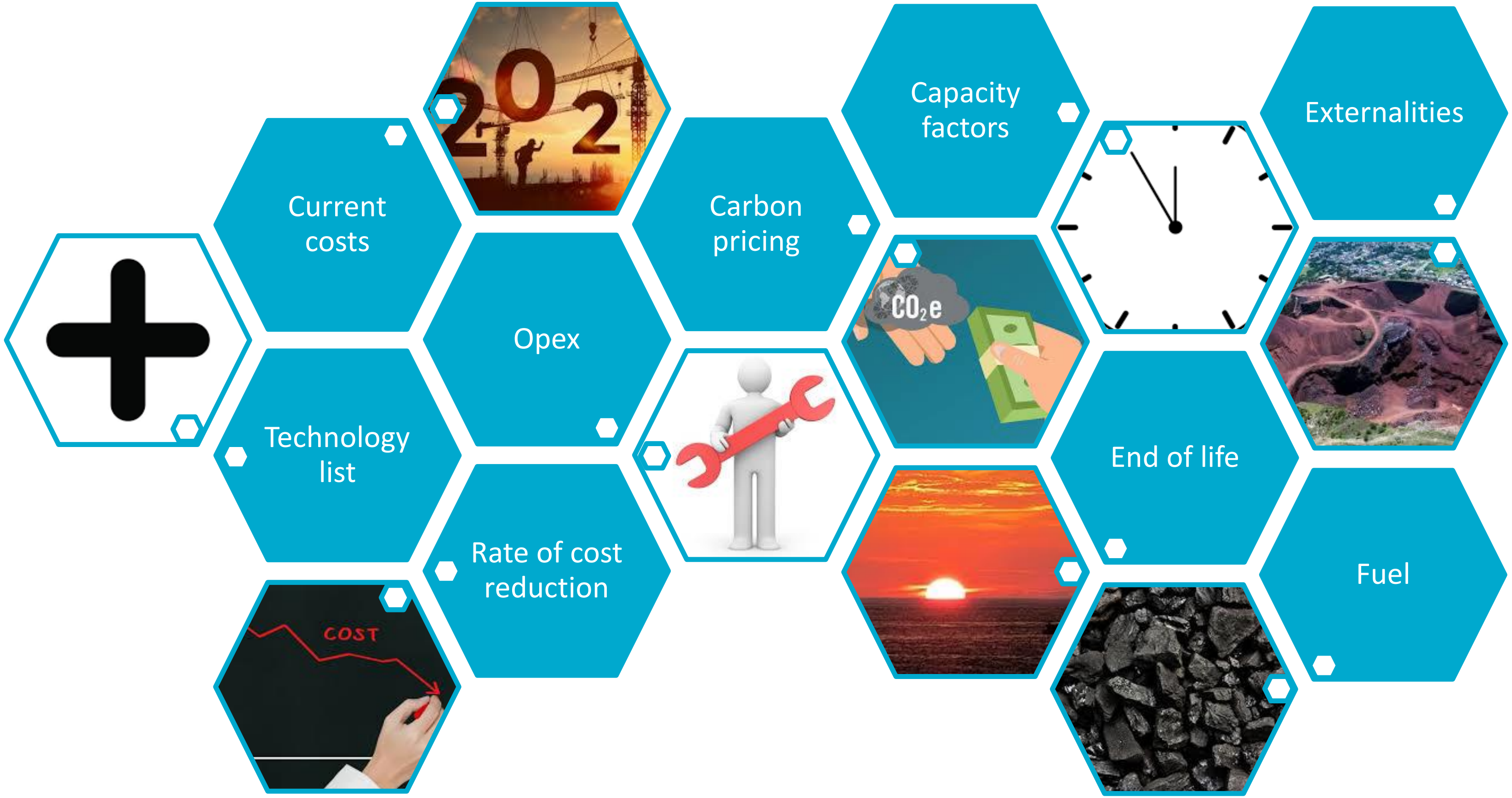
GenCost 2020-21:

Consultation draft feedback

March 2021

Australia’s National Science Agency

Submissions major themes



GenCost topics with no connection to ISP

- Nuclear SMR
- Global carbon pricing
- Levelised Cost of Electricity (LCOE) input methodology

These will be covered but will not impact AEMO ISP inputs

Rate of cost reduction

Input

- Stakeholders believe evidence support faster rate of cost reduction for
  - Batteries
  - Offshore wind

