

Grid Reliability and Integration Challenges

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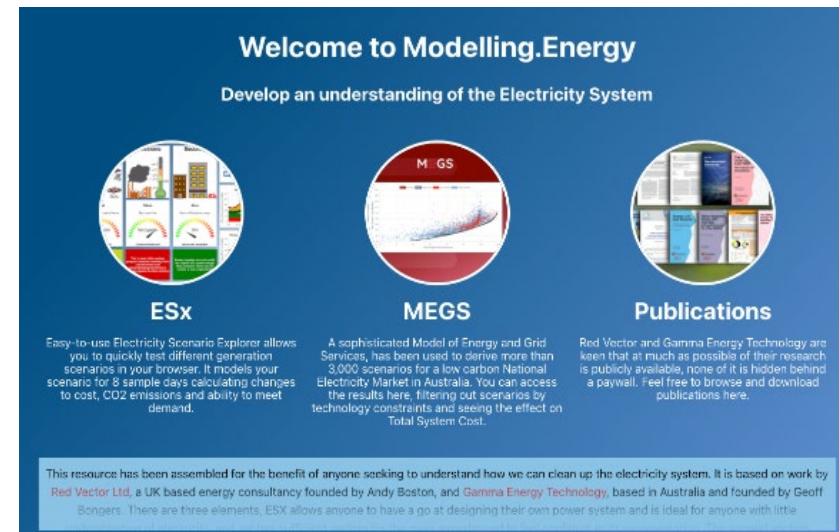
Talk Outline

- Weather
- Total System Cost
- Australian Diverse Lowest Cost System
- Preliminary Japanese Work
- Final Thoughts

The Team & Our Work

- Geoff Bongers
- Joshua Humphreys
- Nathan Bongers
- Stephanie Byrom
- Andy Boston
- Brent Cutts
- Chris Brown

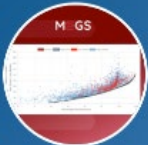
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Welcome to Modelling.Energy
Develop an understanding of the Electricity System



ESx
Easy-to-use Electricity Scenario Explorer allows you to quickly test different generation scenarios in your browser. It models your scenario for 8 sample days calculating changes to cost, CO2 emissions and ability to meet demand.



MEGS
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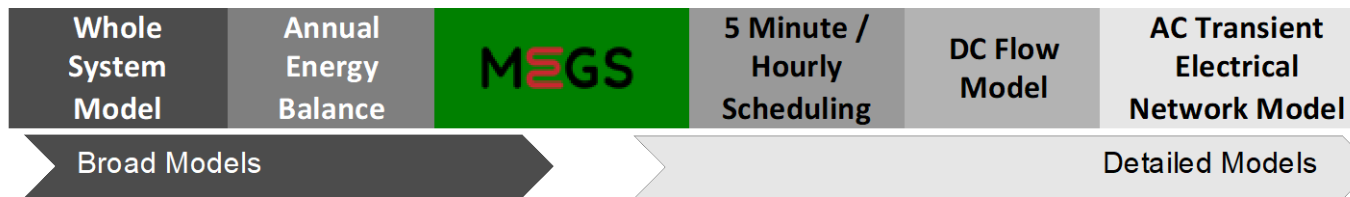


Publications
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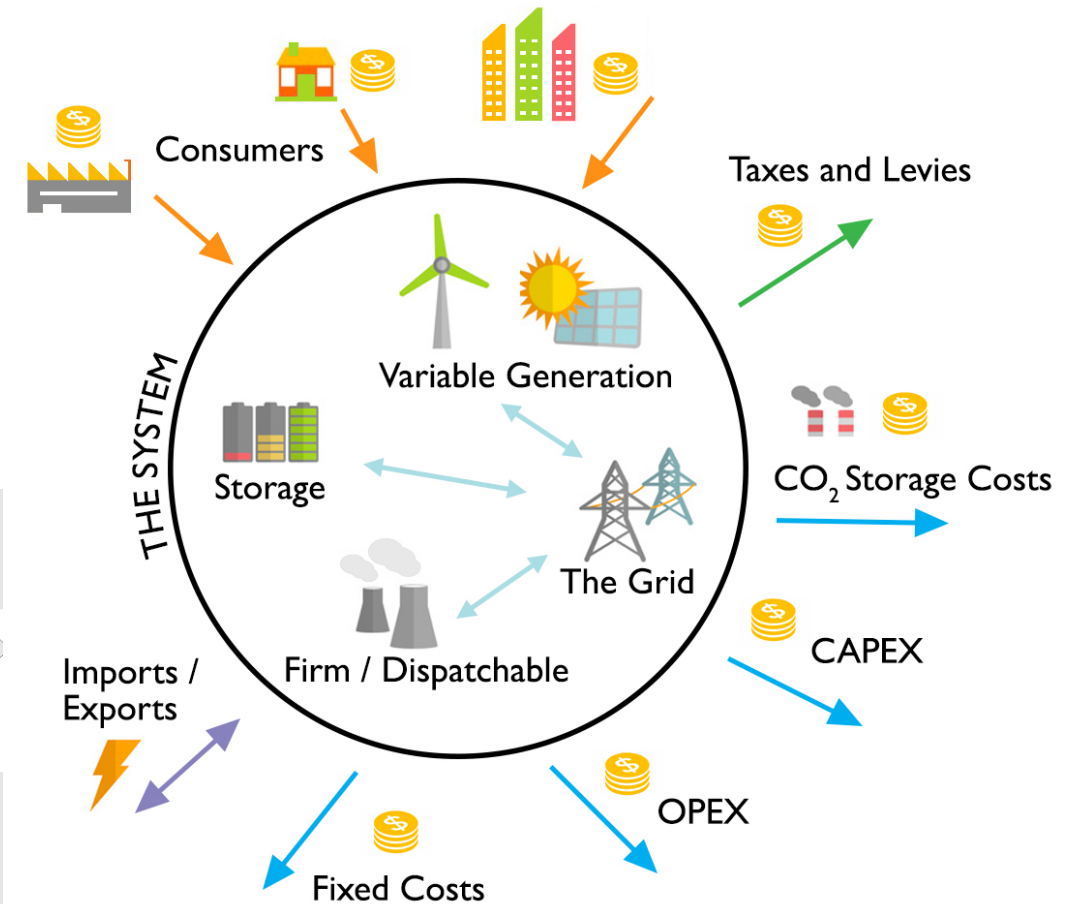
This resource has been assembled for the benefit of anyone seeking to understand how we can clean up the electricity system. It is based on work by Red Vector Ltd, a UK based energy consultancy founded by Andy Boston, and Gamma Energy Technology, based in Australia and founded by Geoff Bongers. There are three elements. ESx allows anyone to have a go at designing their own power system and is ideal for anyone with little

