Opportunities for Communities

- **Energy in Society**
- **Low Cost Reliable Ultra Low carbon grid power**
- **Nuclear Power Plant Options and Applications**
- **Participate in the Nuclear Fuel Cycle**

James Hansen and Tom Wrigley at COP 27
Both advocates for nuclear energy to be in the mix

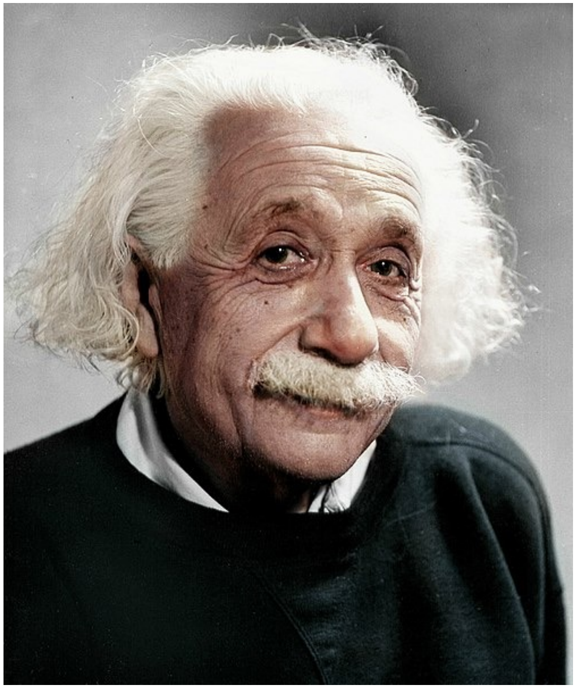
$E=MC^2$

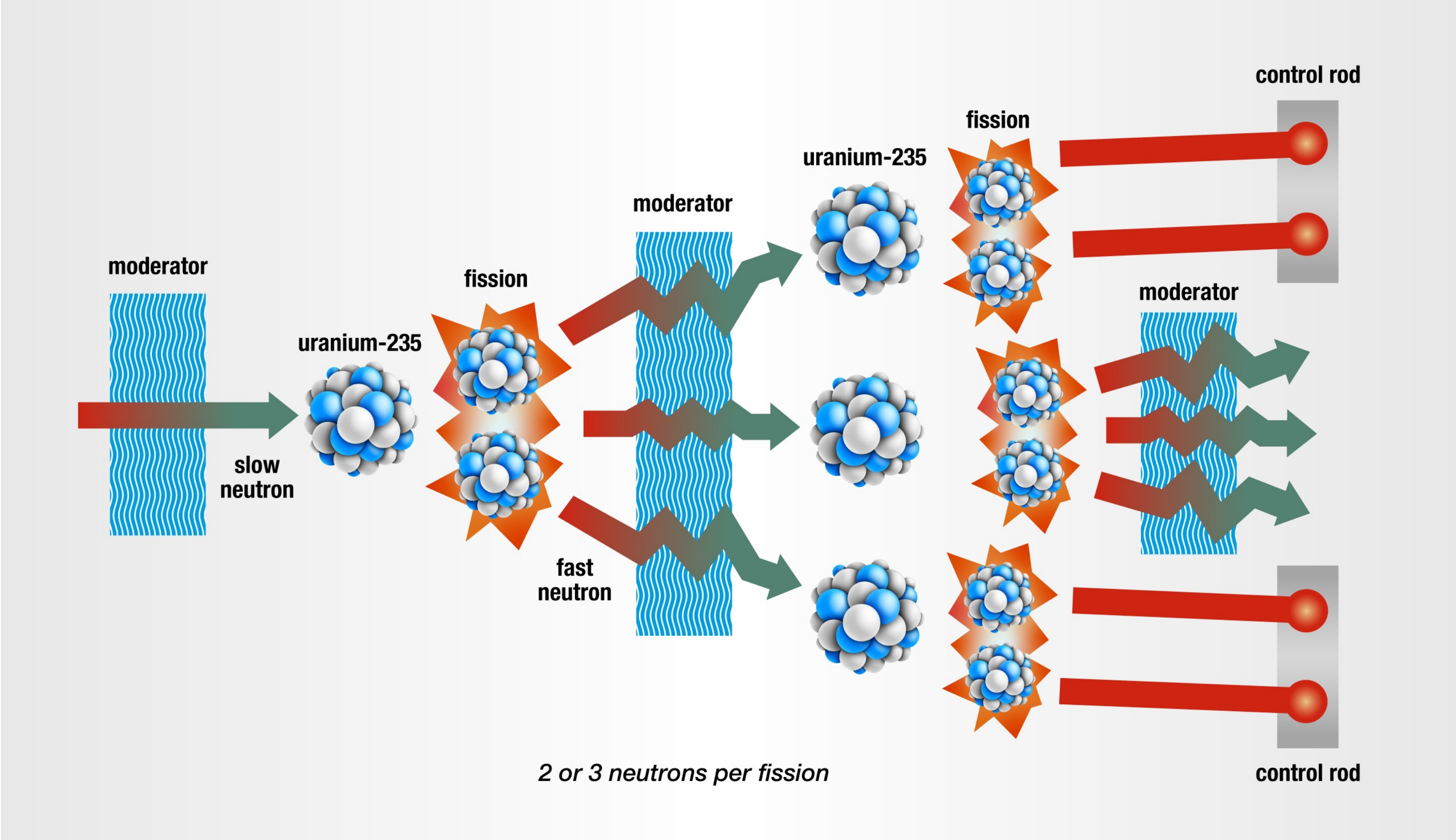
The "tamed" nuclear fission reaction

236.053 amu in - 235.867 amu out = 0.186 amu

0.186 x C^2= 172.57 MeV + 26 MeV delayed

In a nuclear reactor the neutron-driven chain reaction is controlled and stable, producing heat at steady rate. Uranium enriched to 3% to 6% U^{235}

