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Busting Myths about Renewable Energy

How to achieve 100% renewable electricity

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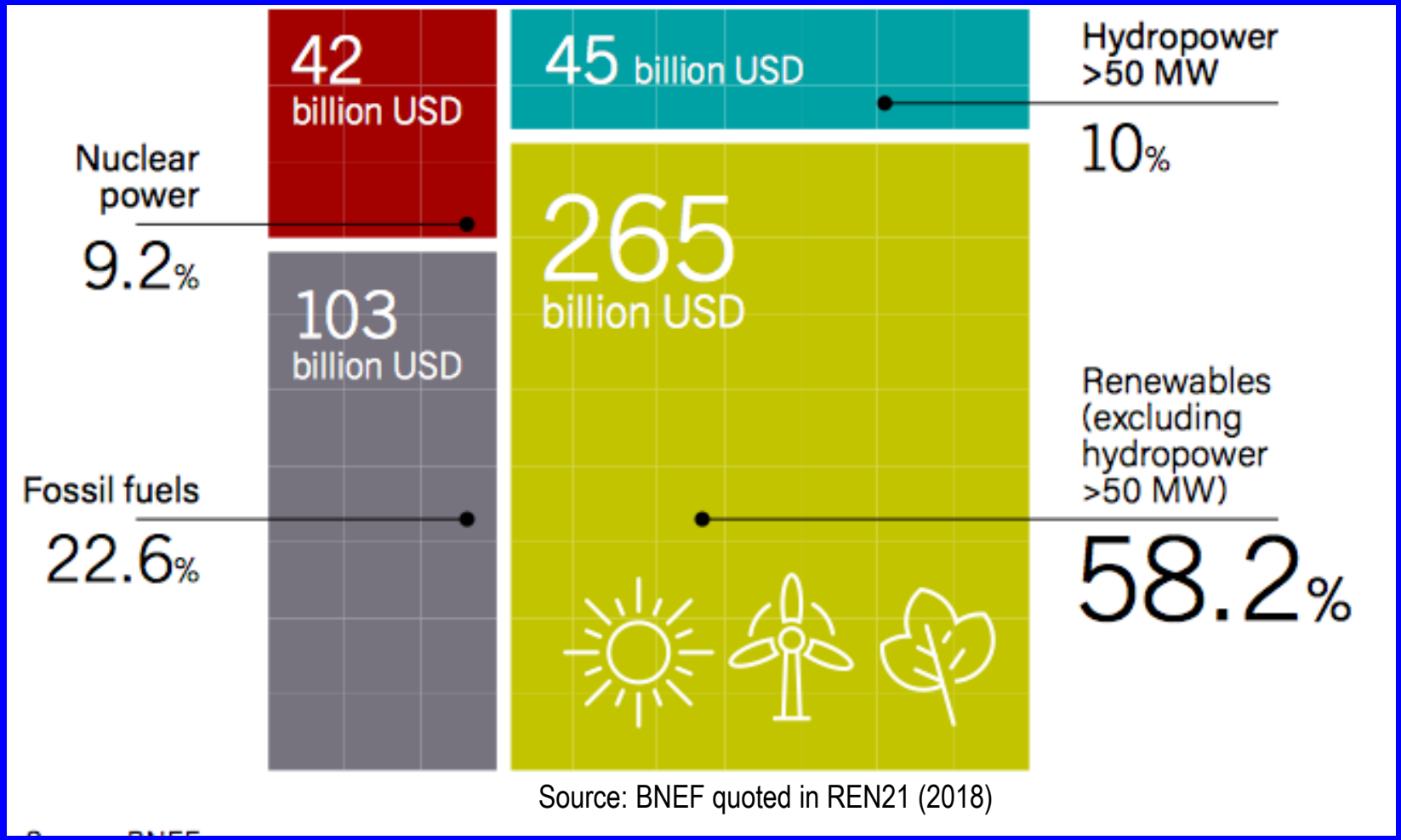
How Renewable Energy can replace Fossil Fuels

Energy end-use 2017	Energy end-use	Future renewable energy contribution
Electricity **Australia: coal 63%, gas 20%, renewables 17%**		Could reach 100% renewables in USA, Australia, Europe, etc. within about 2 decades.
Transport **Currently mostly oil**		Urban: electric public transport & elec. cars, cycling & walking; inter-city high-speed rail; challenge: air & sea transport need renewable fuels
Heat (non-electrical) **Currently mostly gas**		Low temperature heating & cooling from direct solar & electric heat pumps; high temperature from renewable electricity

Electricity will supply most heating/cooling and transport.