Total System Cost

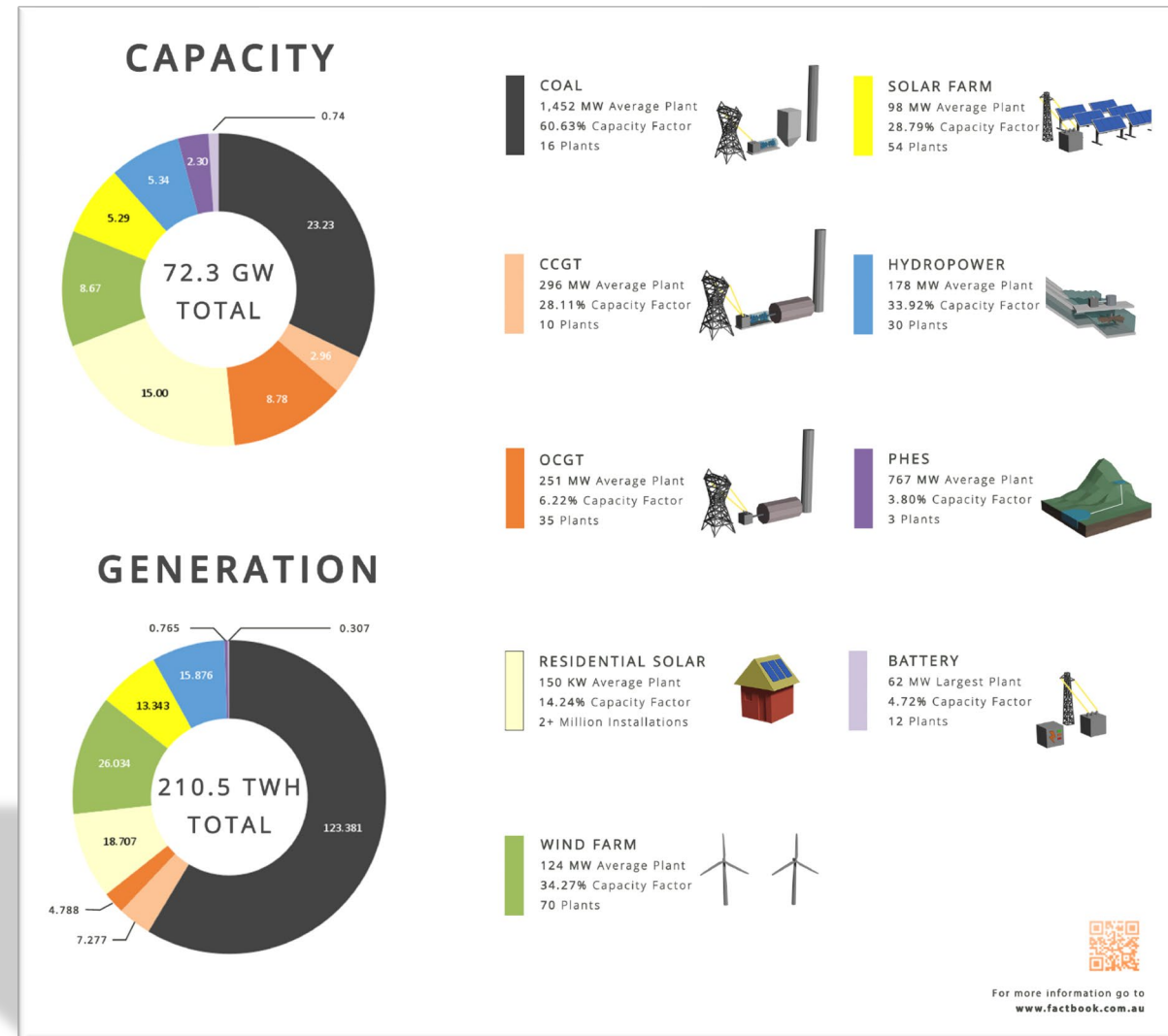
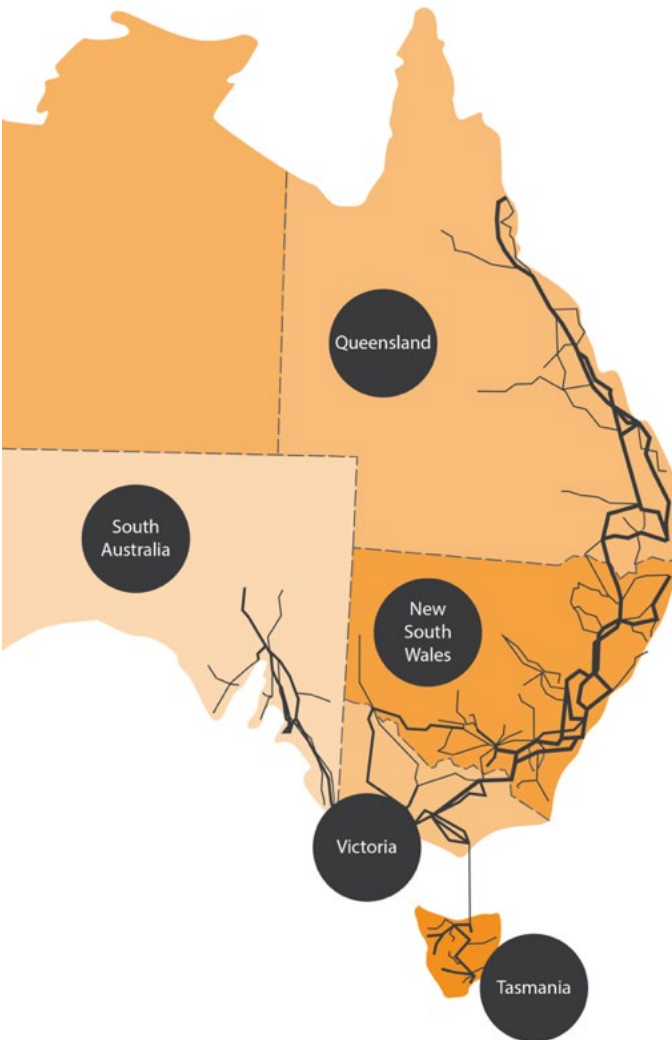
- Power generation, storage and transmission assets are those shown within the 'system' circle, these are the physical elements of the system.
- Costs refer to any payments (blue & green arrows) that leave the electricity system
- The price paid by consumers (orange arrows) must cover all of these outgoings and hence is equal to the **Total System Cost**.



Small No. of Scenarios	Many Annual Scenarios	100s of Scenarios	A Daily to Yearly Resolution	Simple Point in Time	Single Point in Time
Complex techno-economic models. Economics: whole energy system (heat, transport, power).	Simple spreadsheet solutions, includes economics.	Interconnect capabilities. Includes economics and system stability. Medium resolution	Includes economics and unit dynamics (ramping, on-times etc).	Good estimate of system strength. Interconnect capabilities.	Represents electrical engineering excellently: system fault stability, inertia requirements.