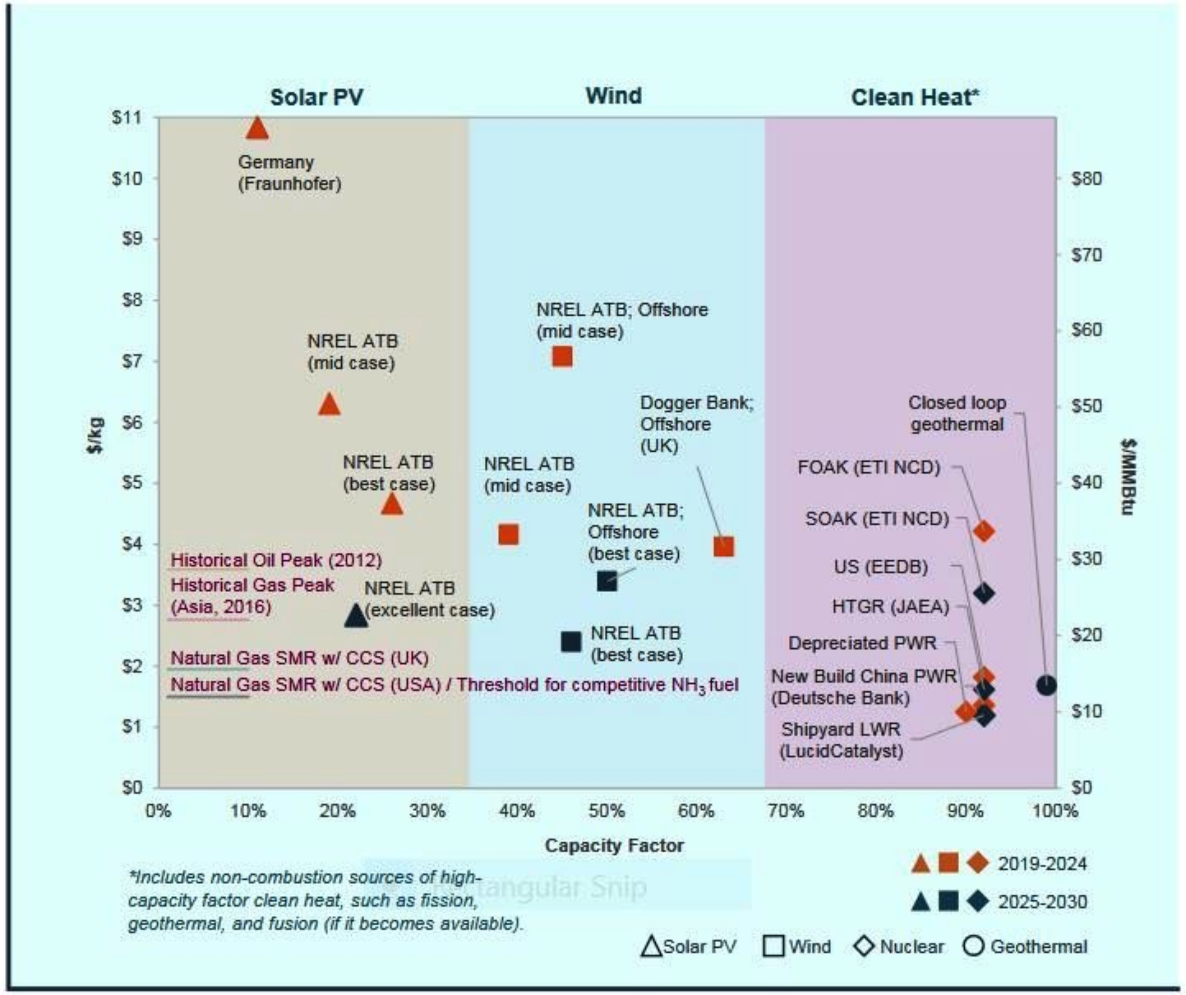




e.g. $1n + {}^{235}U \rightarrow {}^{137}Cs + {}^{96}Rb + 3$neutrons

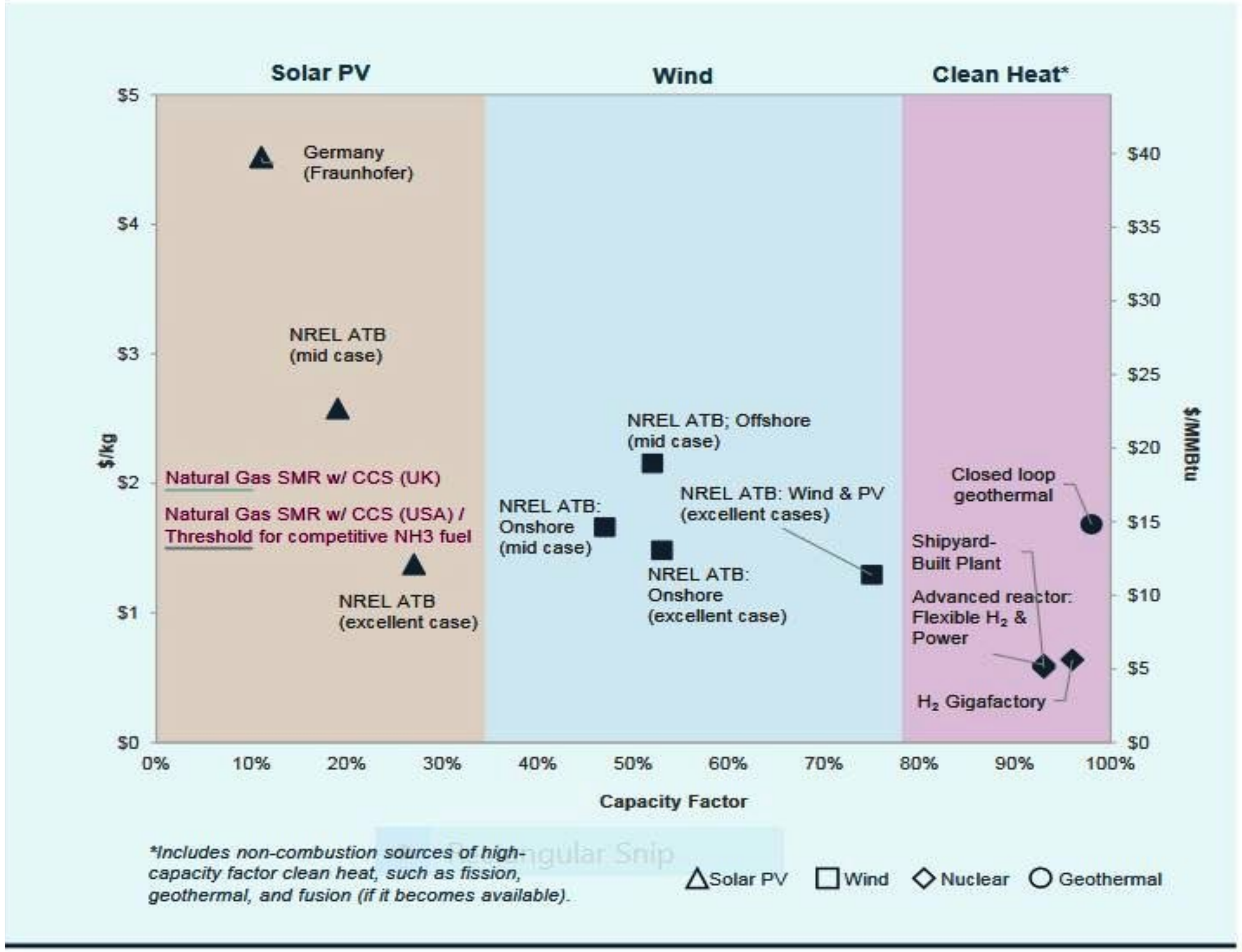
Hydrogen production costs Now through to 2050

Figure 10. **Cost of hydrogen production from different energy technologies in the real world now and in 2030**



Sources: Unless otherwise indicated, capital and operating costs and capacity factors for solar and wind were sourced from the National Renewable Energy Laboratory's Annual Technology Baseline (NREL ATB). Nuclear costs and capacity factors were sourced from "The ETI Nuclear Cost Drivers Project: Full Technical Report," (by LucidCatalyst) September 2020 as well as the NREL ATB. Sources for the range in electrolyzer costs included publications from McKinsey, Bloomberg New Energy Finance, the IEA, NREL, and Idaho National Laboratory. For more detail on sources and assumptions, please refer to Appendix A.