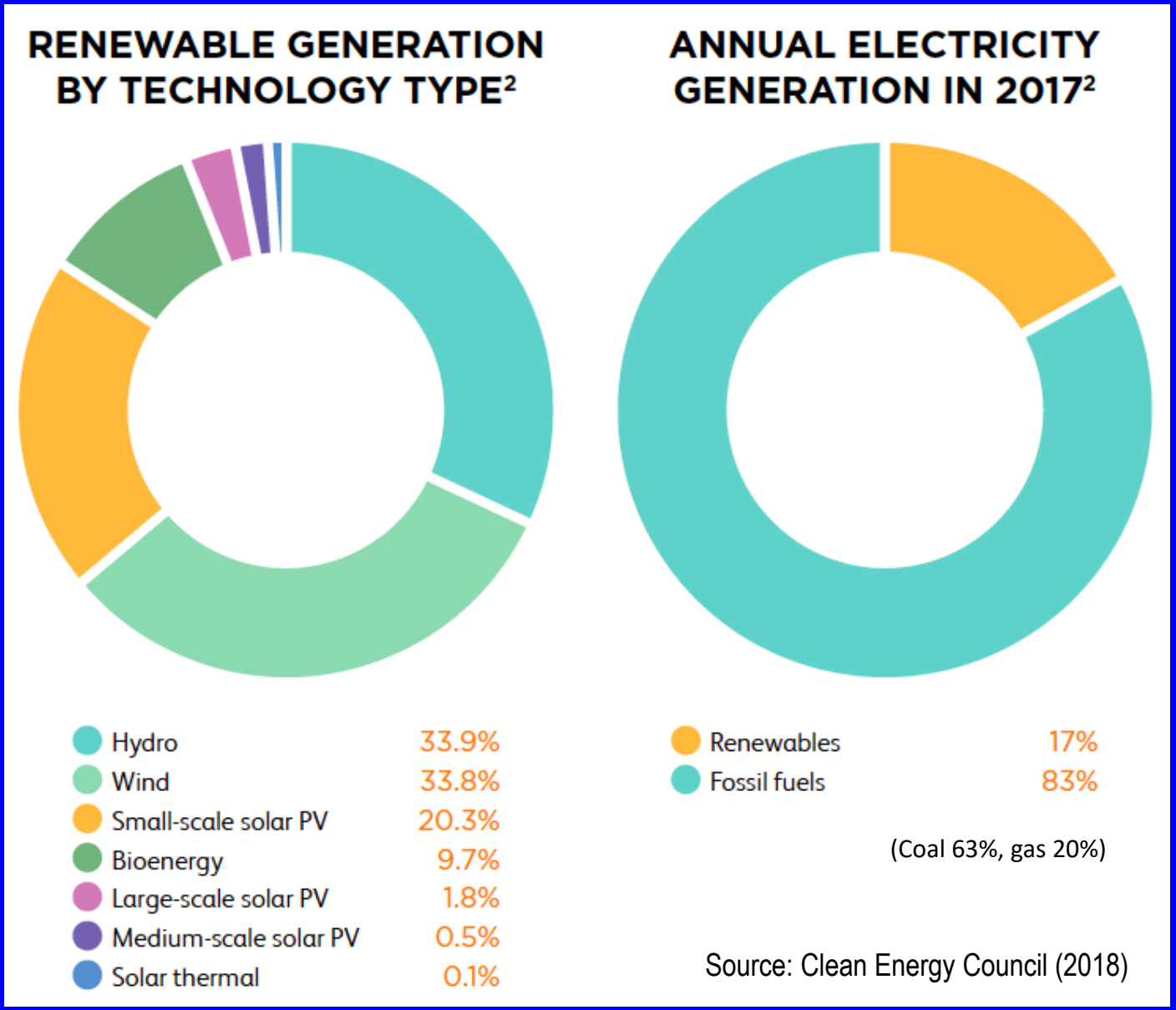
Global Investment in New Power Generation, 2017



Source: BNEF quoted in REN21 (2018)

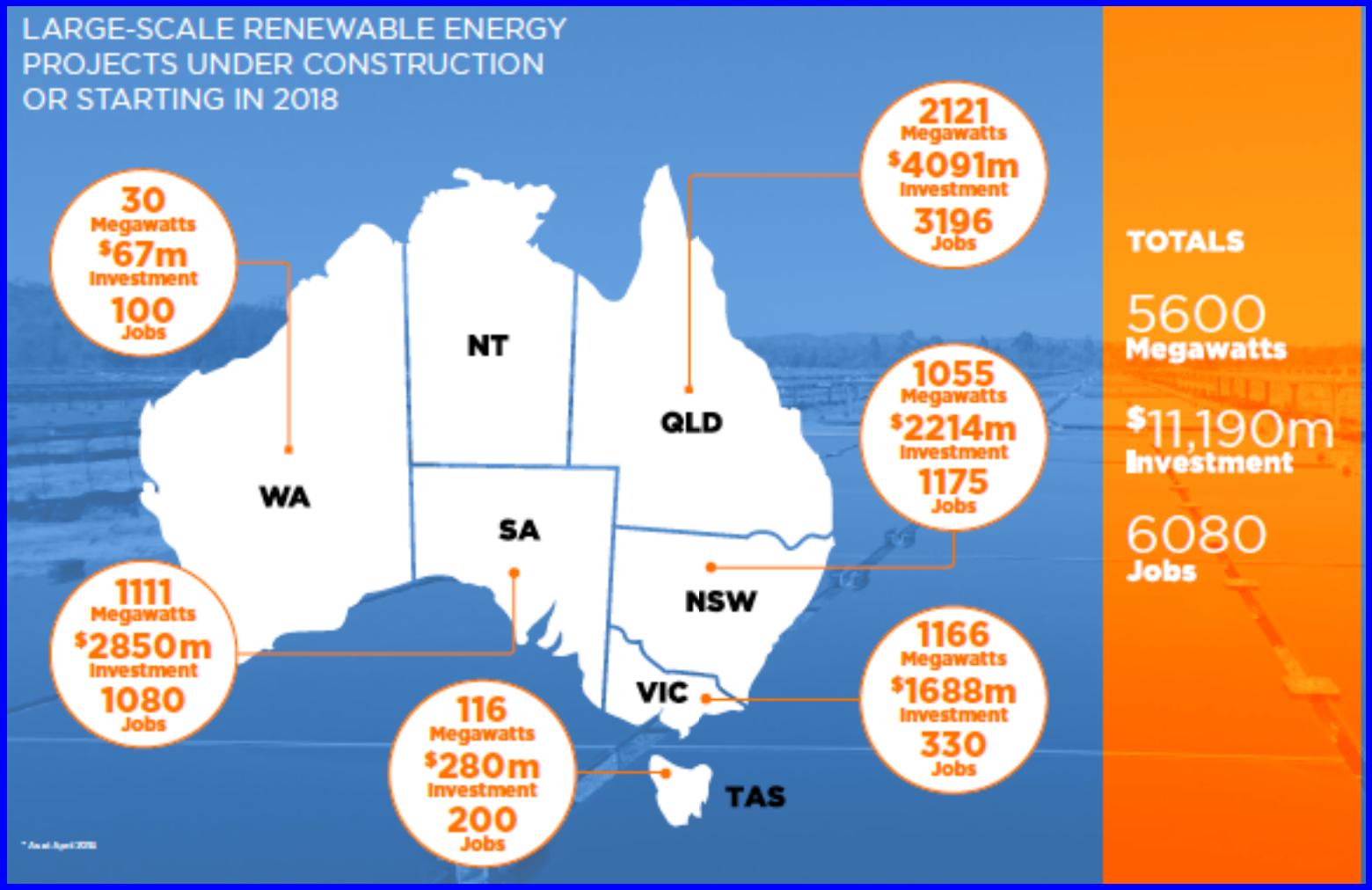
Renewable energy is now mainstream, no longer ‘alternative’.