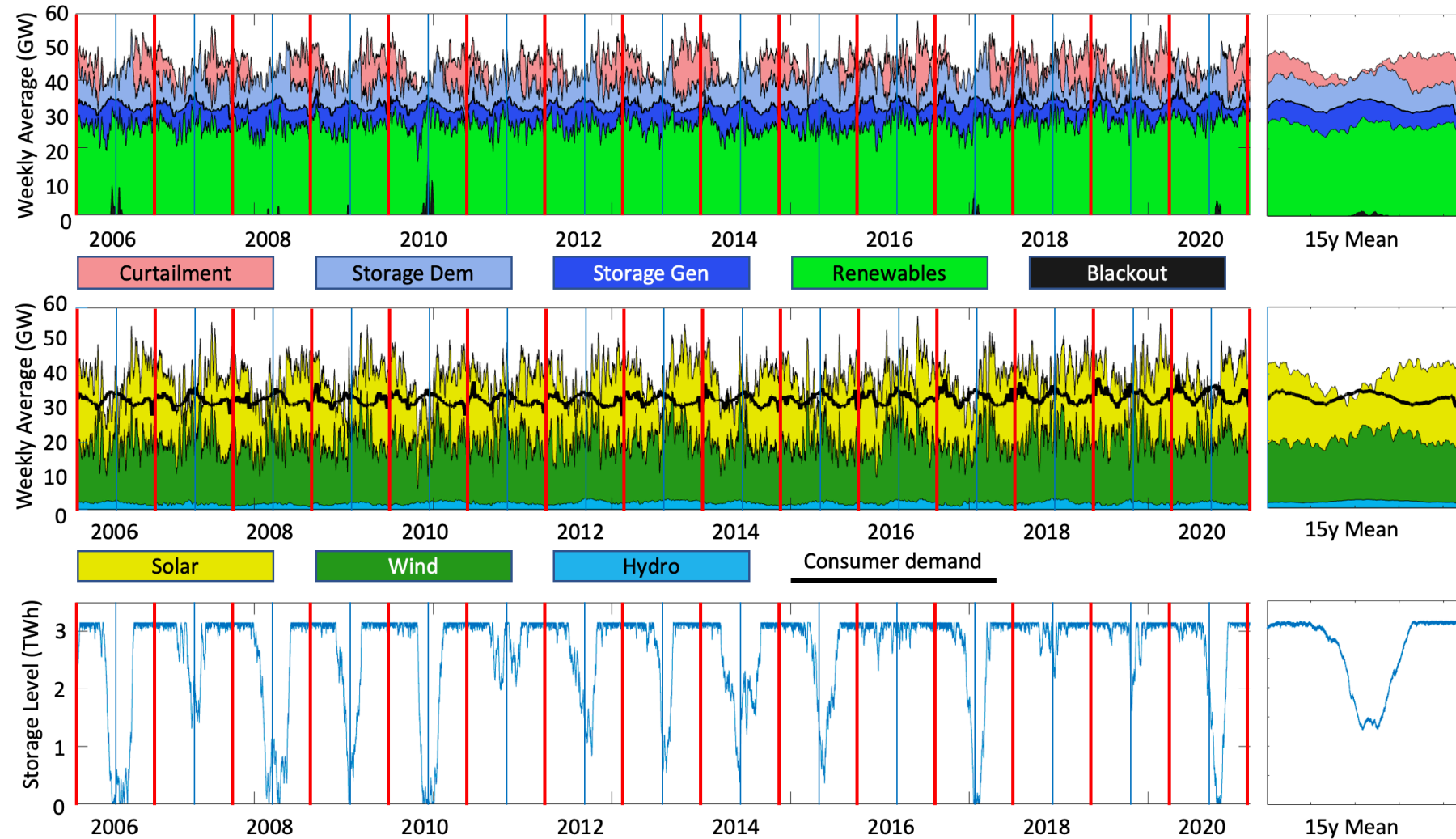
The Australian East Coast Grid (the NEM)



Renewable Only Energy Systems

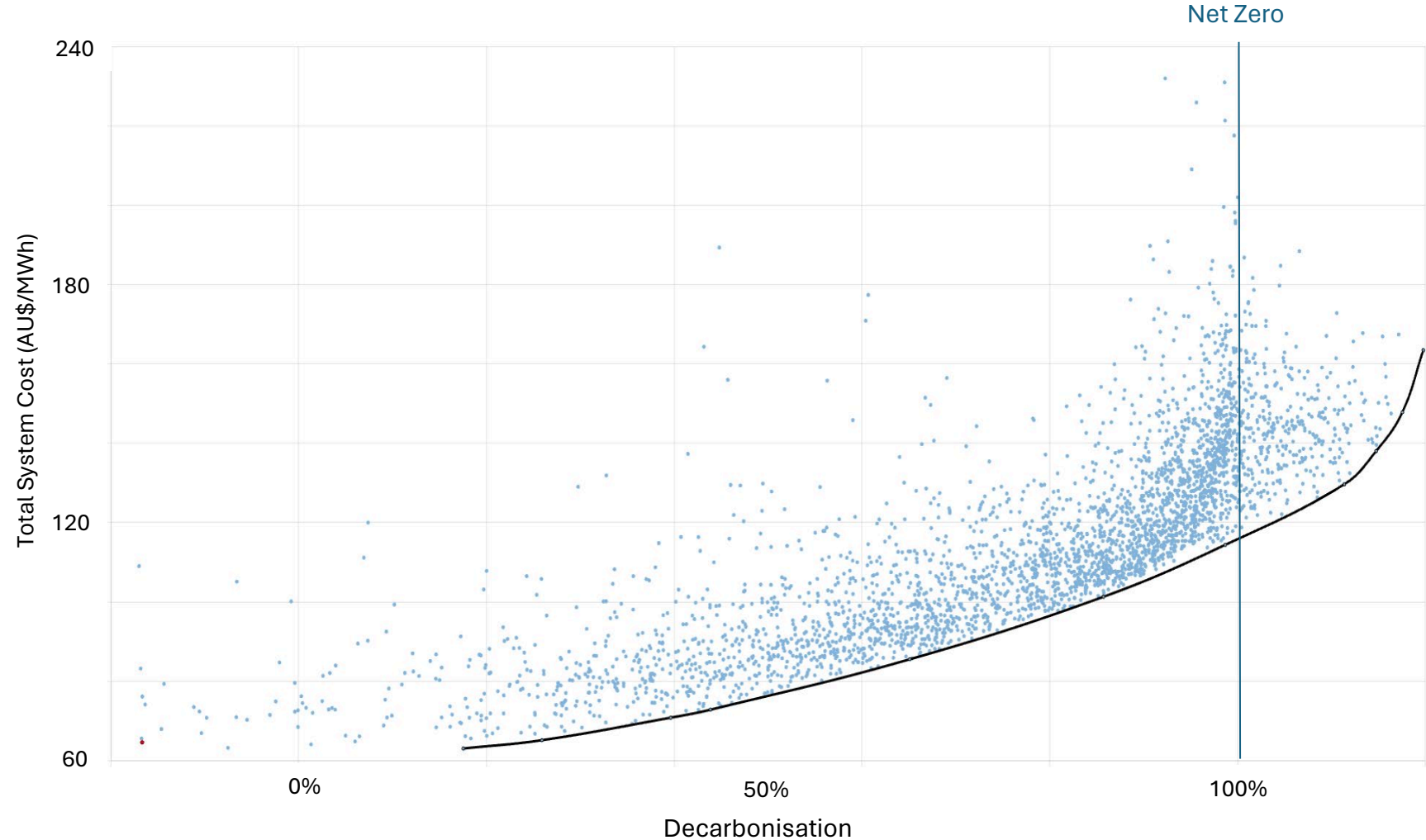
Weather is KEY to keeping the lights on

- The National Electricity Market (NEM) – Australia’s East Coast electricity network – is 72GW in capacity.
- It consumes 210TWh annually (2022).
- 15 different weather years
- 50:50 wind:solar
- 20% overbuild
- 3TWh of Storage
 - (9 x Snowy 2.0)
- Copperplate NEM
- “Blackout” indicates amount of additional storage or replacement generation needed to keep lights on
- **Weather is a critical component to reliability**