Figure 11. **Projected cost of hydrogen production from different energy technologies in 2050**



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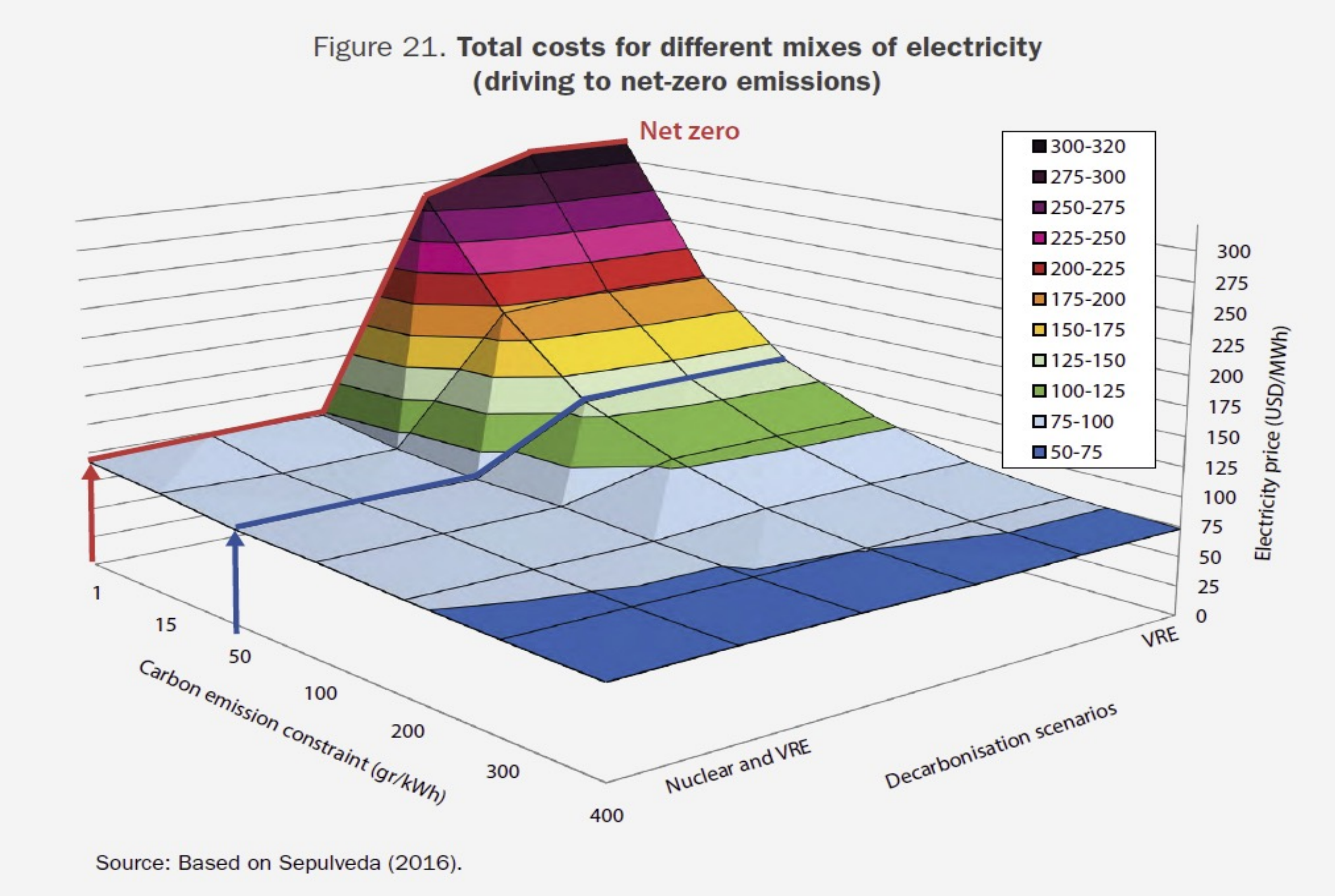
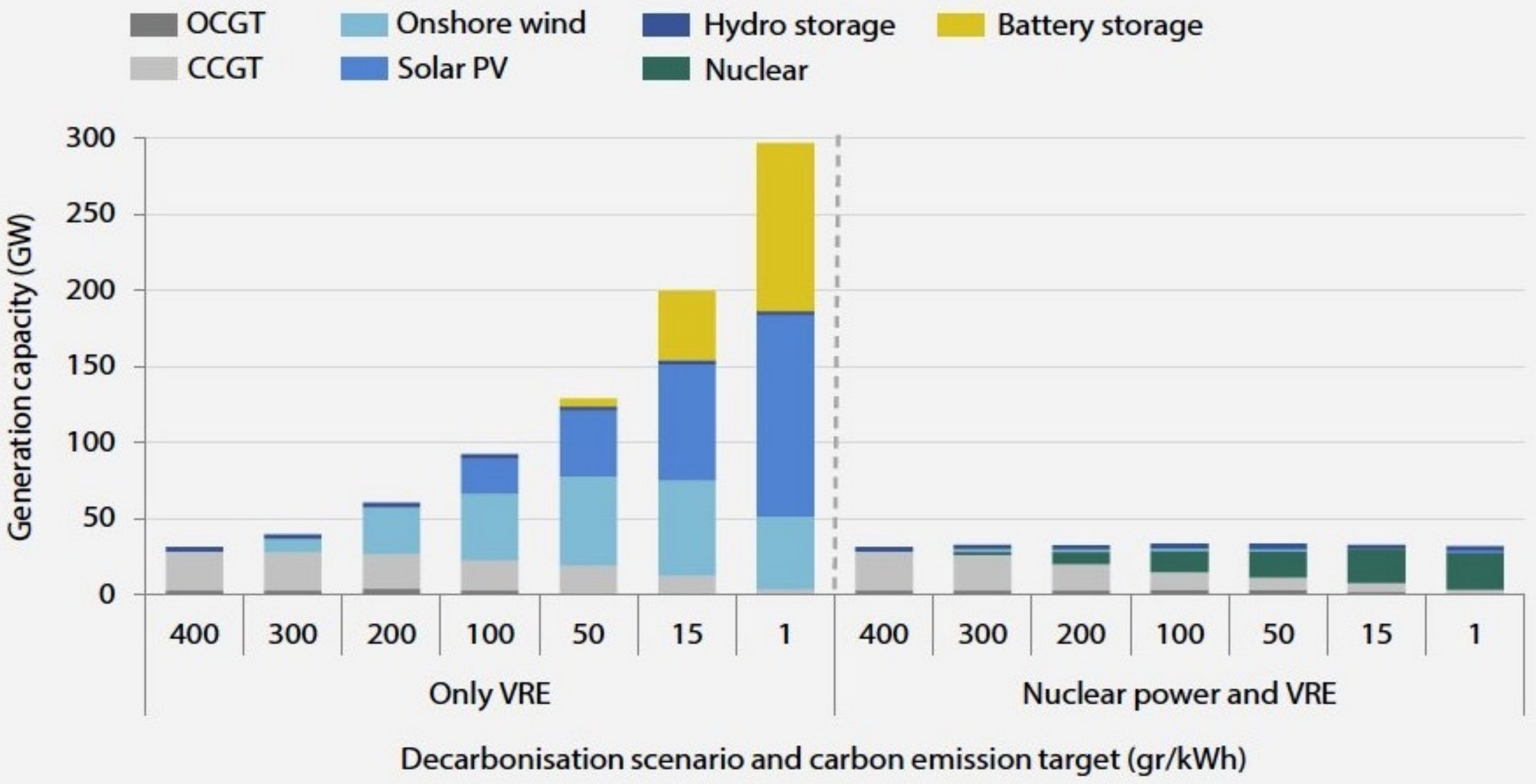
Emissions target vs Gen Mix vs Energy cost

