- Maximum use of catalogue items
- “Off the shelf” turbine/generator

Ontario Points to Reindustrialising Western Economies through a Nuclear Renaissance

In week of 3/7/2023:

- Additional 4,800 MW of large nuclear at Bruce Power Plant – will become biggest in the world at about 11,000 MW
- Four BWRX 300 small nuclear power plants at Darlington with 1,200MW

Manufacturing:

- Vehicles $17 billion in 2 years – mainly EV's
- VW investing $7 billion in EV battery manufacture, Unicore $1.5 billion and Stelantis & LG $5 billion have new factory opening in 2024
- **Unicore** attracted to manufacture of batteries with 24/7net zero emissions electricity

Locations for NPP's

https://nuclearforclimate.com.au/

Site	Location	Number of SNPP's	Cooling
		Probables	
PO - 4	Portland	4 x 300MW	Ist pass from sea
PH - 2	Point Henry	2 x 300MW	Ist pass from sea
TB - 6	Tyabb	2 x 300MW	Ist pass from sea
YN - 4	Yallourn	4 x 300MW	Evaporative and Hybrid
HZ - 4	Hazelwood	4 x 300MW	Evaporative and Hybrid
LYA - 6	Loy Yang A	6 x 300MW	Evaporative and Hybrid
LYB - 4	Loy Yang B	4 x 300MW	Evaporative and Hybrid
	Total	26 x 300MW	
		Possibles	
AL - 2	Alexandra	2 x 300MW	Evaporative and Hybrid
LE - 2	Lake Eildon	2 x 300MW	Evaporative and Hybrid
DG - 2	Dederang	2 x 300MW	Evaporative and Hybrid
ML - 2	Moorabool	2 x 300MW	Evaporative and Hybrid
MI - 2	Mildura	2 x 300MW	Evaporative and Hybrid
	Total	10 x 300MW	

Conclusions

1. AEMO's Step Change Scenario cannot be built in a reasonable time frame and provides neither low cost electricity nor low emissions
2. Nuclear energy is our lowest cost, proven ultra low carbon emitting technology
3. We must learn from, and collaborate with, success stories
4. There will be no low cost, low carbon electricity generation without nuclear energy being our key resource
5. The use of Large and SMR's on the NEM can be ensured by partnering with great friends in Canada, USA, UK and South Korea
6. <u>Anti Nuclear legislation must be removed with all urgency</u>

Now for a Q&A

Robert Parker
Nuclear For Climate Australia
https://nuclearforclimate.com.au/
info@nuclearforclimate.com.au