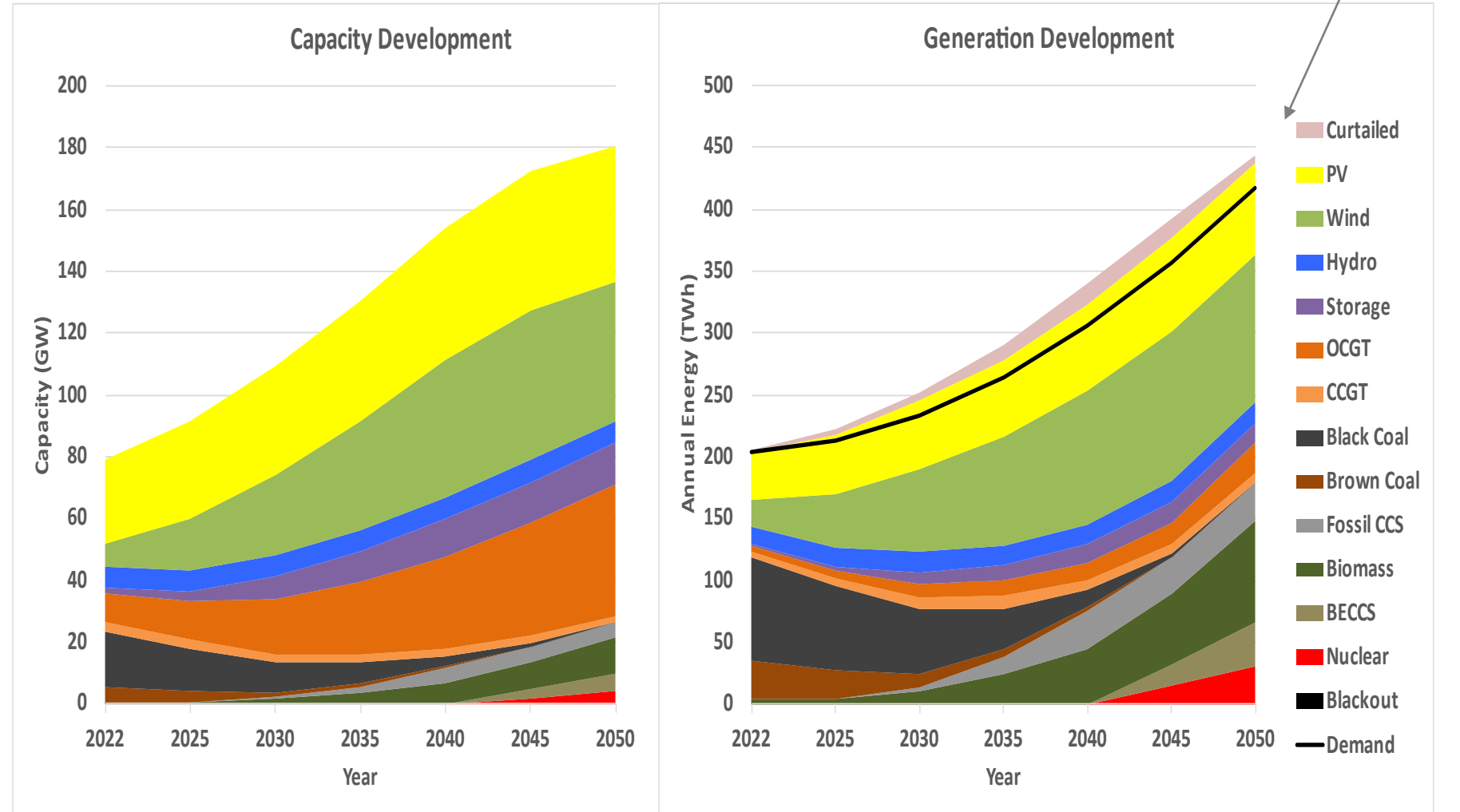
Australia's Lowest Cost Frontier

- Lowest cost frontier on a TSC vs Decarbonisation chart is convex and rising in cost
- This is 3,300 scenarios with random capacities of Coal, CCGT, PV, Wind, Batteries, Coal-CCS, BECCS, Biomass and Nuclear.
- BECCS is required for decarbonisation beyond net zero.