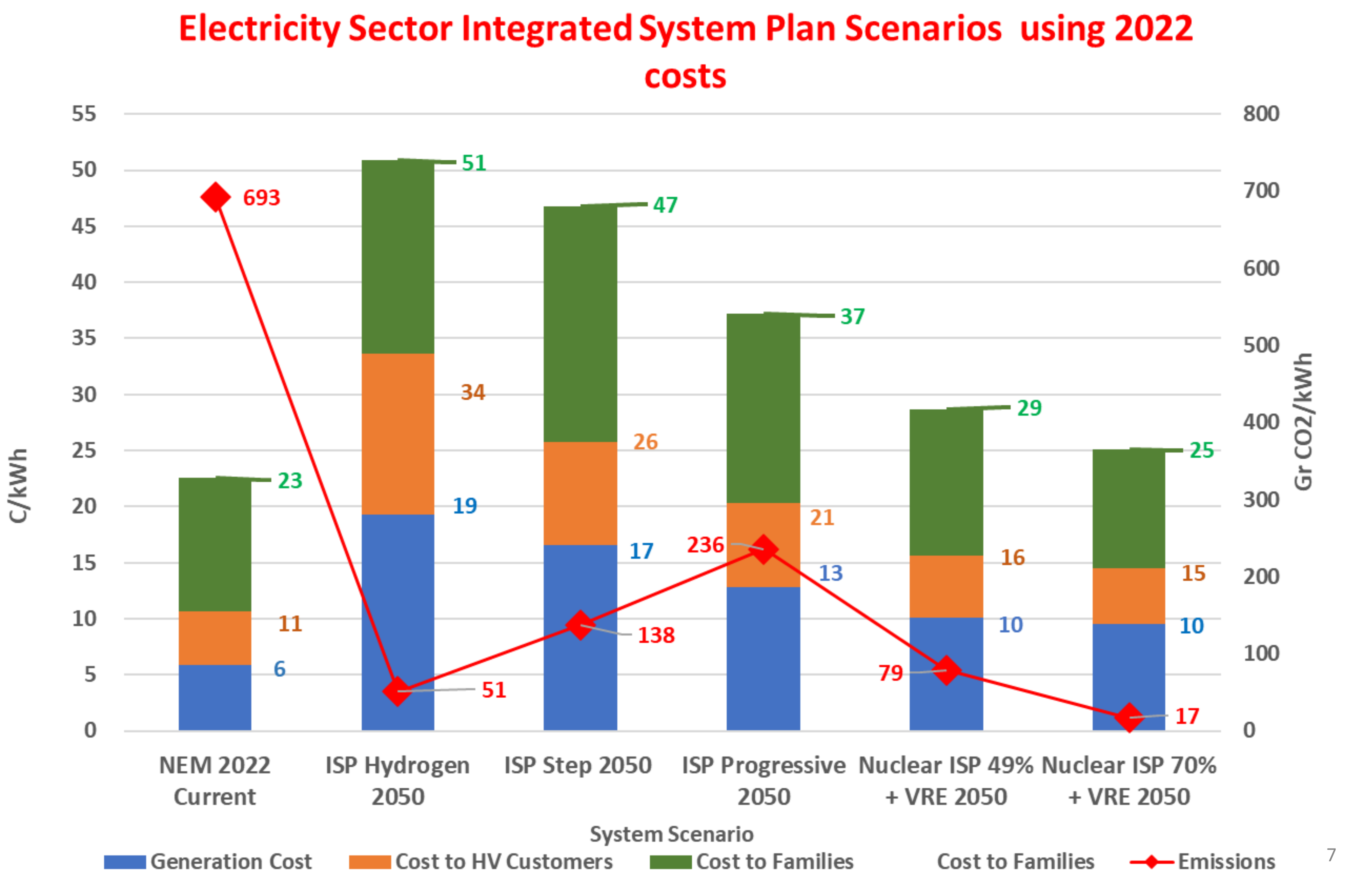


Its Vital to Design the System for the End Goal – If not, A Massive Cost Risk

Figure 22. **Driving to net zero with different mixes of generation capacity**



Source: Based on Sepulveda (2016).