Considerations

- We have found other studies (IEA) supporting revised assumptions for offshore wind and support this change
- Explore uncertainty in battery learning rate (next slide)
- Historical learning rate is an input. Future deployment and the rate of change in costs is an output of the model. However, batteries are impacted by global electric vehicle deployment assumptions

Rate of cost reduction

Input

- Concern that cost reduction range for batteries is too narrow

Considerations

- We can revisit range of electric vehicle adoption but battery pack is eventually a small component of total costs
- We will look into developing broader range in BOP cost trajectories
- We can explore uncertainty in the battery learning rate by scenario

Rate of cost reduction

Input

- PEM electrolysers can fall faster

Considerations

- No references provided for lower current costs
- Our High VRE scenario consistent with 2025 view ($750/kW PEM)

Technology list

Input

- Stakeholders would like the study to add
  - Compressed air energy storage
  - Non-lithium based batteries

Considerations

- Projects are very limited or announced only
- Our goal from the commencement of GenCost is to keep the study lean (previous studies became overblown with low deployment technology)
- Not considering any change for 2020-21 but could be considered in future years

Operating and maintenance cost

Input

- Stakeholders advise that opex is too high for
  - Batteries
  - Nuclear SMR

Considerations

- We are considering changes to the way we approach the relationship between opex and battery size
- We agree the variable opex for nuclear SMR doesn’t appear to be supported by other sources and will be revised down

Capacity factors

Input

- LCOE renewable capacity factors not consistent with REZ information
- Low range of LCOE wind capacity factor is not consistent with observed generation
- Coal/nuclear capacity factors are not consistent with global work

Considerations

- LCOE analysis requires a range, REZ is an average
- New-build wind will have higher capacity factors than existing
- Coal/nuclear capacity factors reflect real world likely operation not theoretical availability (maximum observed is 80%)

Coal fuel costs applied in LCOE analysis

Input

- Assumed coal prices in GenCost are well above existing plant costs

Considerations

- GenCost exclusively focuses on new-build plant who face higher costs and competition from export market
- AEMO assumptions includes lower coal costs for existing plant

Externalities

Input

- Renewables have several additional costs which are not captured

Considerations

- All technologies imposed additional impacts beyond their delivered cost of electricity
- To compare technologies on a common basis we ignore most externalities
- We did include a new method for calculating the integration costs of renewables as these directly relate to electricity costs and AEMO modelling captures these as well

CSIRO

End of life period

Input

- The full technical life for coal plants should be used for all calculations

Considerations

- Technical life is used in GenCost and AEMO modelling to understand maximum date before retirement (if no investment in life extension)
- Economic life or the period of the loan for LCOE calculations will be shorter than technical life to reduce risk to the financial institution
- If a government investor were to guarantee a longer loan period, then that is an exception. However, we assume standard financing arrangements

End of life period

Input

- Battery life warranties are beginning to stretch to 20 years
- Battery life should not be 20 years

Considerations

- Current assumption – project life is 20 years but batteries is 10
- 20 years not yet standard
- Highlight lengthening battery life in reporting
- Other approaches?

Carbon pricing

Why included in GenCost?

- To implement global emission abatement scenarios in our global electricity model

- To represent risk to high emission generation investment in LCOE calculations

- Approach used in GenCost is separate from AEMO ISP

Carbon pricing: global modelling

Our global abatement scenarios are based on IEA World Energy Outlook scenarios

- IEA publishes carbon prices and other country policies
- We cannot quite match the global emission outcomes in our model because of different global model formulations
- In the draft, we adjusted the carbon price (upwards) until we matched emission outcomes

Carbon pricing: global modelling

Considerations

- Increasing the carbon price end point likely has no impact – it's the closure of plant and avoided investment in the early years which leads to the lower emission outcome

- We could raise carbon prices in the early years and keep same end-point

- More consistent with IEA to adjust other policies that result in earlier action, and keep carbon prices aligned

Carbon pricing: LCOE

Considerations

- Some stakeholders assumed that our main conclusion in regard to the competitiveness of renewables was only because we included a carbon price
  - The conclusion was in no way dependent on inclusion of carbon prices
- We plan to remove carbon pricing from the LCOE comparisons to avoid confusion

Battery round trip efficiency

Input

- Consider increasing RTE over time consistent with approach to capacity factor of wind, for example

Considerations

- There are existing variations due to level of auxiliary power required
- Reasonable to expect some improvement

Current cost: Batteries

Input

- Project due for deployment in 2021 are already lower cost
- Consistent inclusion of contingency costs