Renewable Share of Australian Electricity 2017



Wind & hydro each supply one-third RE

Australia: New RE Jobs & Investment



Source: Clean Energy Council (2018)

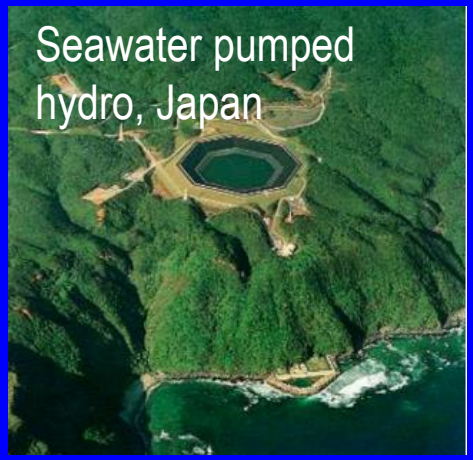
Diversity of RE Sources and Siting

Australia has most RE resources!

CST with thermal storage

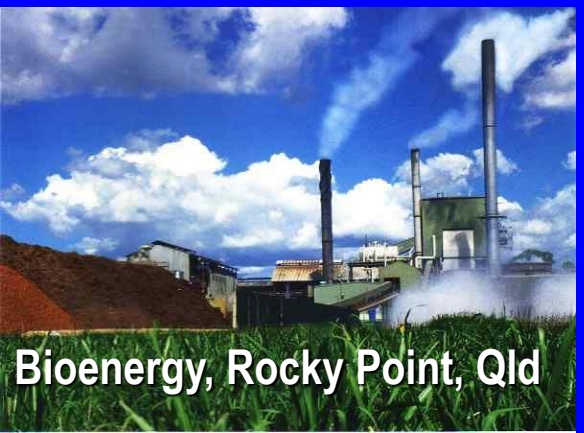
Wind, Albany, WA

PV solar tiles



Seawater pumped hydro, Japan

Geothermal



Bioenergy, Rocky Point, Qld

Hydro

Wave power, near Fremantle

How to Achieve 100% Renewable Electricity

1. Dispatchable renewables: big hydro, geothermal

Norway

Iceland

New Zealand

Bhutan

Tasmania

Etc.

95-100% exists for regions with dispatchable RE resources

How to Achieve 100% net Renewable Electricity

2. Variable renewables with strong interconnections

- Denmark 44% wind
- Scotland 68% of consumption, mostly wind
- A.C.T: on track for 100% by 2020
- North German states 100% net, mostly wind

