How advanced nuclear technology could be a vital part of Australia's clean energy future

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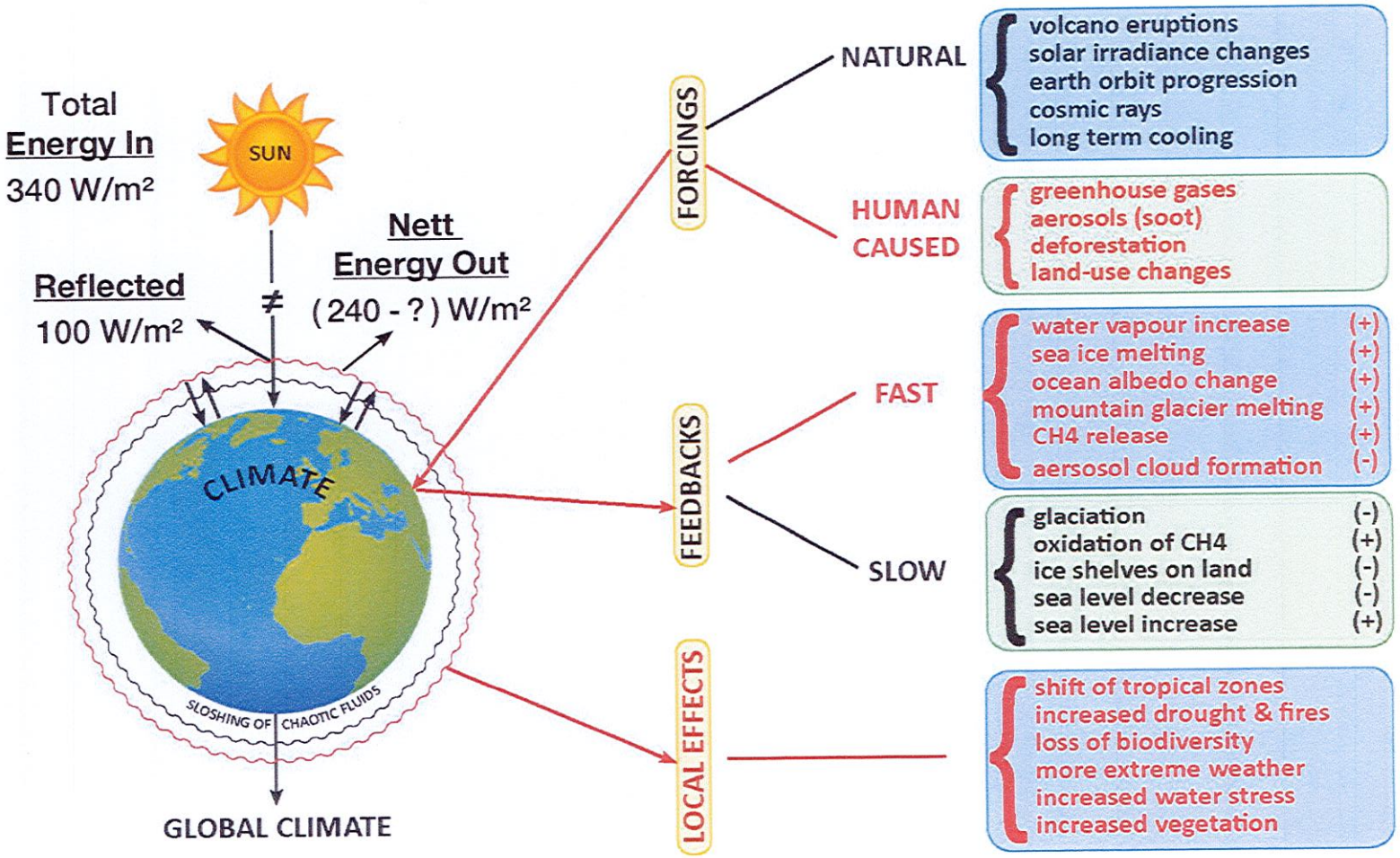
Are we forcing the climate?

Climate change follows a net radiative energy imbalance with the sun. As long as this imbalance remains, the climate will change so as to reduce the imbalance.