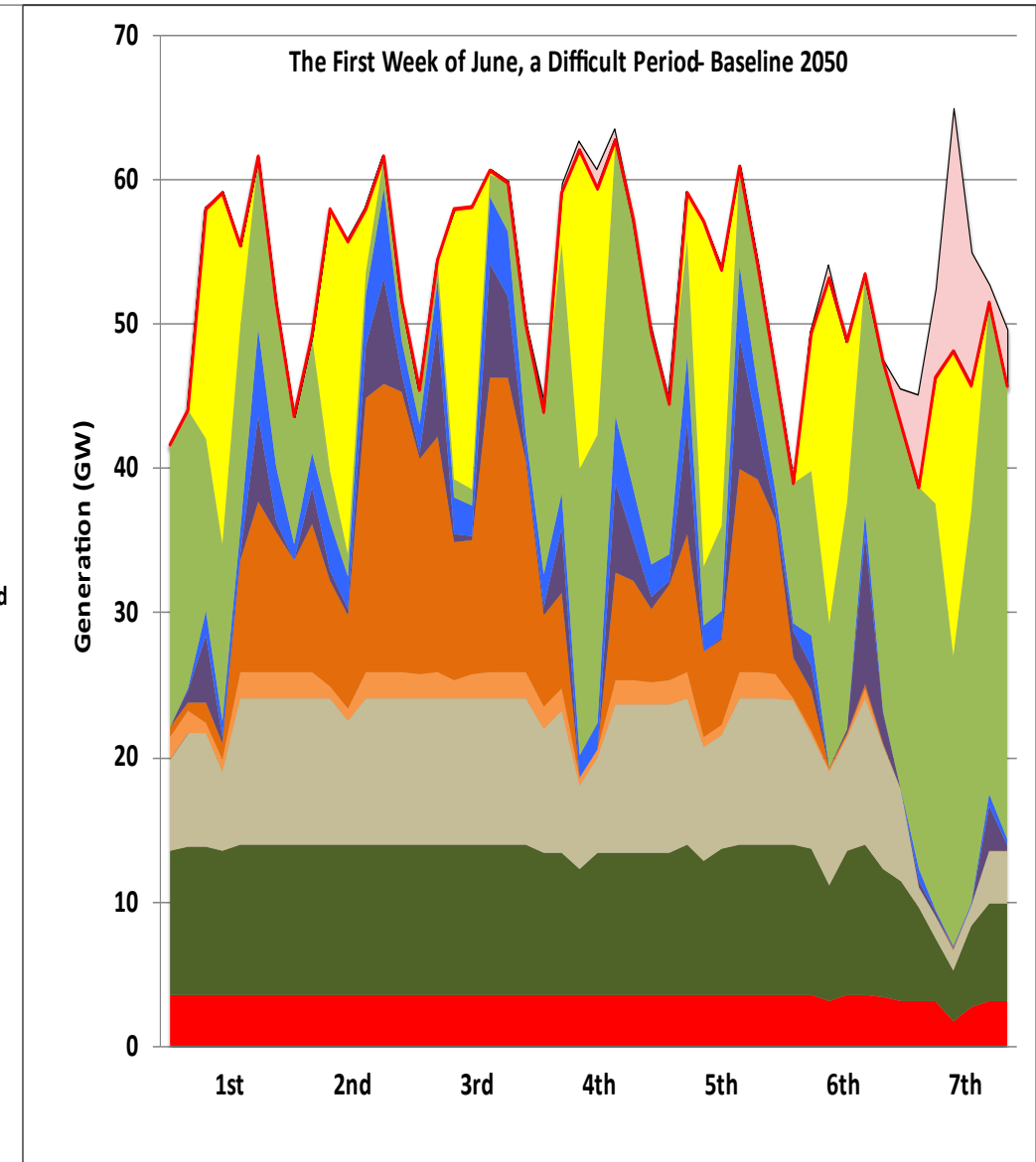
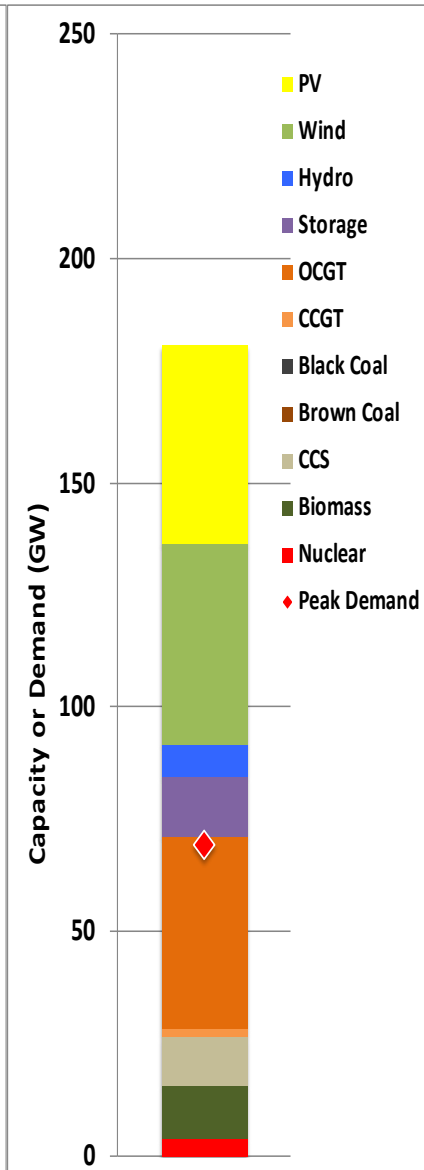
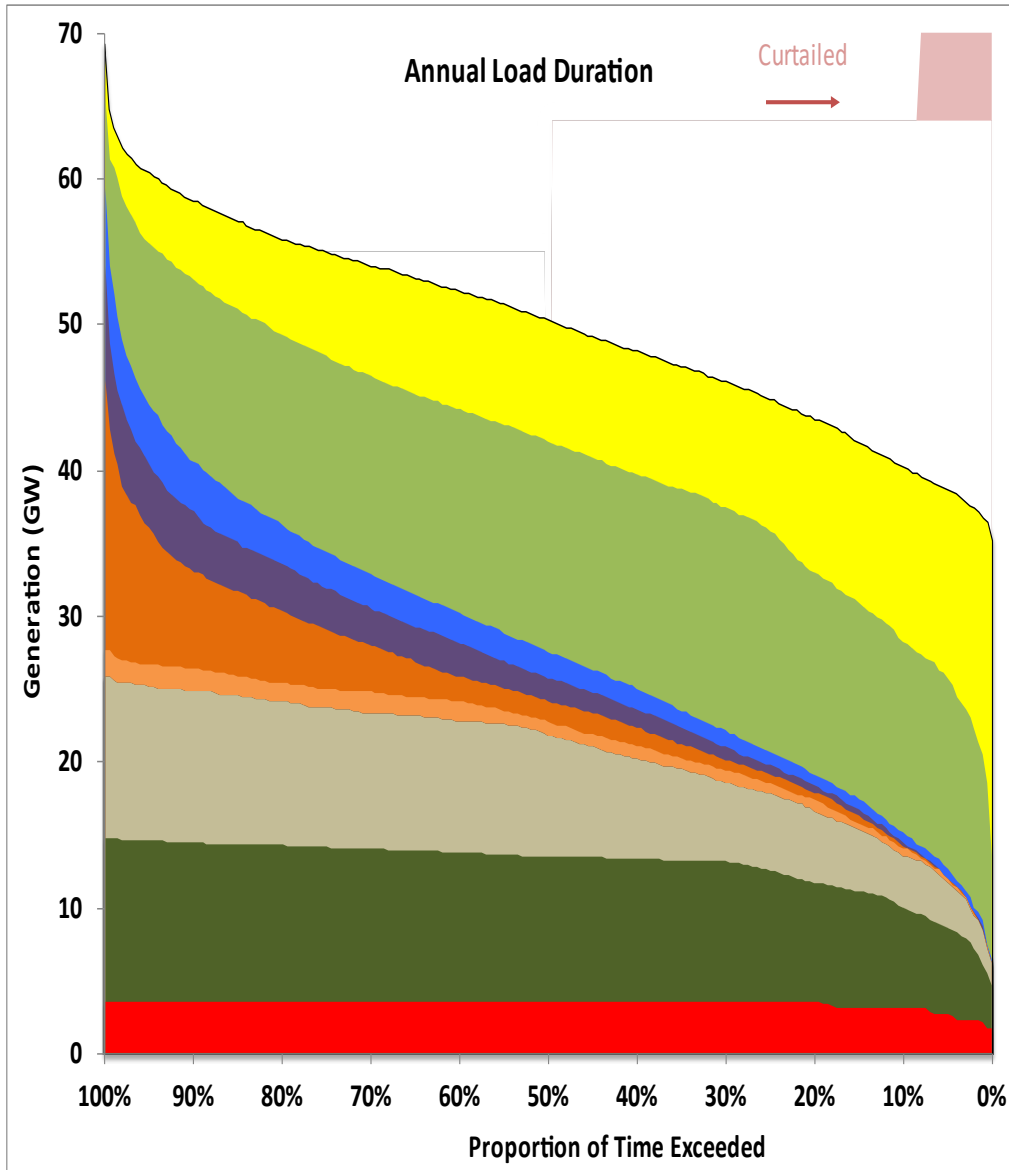