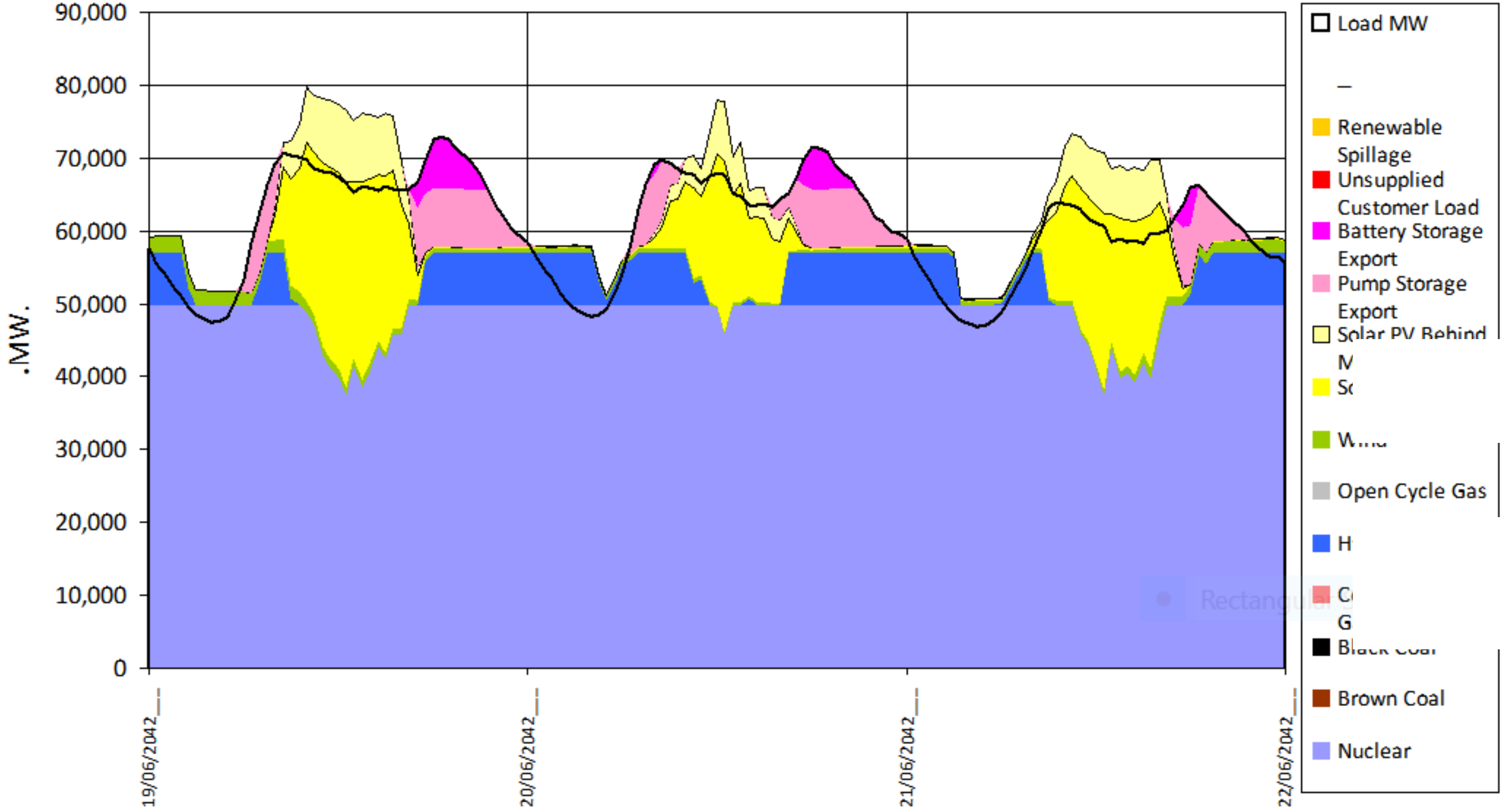


Electricity Sector Integrated System Plan Scenarios using 2022 costs
C/kWh
Gr CO2/kWh
55
50
45
40
35
30
25
20
15
10
5
0
800
700
600
500
400
300
200
100
0
693
51
138
236
79
17
23
11
6
51
34
19
47
26
17
37
21
13
29
16
10
25
15
10
NEM 2022 Current
ISP Hydrogen 2050
ISP Step 2050
ISP Progressive 2050
Nuclear ISP 49% + VRE 2050
Nuclear ISP 70% + VRE 2050
System Scenario
Generation Cost
Cost to HV Customers
Cost to Families
Cost to Families
Emissions

Electric Power Consulting Pty Ltd
Power System Generation Mix Model

Three Day Plot of Nuclear Integrated System Plan

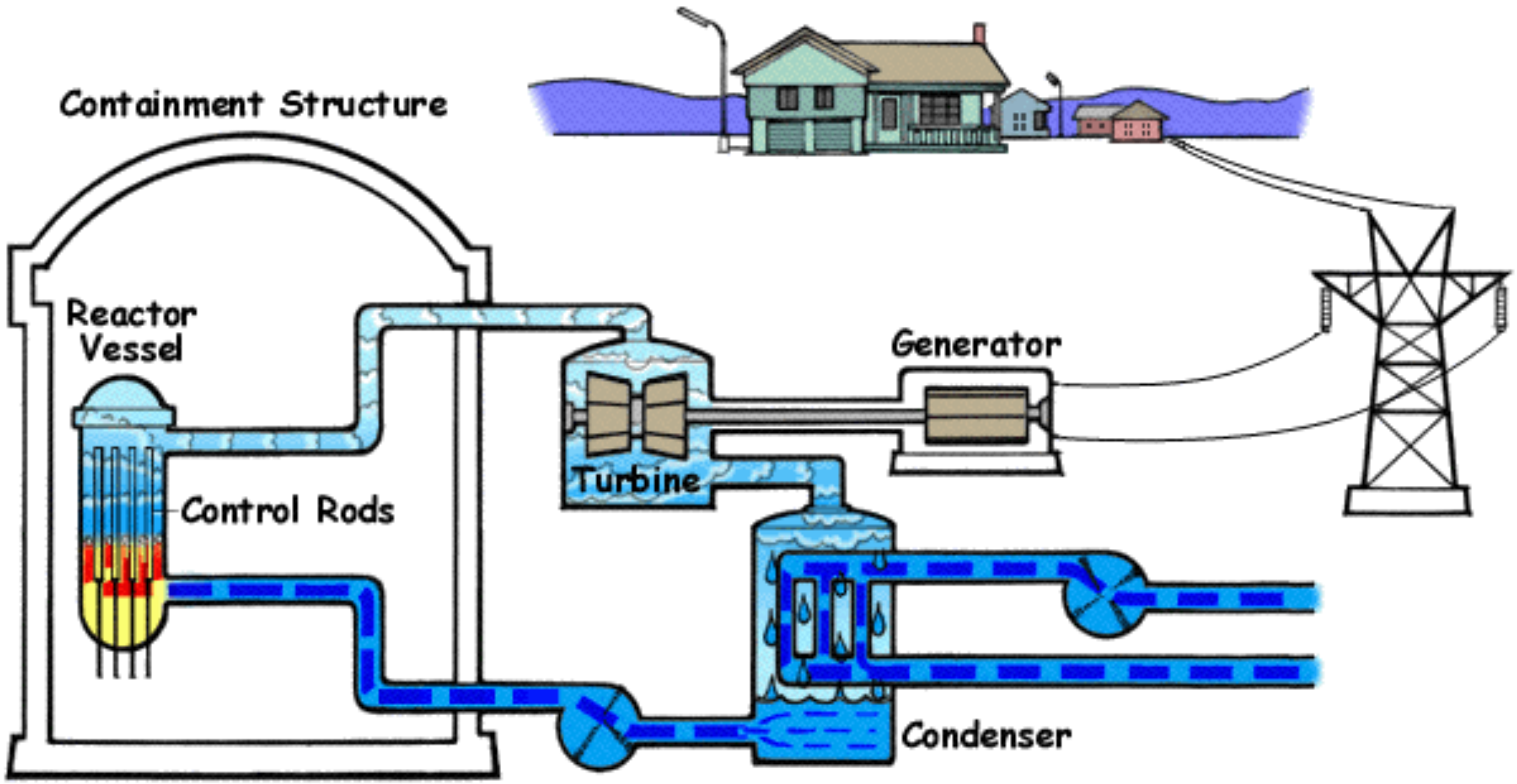
- **Note the demand curve**
- **Nuclear Provides 70% base load, solar 21%, Wind 6% and Hydro 3%**
- **Solar in excess of demand goes to battery and pumped storage**