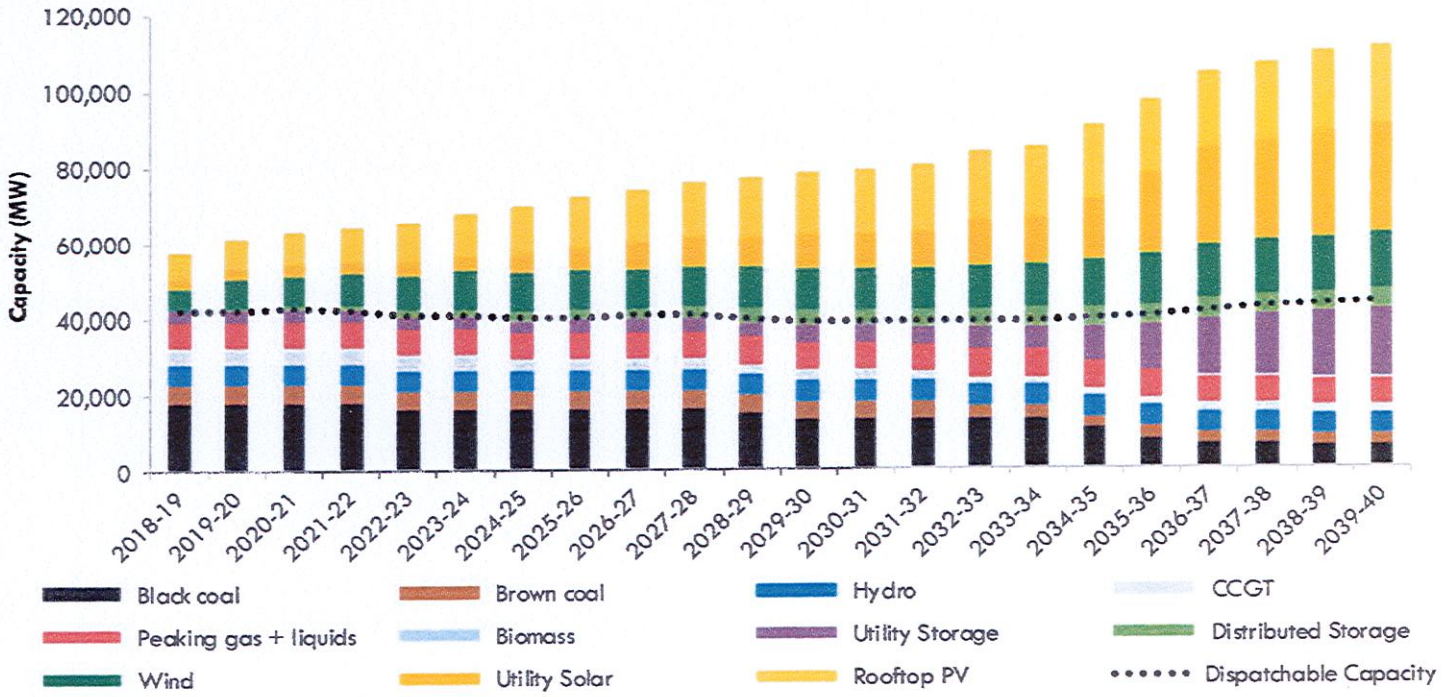


From the AEMO Integrated System Plan

" Systems with lots of non-synchronous generation like wind and solar are weaker and harder to control -- raising the risk of cascading blackouts. "

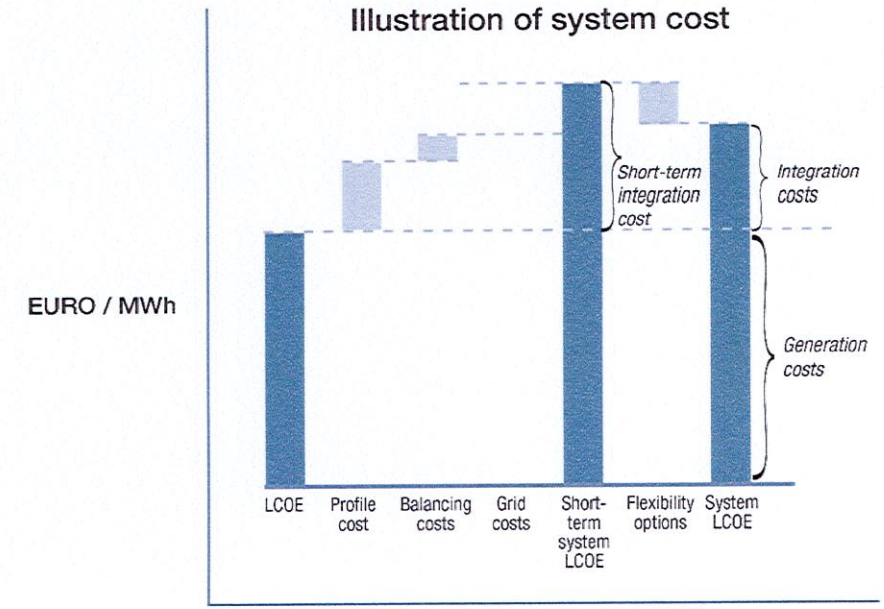
Anne Pearson , Chief Executive of AEMC (April, 2019)