Became routine recently

How to Achieve 100% net Renewable Electricity

3. Variable renewables purchased from elsewhere and/or installed on site – medium interconnections

Google data centre,
The Netherlands

Tesla Gigafactory, USA, under construction

Now affordable & straightforward

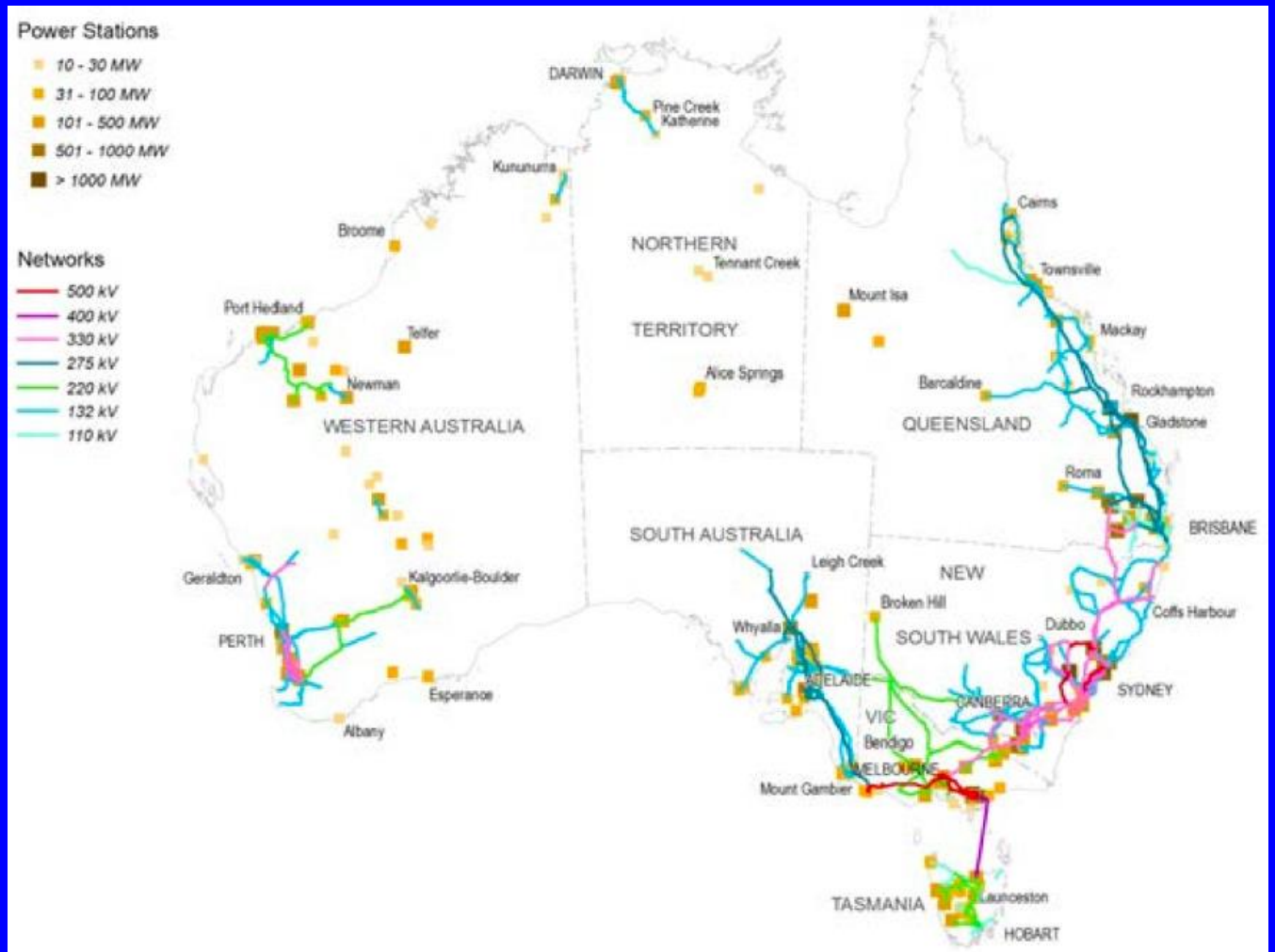
Multinational: Google 100%, Apple 100%, Tesla gigafactory 100%

Australia: • A.C.T again

- Sun Metals 124 MW solar farm for 1/3 zinc refinery – operating;
- Whyalla steelworks 1 GW solar + storage – planned;
- BlueScope PPA 88 MW of new solar farm for Port Kembla steelworks – announced

How to Achieve 100% Renewable Electricity

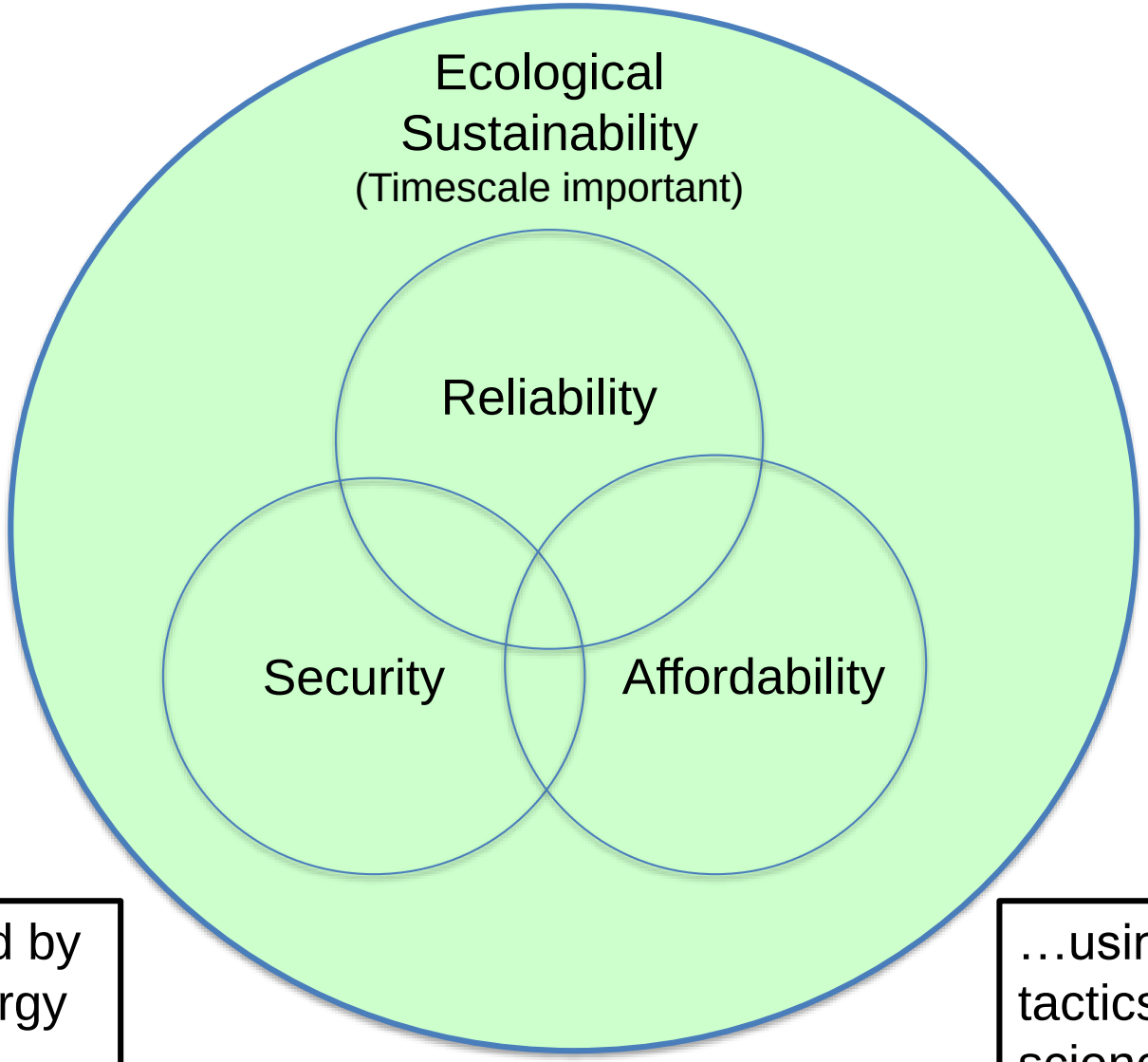
4. Variable renewables with local generation and weak or no interconnections