Recently completed four unit Barakah project in UAE with 5,600 MWe South Korean Plants

Darlington Nuclear Power Plant in Ontario
4 units of 878MWe = 3,512MW

Boiling Water Reactor (BWR)



Small Modular Reactors

On-grid SMRs

- 150 to 300 Mwe
- Reliable, baseload power
- Displace coal-fired generation
- Near term deployment; by the end of this decade

Examples:

- GE-Hitachi BWRX-300

Advanced Reactors

- 10 to 150 Mwe
- Advanced reactors
- Heavy industrial applications
- Expected to be deployed in mid-2030s

Examples:

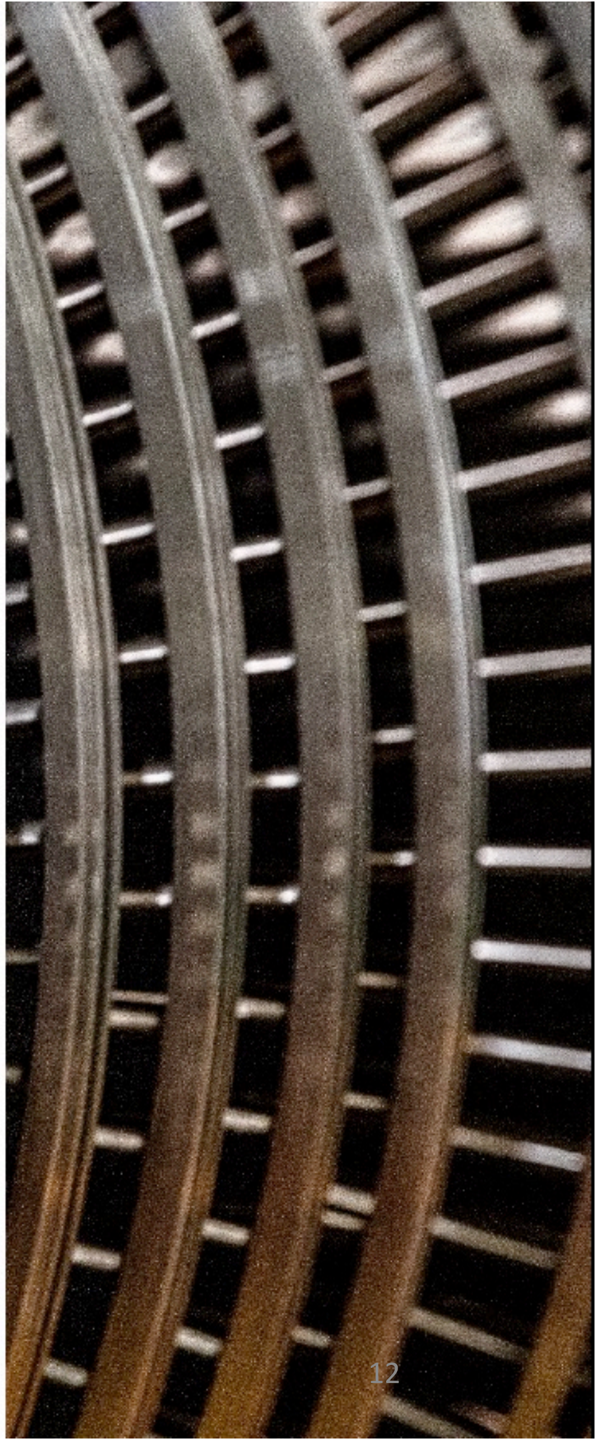
- ARC
- Moltex
- X-Energy

Off-grid SMRs

- 1 to 10 MWe
- Ideal for remote industrial and off-grid communities
- Commercial demonstration in the mid/late 2020s.

Examples:

- Global First Power MMR
- Westinghouse eVinci

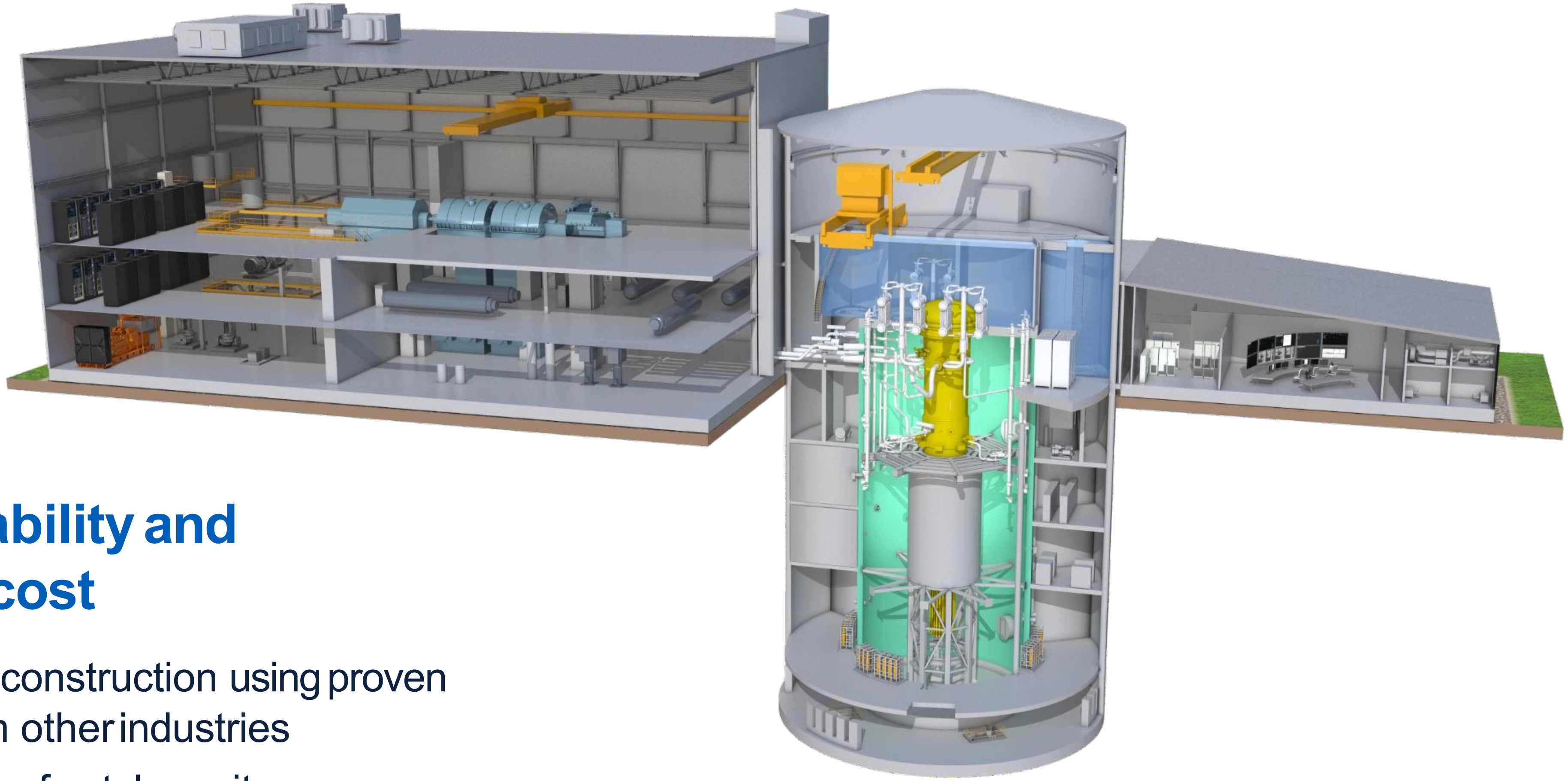


Darlington New Nuclear Project – Ontario Power Generation (OPG)