Considerations

- Our current cost definition is backward looking – ideally evidence is from completed projects
- Observing significant variation in completed project costs
- Based on some more recent information could reduce 2020-21 cost by 4%

Current cost: Large-scale solar PV

Input

- Reduction has not been as fast when considering
  - Observed EPC prices
  - Increase in assumed in size from 100MW to 200MW
  - Increased obligations to do no harm leading to extra costs to support system strength

Considerations

- Standard size assumption (are planned project sizes reflecting final build size?)
- Highlight additional costs in the report

Current cost: Nuclear SMR

- **GHD 2018**: 100% higher than conventional nuclear. Source not well-documented. Appears to be IEA /Nuclear Energy Association *Projected costs of electricity generation 2015* which was reproduced on the World Nuclear Association website.

two SMR-based plants are under construction, one in Argentina (CAREM reactor) and one in Russia (KLT-40s, a floating power plant). Because of their size, the specific per-MW costs of SMRs are likely to be higher (typically 50% to 100% higher per kWe for a single SMR plant) than those of large generation III reactors. However, economies of volume could compensate economies of scale if a sufficiently large number of identical SMR designs are built and replicated in factory assembly workshops. Lower

Pg 159

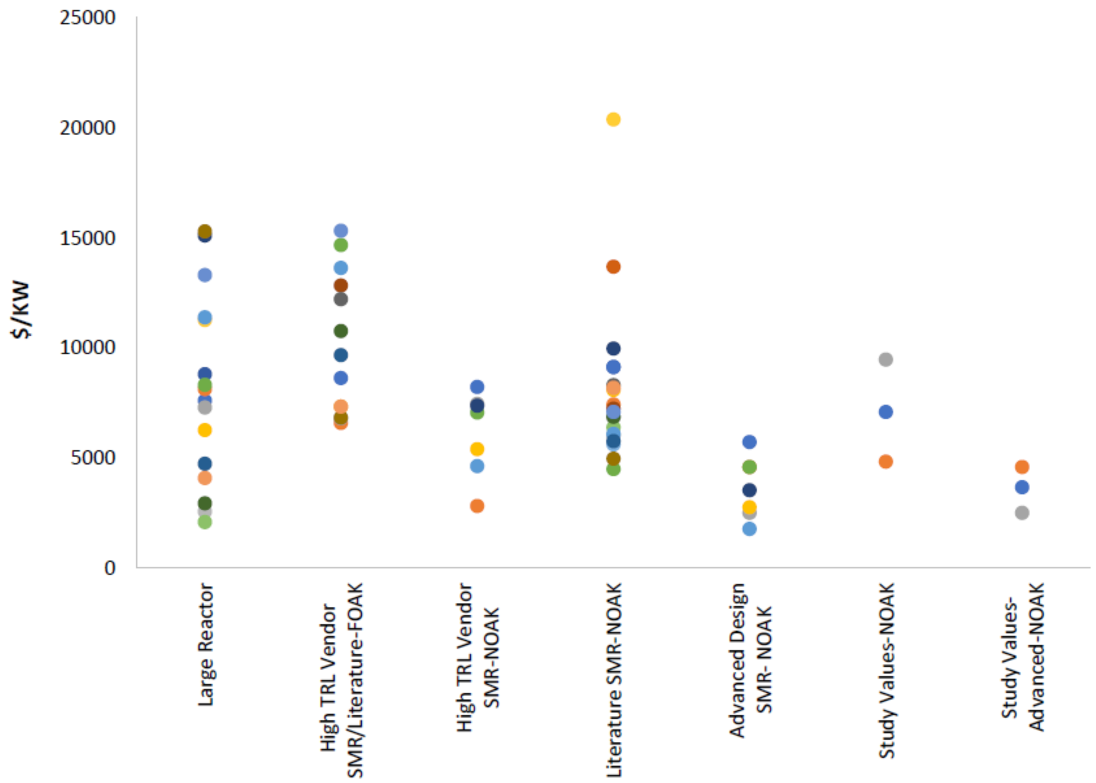
- 2×$US5,600/kW÷0.7 = $A16,000/kW

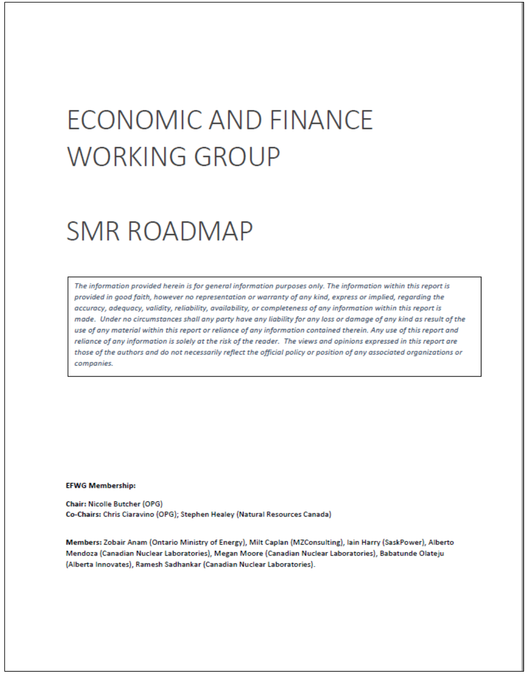
average of a range which could be between USD 4 530 and 5 600/kW. Pg 41

Current Lazard's cost range conventional nuclear: US$6,025-US$9,800/kW
Take mid-point, 50% premium and 0.75 A$/US$= $15,825/kW

Current cost: Nuclear SMR

Stakeholders advised this data source is preferable to GHD's estimate





ECONOMIC AND FINANCE WORKING GROUP

SMR ROADMAP

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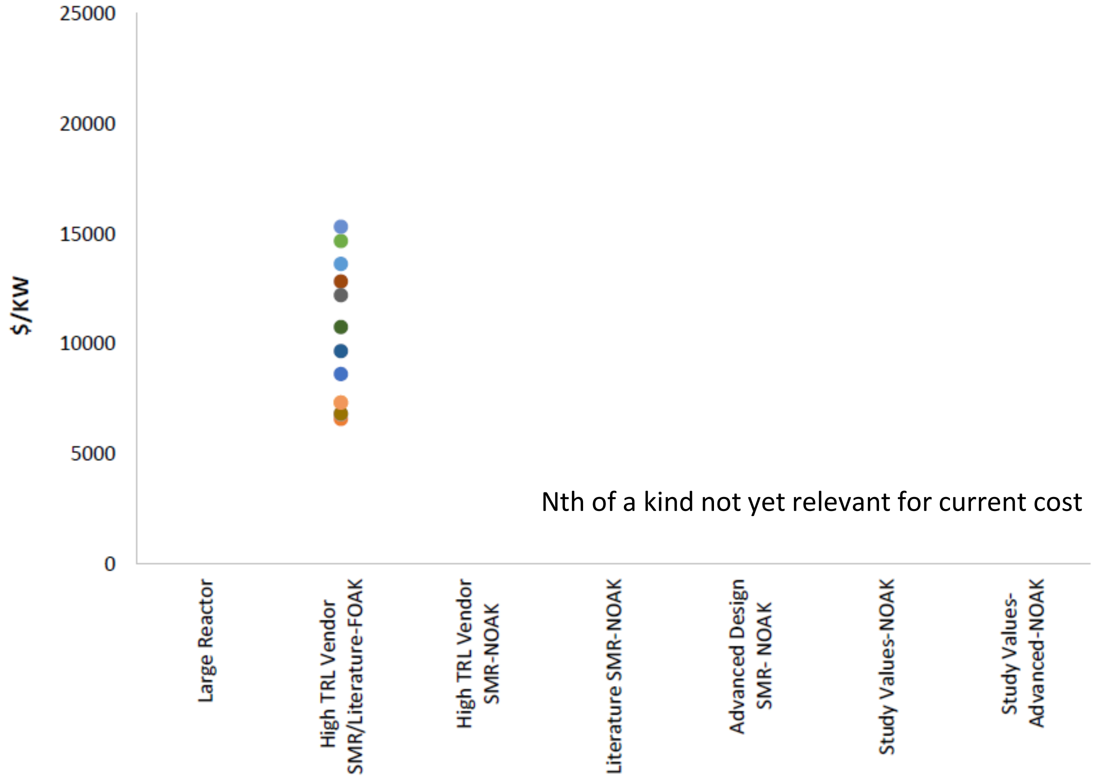
Published 2019