- South Australia
- Australian National Electricity Market
- South West Integrated System, W.A.
- USA

Competitive with new fossil, but more challenging, because strategic planning is required

Requirements of an Electricity System



Misrepresented by renewable energy deniers…

…using similar tactics to climate science deniers

The Main Reliability Myths

Myth 1: 'Base-load (operate 24/7) power stations, either coal or nuclear, are necessary, and RE cannot provide them'

Myth 2: 'Base-load power stations must run continuously as backup for RE'

Myth 3: 'RE needs vast amounts of expensive electrical storage'

Myth 4: 'Every power station in a system must be dispatchable'

These & other myths refuted by (1) practical experience (e.g. SA & Denmark already operate occasionally at 100% RE);
(2) computer simulations balancing supply & demand every hour

Simulations of 100% Renewable Electricity

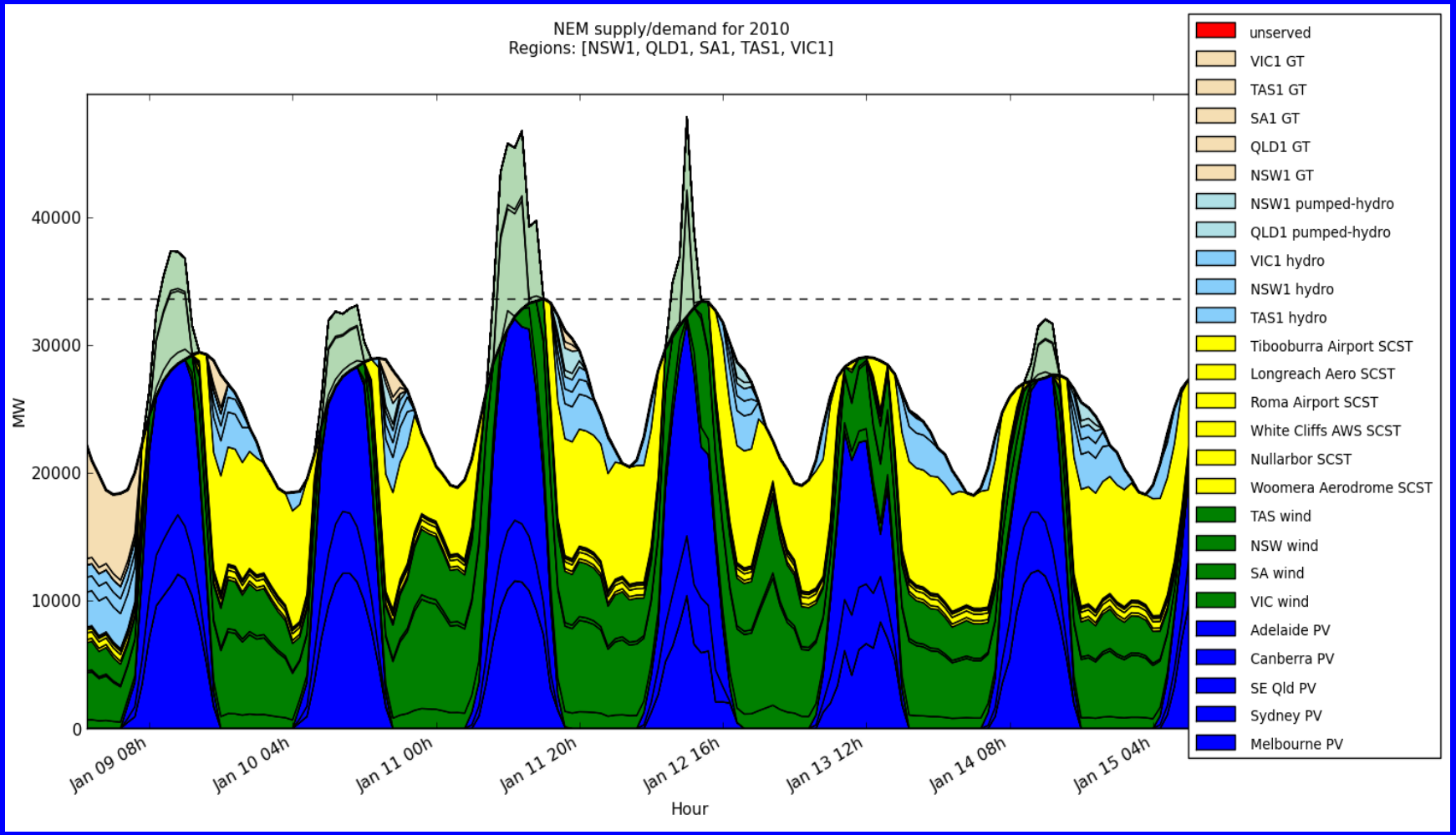
NEM or (NEM + WA)