- Holds Licence to Prepare Site for new site in Clarington, Ontario
  - renewed in 2021 for another 10 years
- OPG has selected a SMR technology – GE Hitachi's BWRX-300
  - 300 MWe boiling water reactor
- OPG intends to apply for a licence to construct in fall 2022
  - Start construction of one BWRX-300 unit by early 2025 with an expected in-service date by 2028

https://www.opg.com/powering-ontario/our-generation/nuclear/darlington-nuclear/darlington-new-nuclear/

Optimized for cost and ease of construction



Constructability and Design-to-cost

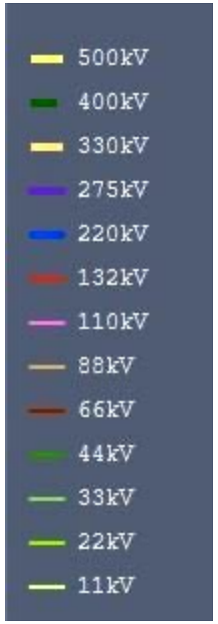
- Underground construction using proven methods from other industries
- Maximum use of catalogue items
- “Off the shelf” turbine/generator

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

Nuclear for CLIMATE AUSTRALIA

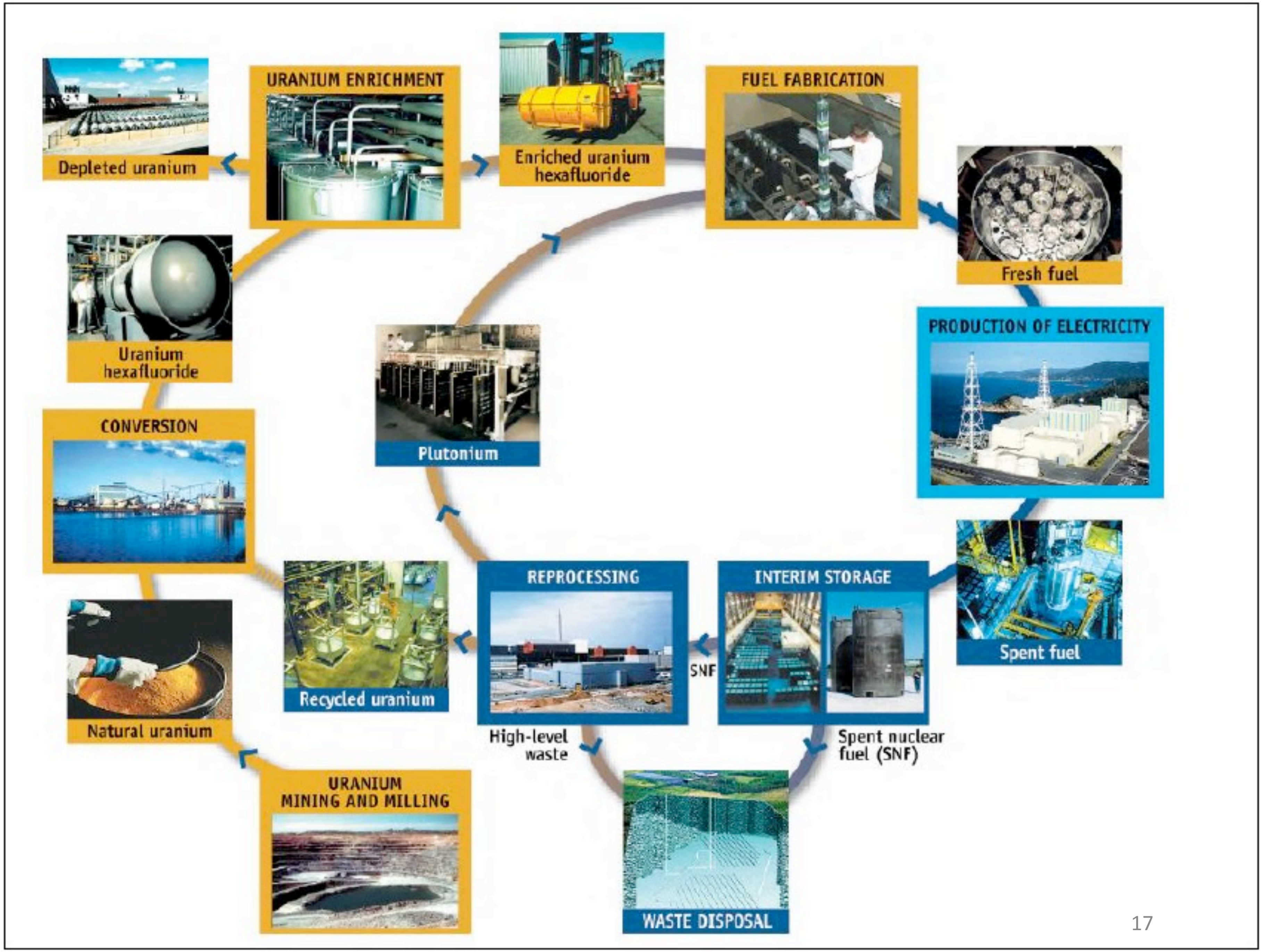
NSW Locations for Nuclear Power Plants



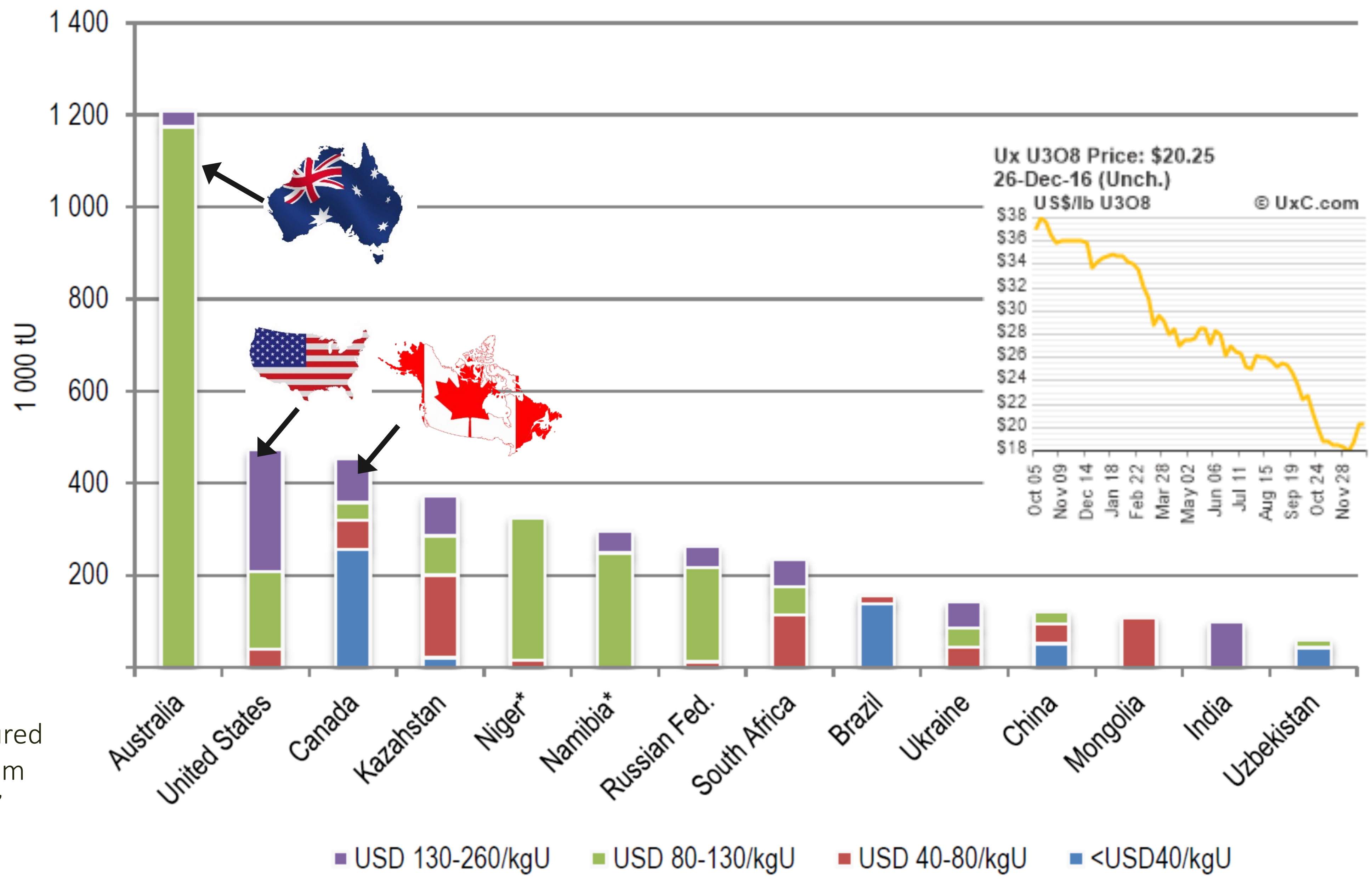
The scheme of open and closed nuclear fuel cycles

From JRC report Figure 3.3.1-1

Technical assessment of nuclear energy with respect to the 'do no significant harm' criteria of Regulation (EU) 2020/852 ('Taxonomy Regulation')