Current cost: Nuclear SMR

We did consider this source in 2019



Range is C$6,593 to C$15,333

In 2019 this converted to: A$7,245 to A$ 16,849

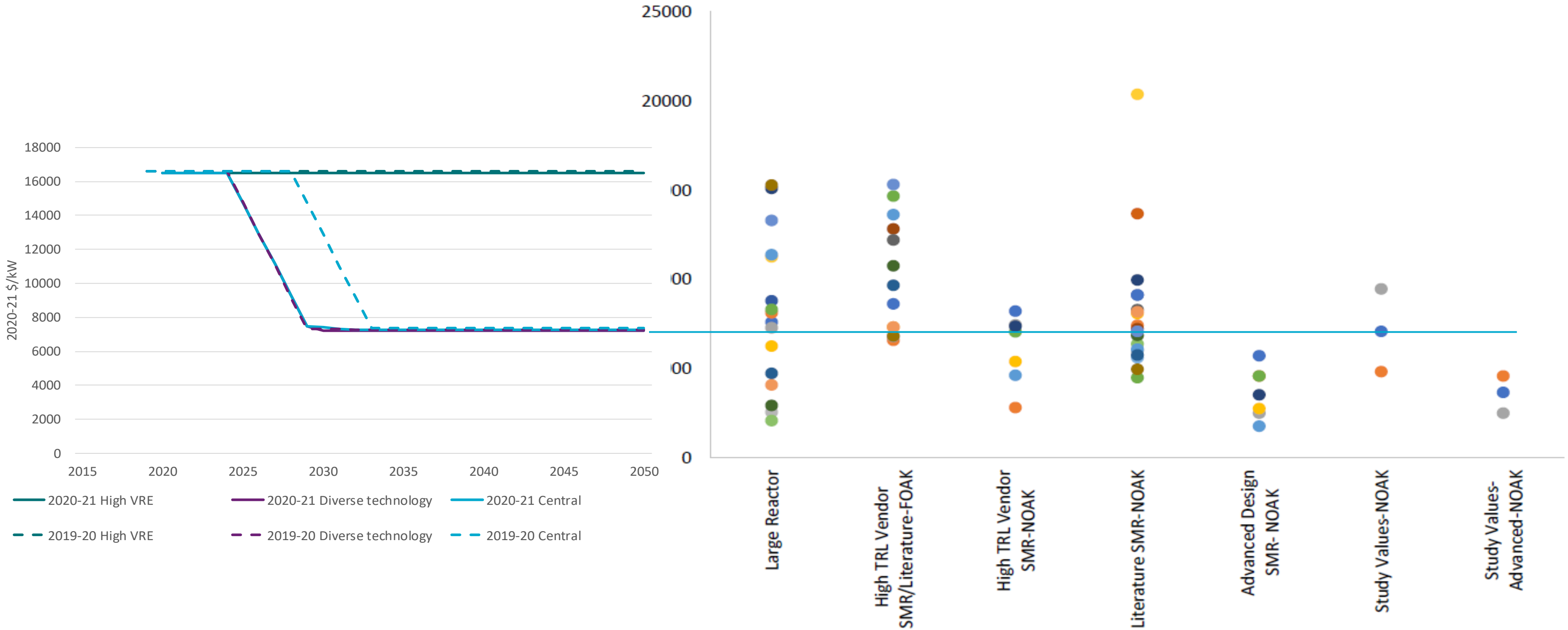
In this context GHD's estimate remained reasonable

Given Australia's lack of experience in deploying nuclear, it seems unlikely our FOAK would be at the lower end of the range.

Current cost: Nuclear SMR

- While the first plant would be expensive we agreed there are potential for cost reductions with modular manufacturing
- In 2018 we were not modelling SMR as a separate technology category with its own learning ability outside conventional nuclear
- We invested in GALLM to include SMR and we started to be able to show results with large future improvements in SMR

Current cost: Nuclear SMR



Also confirming the US EIA Annual Energy Outlook 2021 list SMR as available in 2028 at $US6,802 or $A9,069 (0.75 A$/US$)

Current cost: Nuclear SMR

- We can be clearer in the report that we have considered more sources than GHD

- Several submissions proposed we exclude SMR
- Pros:
  - Limited investor interest
  - The project is not likely to invest in major updates
- Cons:
  - The technology will remain in the model because it exists in other countries
  - Reduces transparency of the modelling

- Interested in other views.

Key questions/discussions

- Are large-scale solar PV costs appropriate? Should a smaller project size be used as the basis?
- Views on the appropriate technical life of the battery component?
- Views on assuming an improvement rate in battery RTE?
- Should nuclear SMR costs continue to be included in the GenCost report?

Thank you

CSIRO Energy
Paul Graham
Chief Economist Energy

+61 2 4960 6061
paul.graham@csiro.au