Australia's NEM – a 2050 solution

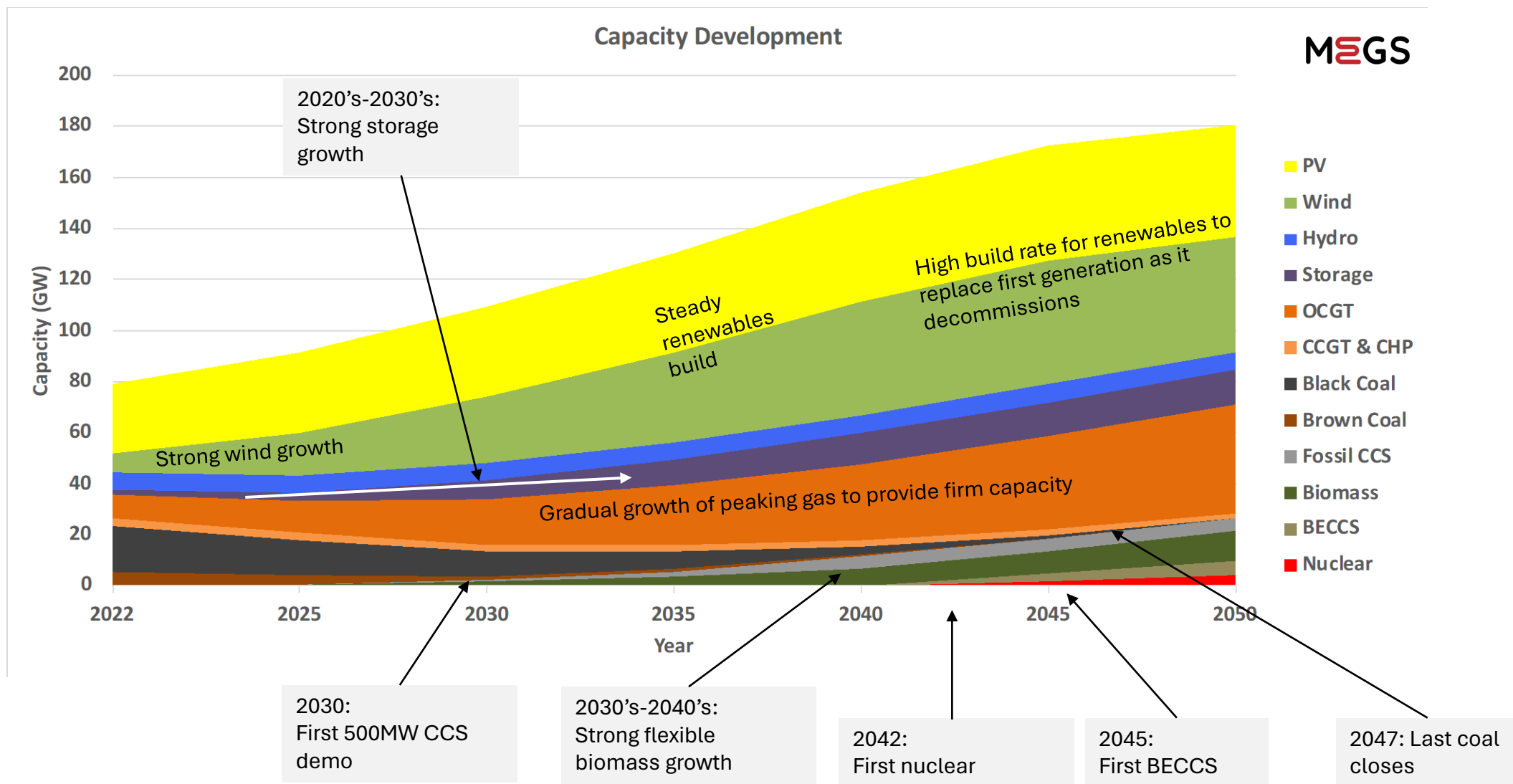
- “Only” 100GW of variable renewables, only half of generation is from wind and solar.
- Huge amount of peaking gas although load factor is very low.
- Although only limited capacity Biomass and CCS are important for mid merit flexibility.
- BECCS has an important role to play in offsetting emissions.
- Nuclear small but growing proportion of solution as old renewables retire.



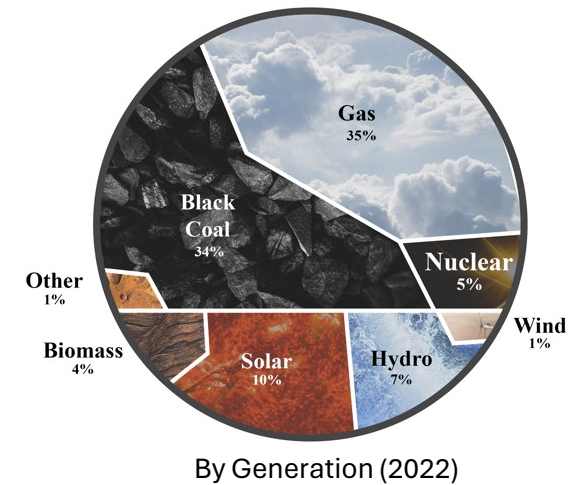
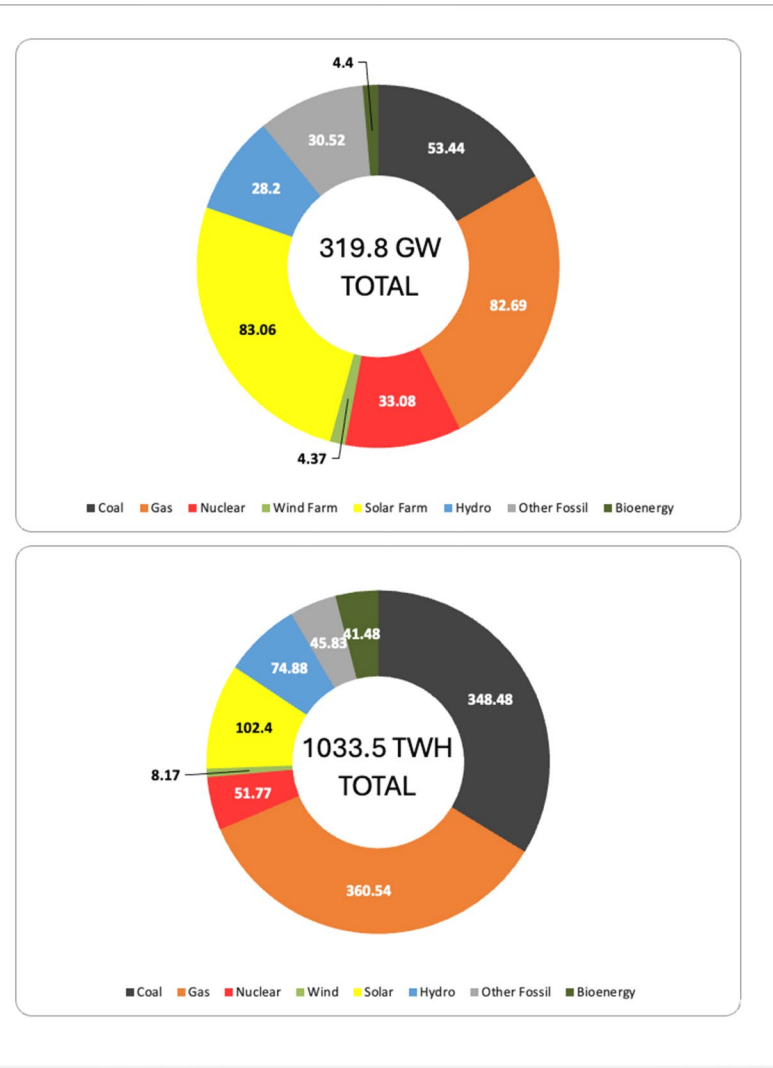
The National Energy Market – a complex week