Reference	Simulation program
Wright & Hearps (2010)	In-house
Elliston et al. (2012)	NEMO
Elliston et al. (2013)	NEMO
AEMO (2013)	Probabilistic and time-sequential models
Elliston et al. (2014)	NEMO
Elliston et al. (2016)	NEMO
Lenzen et al. (2016)	In-house
Blakers et al. (2017)	NEMO variant

Notes

- NEMO is open-source program developed by Ben Elliston at UNSW
- All Australian simulations have time-steps of either 1 hour or ½ hour
- Some simulations determine economic optimal mix

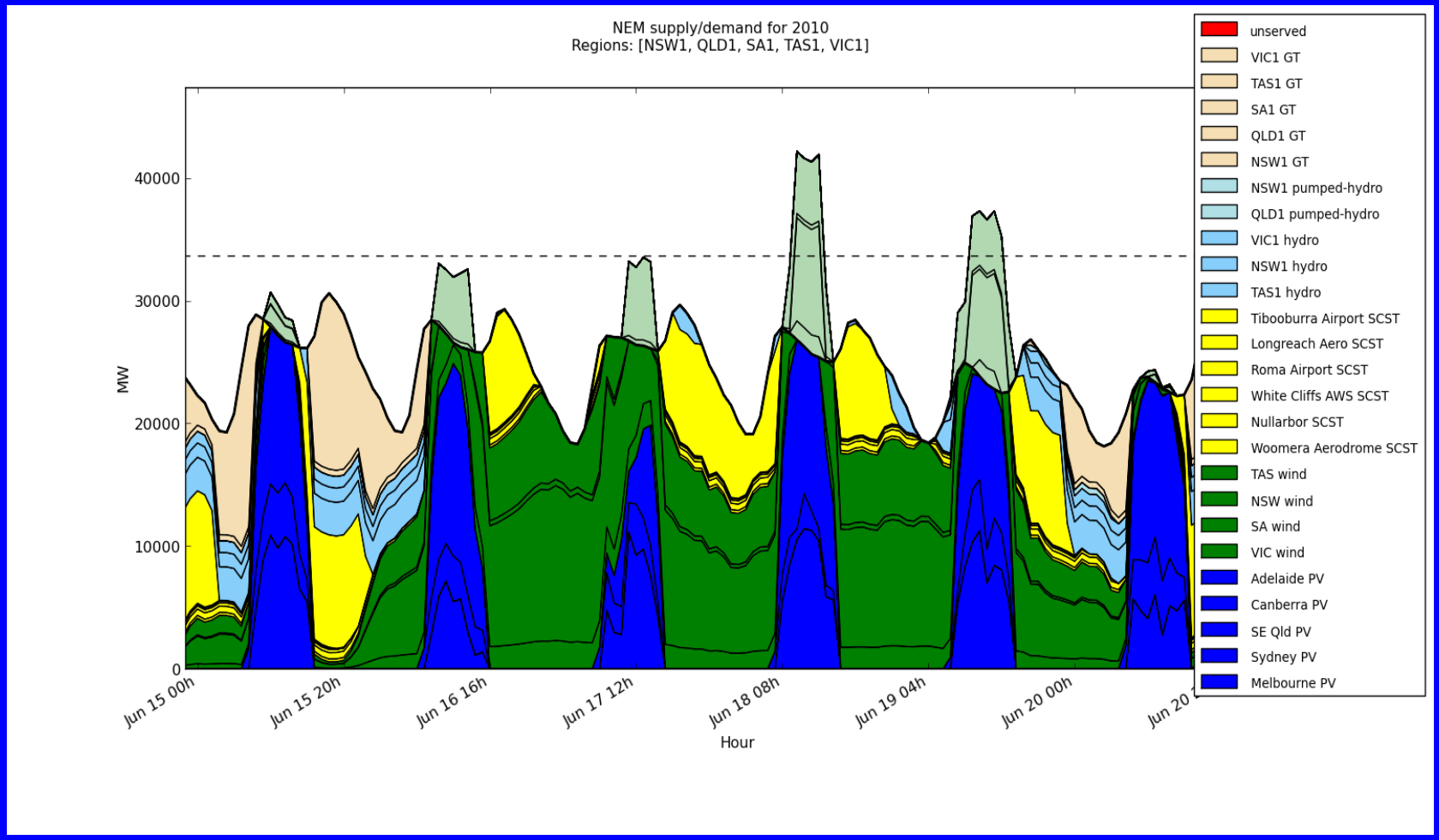
UNSW Simulation of 100% RE in NEM for a Typical Week in Summer 2010 – Optimal Mix of RE



Source: Elliston, Diesendorf, MacGill (2012)

In summer, negligible gas turbine (GT) energy used.