Uranium prices are low and set by politically stable countries



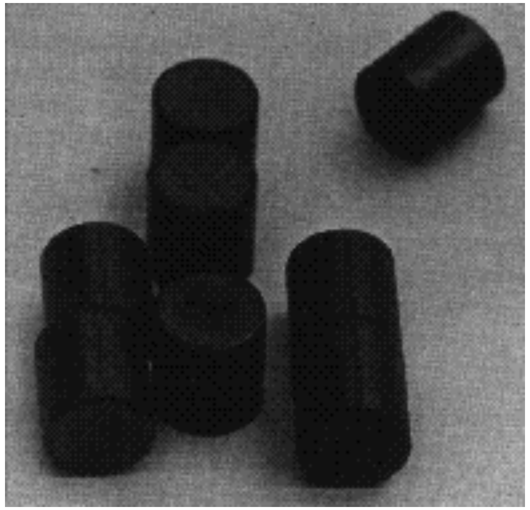
Reasonably Assured U Resources (from OECD “redbook” 2014)

A nuclear power plant uses uranium within fabricated fuel assemblies

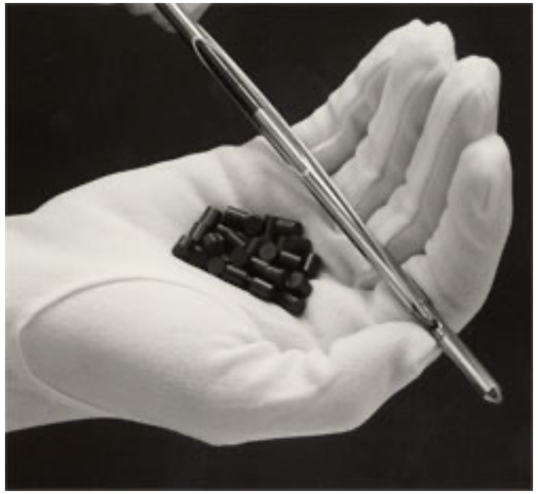
U ore

Yellow cake (U_3O_8)

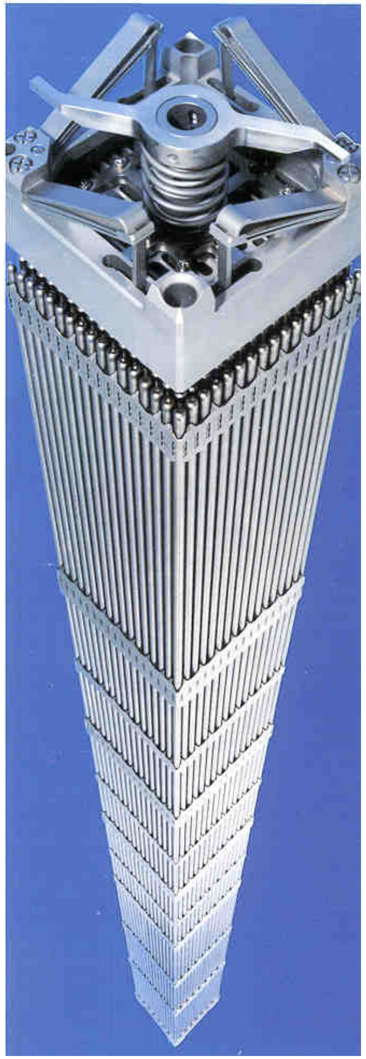
Enriched uranium dioxide (UO_2) pellets



Fuel pin



Fuel assembly



Nuclear for CLIMATE AUSTRALIA

Conclusions

1. Electricity is the life blood of our economy but industry and the broader economy will be destroyed if it becomes too expensive and load shedding is required
2. We need to look at the best International precedent as we move to an ultra low carbon future – Ontario is a standout example
3. Look at all options for energy generation and that needs to include nuclear energy in the mix
4. Current policies focused only on wind and solar have poor outcomes in locations such as California, Germany and locally in South Australia
5. **Repeal the anti-nuclear fuel cycle legislation**

Now for a Q&A

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