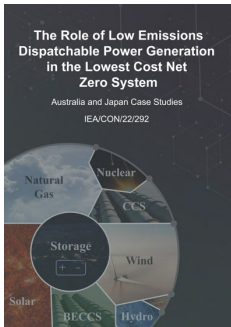
A Critical Transition...



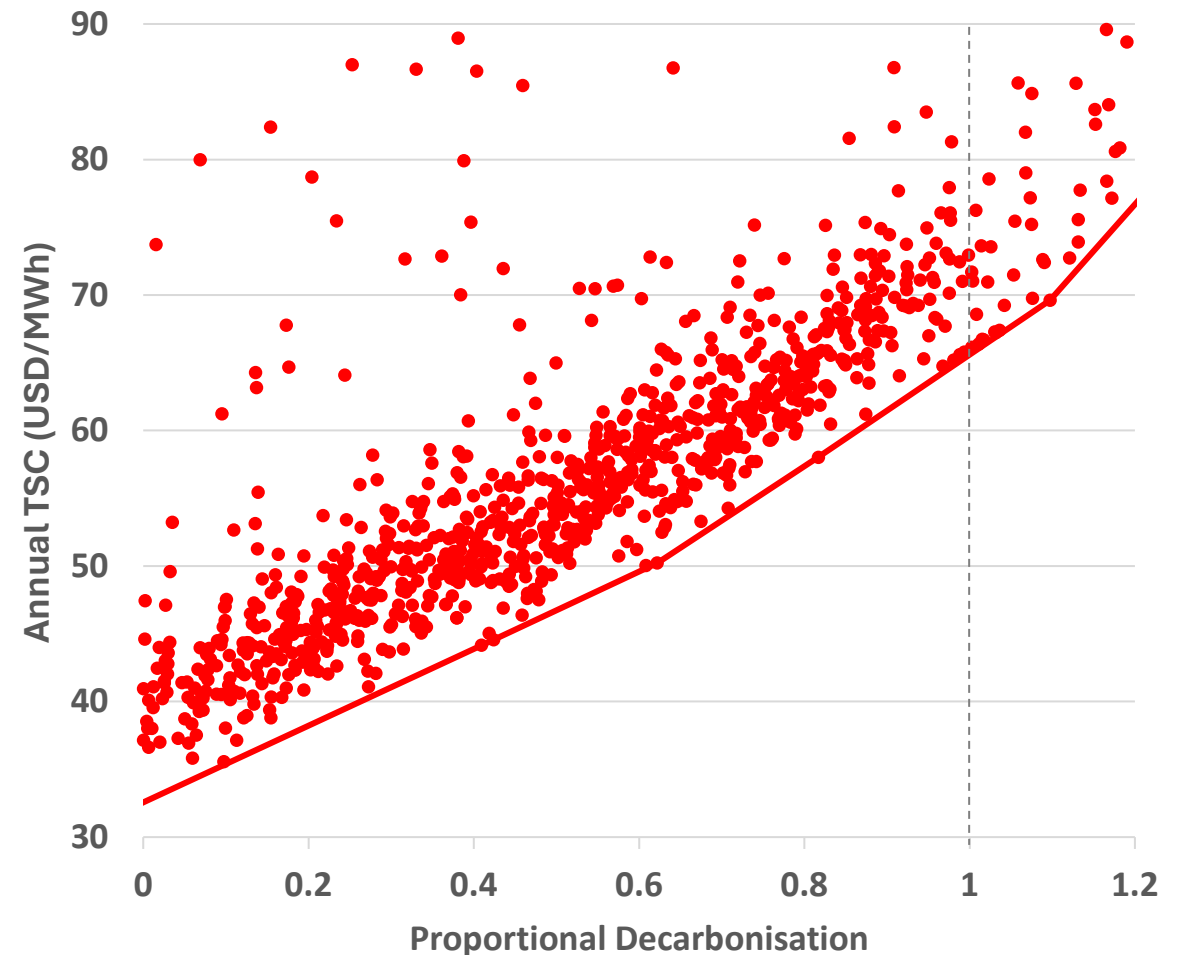
The Japanese Grid



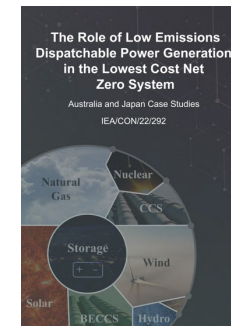
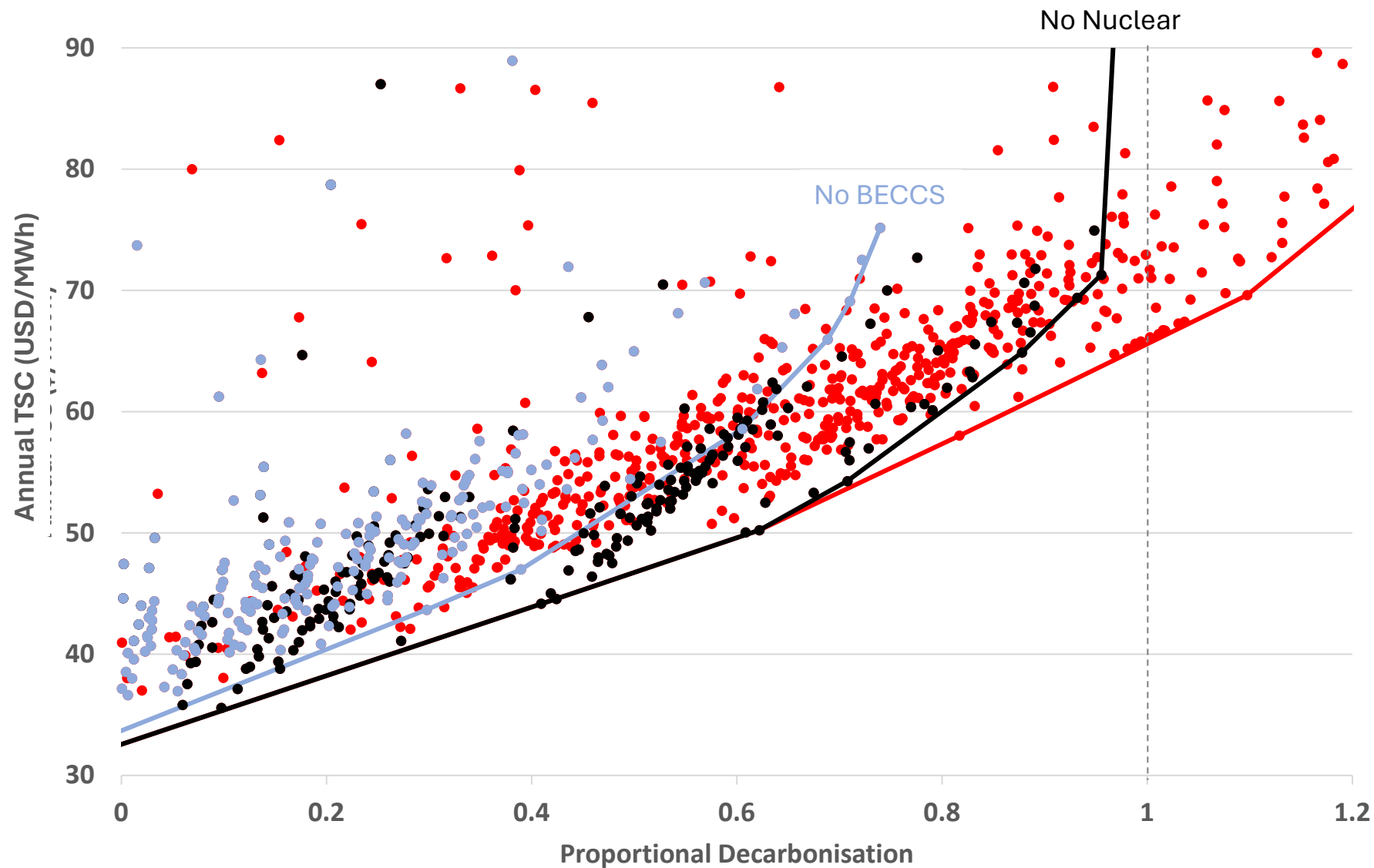
Japan's Lowest Cost Frontier



- Currently embargoed report with the IEA GHG.
- All solutions are more expensive than the current grid.
- Greater than 100% decarbonisation is possible with the use of BECCS.
- Watch the IEA GHG for the report and a webinar.



What If



- While each “dot” or scenario is a competent grid they are not all the same cost.
- Restricting no new nuclear results in more expensive solutions from about 60% decarbonisation.
- Restricting BECCS costs more from the beginning of the decarbonisation journey!

Final Thoughts

- Weather is real!
 - You can't just prepare for one drought
- There are better solutions (not just on the couple we presented...)