UNSW Simulation of 100% RE in NEM for a Challenging Period: 6 Days in Winter 2010

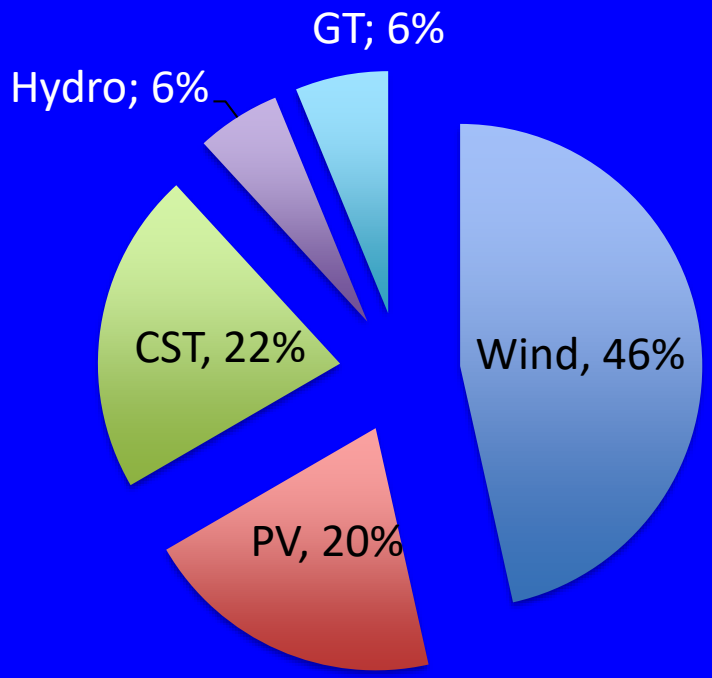


Source: Elliston, Diesendorf, MacGill (2012)

In calm winter evenings following cloudy days, gas turbines & demand management fill the gaps.

Myth: “Renewable Energy is too unreliable”

Busted by UNSW evaluation of Optimal Mix of RE for annual generation



Although variable RE (wind + PV) contributes two-thirds of annual energy, reliability is maintained!

- Source: Elliston, MacGill, Diesendorf (2014)
- Technology costs projected to 2030 by BREE (2012).
- GT is gas turbines burning renewable fuels; can be replaced by off-river pumped hydro.
- CST is concentrated solar thermal with thermal storage.

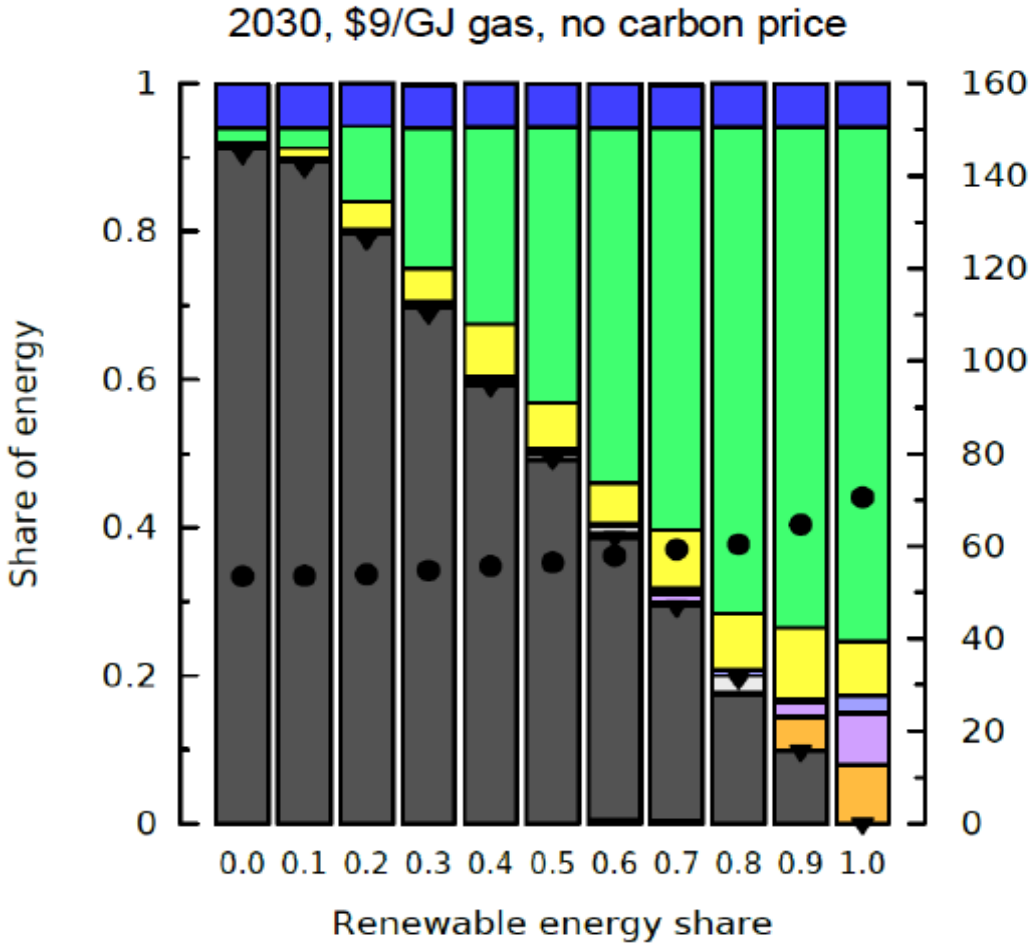
Achieving Reliability in Large-Scale RE

Reliability is a property of the system, not individual generators!