Figure 9 **Forecast NEM generation capacity in the Neutral case**



What are grid integration system costs ?

- Wind and solarPV are intermittent, variable, fluctuating with availability (profile)
- Power output cannot be predicted with certainty (balancing)
- Favourable sites often a long way from points of demand (grid)
- Not directly synchronised with the grid, require separate power electronics
- Modular output, individually much smaller than conventional generators
- But have low marginal costs of operation (LCOE)



What benefits could SMR's bring to Australia ?

- Benefits ....
  - lower up-front investment, especially at a brownfield site
  - small land requirement (18 ha for Nu Scale up to 720 MW)
  - shorter construction times, easy transmission connection
  - passive and inherently safe
  - can add or subtract modules in operation as demand requires
  - can mean other benefits as well (e.g. process heat, desalination)
  - clear and certain elimination of carbon emissions
  - combined with smart grid technology, can provide flexible back-up
  - modularity enables mass production, ensures consistent quality
  - less financial risk, more attractive to investors -- **provided that long-term political commitment exists**
  - **a chance to be part of international scientific and engineering collaboration,**

but.....

- would have to be deployed early and in numbers to significantly reduce GHG emissions -- a long-term strategic direction
- **the political decision needs an informed, willing community.**

Nuclear's challenge is up-front cost, but this should not preclude consideration according to the SA Royal Commission

AP 1000+ PWR (1125 MWe)	**SMR 385 MW**	**SMR 360 MW**
Greenfield site A$ 9.3 billion	A$ 3.3 billion	A$ 3.7 billion

Includes cost of all needed infrastructure, including a wharf.

" *This does not necessarily apply to other jurisdictions in Australia."*

September 2019 : ($A = 0.72 $US) : 'overnight' cost estimates
* Korea study tour 2018 : ** CSIRO costGen 2018

* **'big' nuclear** : (1000 MW) FOAK $ 7.0 billion : NOAK $ 6.2 billion
** **coal** : from $ 3000 -- 9000 / kW (e.g. 1000 MW = $ 3.0 -- 9.0 billion)
** **pVsolar / wind** : around $ 2000 / kW (e.g. 400 MW = $ 800 million)
** **solar thermal** : $ 7000 / kW
** **gas** : $ 4000 / kW

NuScale SMR : (300 MW) FOAK $ 1.86 billion : NOAK = $ 1.54 billion
(2019) (720 MW) FOAK $ 4.46 billion : NOAK = $ 3.7billion

What are others doing ?

- 445 operable nuclear power reactors in 31 countries ; 16 countries have 55 new reactors under construction, with another 436 under planning or 'proposed' . China currently has 37 reactors in operation with 19 under construction, and is proposing to add up to 290 more by 2050 (*April 2019*).

- Bangladesh, Belarus, UAE are 'new', currently building eight reactors ; Egypt and Uzbekistan are 'new' with six reactors under planning. In total, 45 countries are 'actively pursuing' or 'strongly interested' in exploring a nuclear program (2017).

- Russia and China using nuclear power development for economic and political advantage in nations across Africa and Asia. This is likely to extend into the Pacific region, possibly to Australia's detriment.

- SMR development is now receiving strong Government support in USA, UK, Canada, China, and Russia. Other countries are picking up on this, but Australian governments have only recently displayed any (lukewarm) interest.

- **For Australia, SMR dispatchable nuclear power would provide reliable, emissions-free, modular base-load power, to work with renewables, storage, hydro, and gas for optimum cost-effective performance.**

A road to the use of Advanced Nuclear Power technology in Australia ?