 - The Lowest TSC solutions include nuclear and CCS
 - If you don't focus on TSC and omit some technologies, you will get an expensive system
 - Renewables and storage remain very important
 - There is still a need for lots of peaking capacity
- There are more questions to answer...



Keeps the lights on easily!

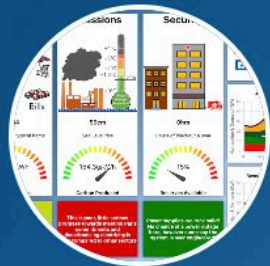


May or may not keep the lights on...

Modelling.Energy Website & The Book – Decarbonised Electricity

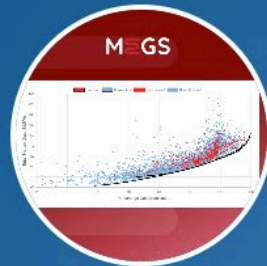
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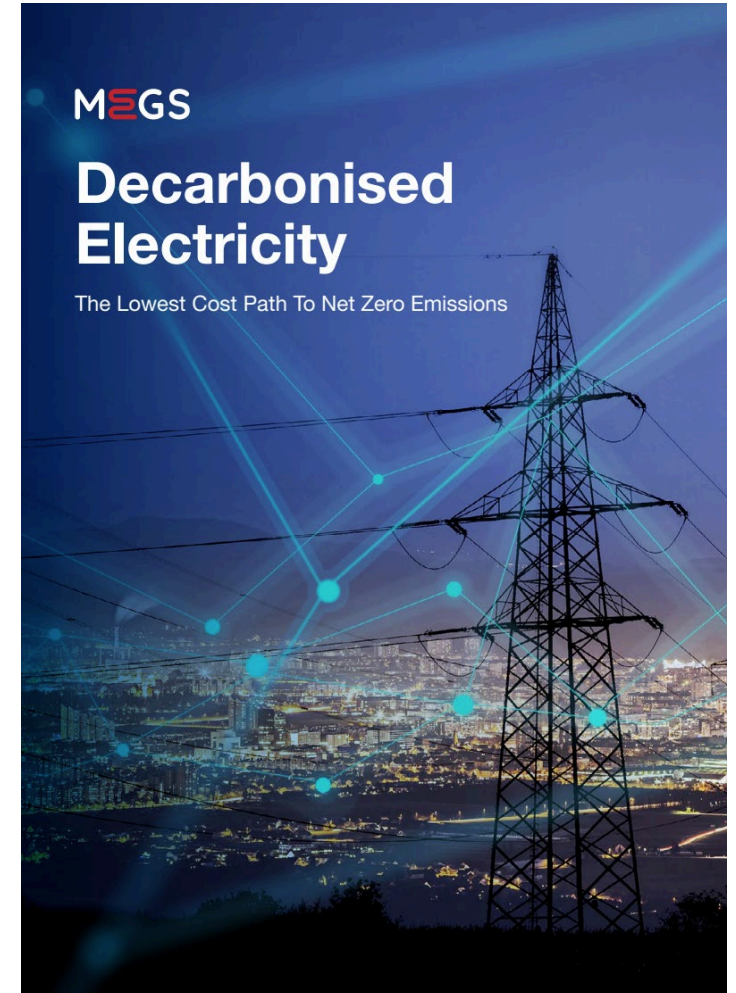
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2010 – a bad renewable weather year

- 2010 is a bad weather year for renewables.
- With 20% overbuild the 3TWh of storage is drained in the first drought
- Subsequent winter droughts would result in blackout
- Alternative is 20GW of backup generation
- This is the KEY to a reliable grid...