- Variable RE balanced with flexible, dispatchable RE technologies & other forms of storage
- Diversity of RE technologies
- Geographic diversity of wind and solar
- Key transmission links
- Smart demand management/response

Affordability & Generation Mix of Increasing RE Share, Australia (Elliston, Riesz, MacGill 2016)

UNSW modelling



- 10-20% RE: $54 /MWh
- 100% RE for $71 /MWh
  - (only $17 /MWh more)
- High wind, low PV
- Costs increase ~ linearly to 80% RE
- Wind displaces coal
- 50% RE < $60/MWh, only $3/MWh more than 10% RE

Affordability Myth, "RE is responsible for high electricity prices", is based on misleading half-truths

South Australia

- "South Australia has highest electricity prices in Australia".
- True on average, but misleading, implying false conclusion

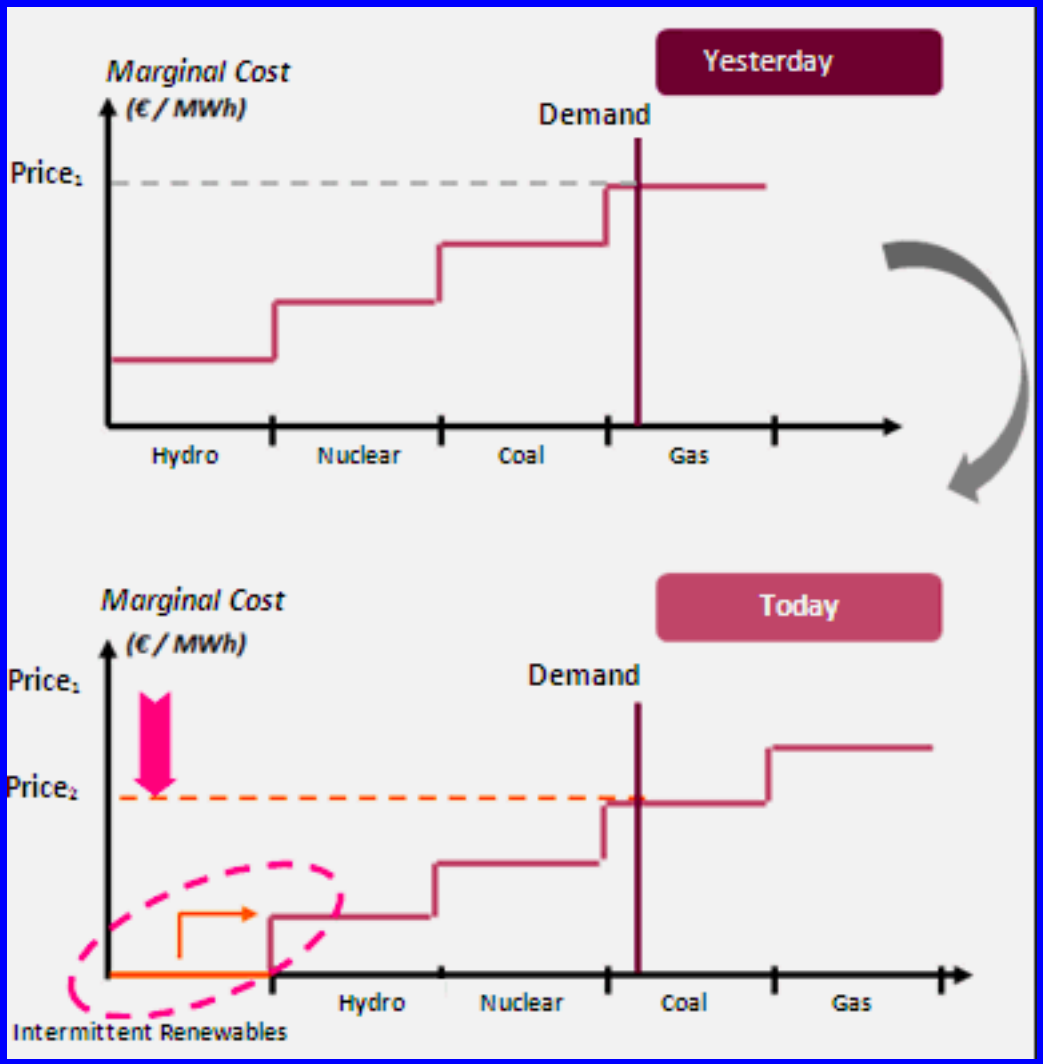
Denmark

- "Denmark has one of highest electricity prices in Europe":
- True but misleading statement implying false conclusion

Both regions

- Fact: High proportion of RE ***reduces*** wholesale price of electricity by the Merit Order Effect

Merit Order Effect reduces Wholesale Electricity Price



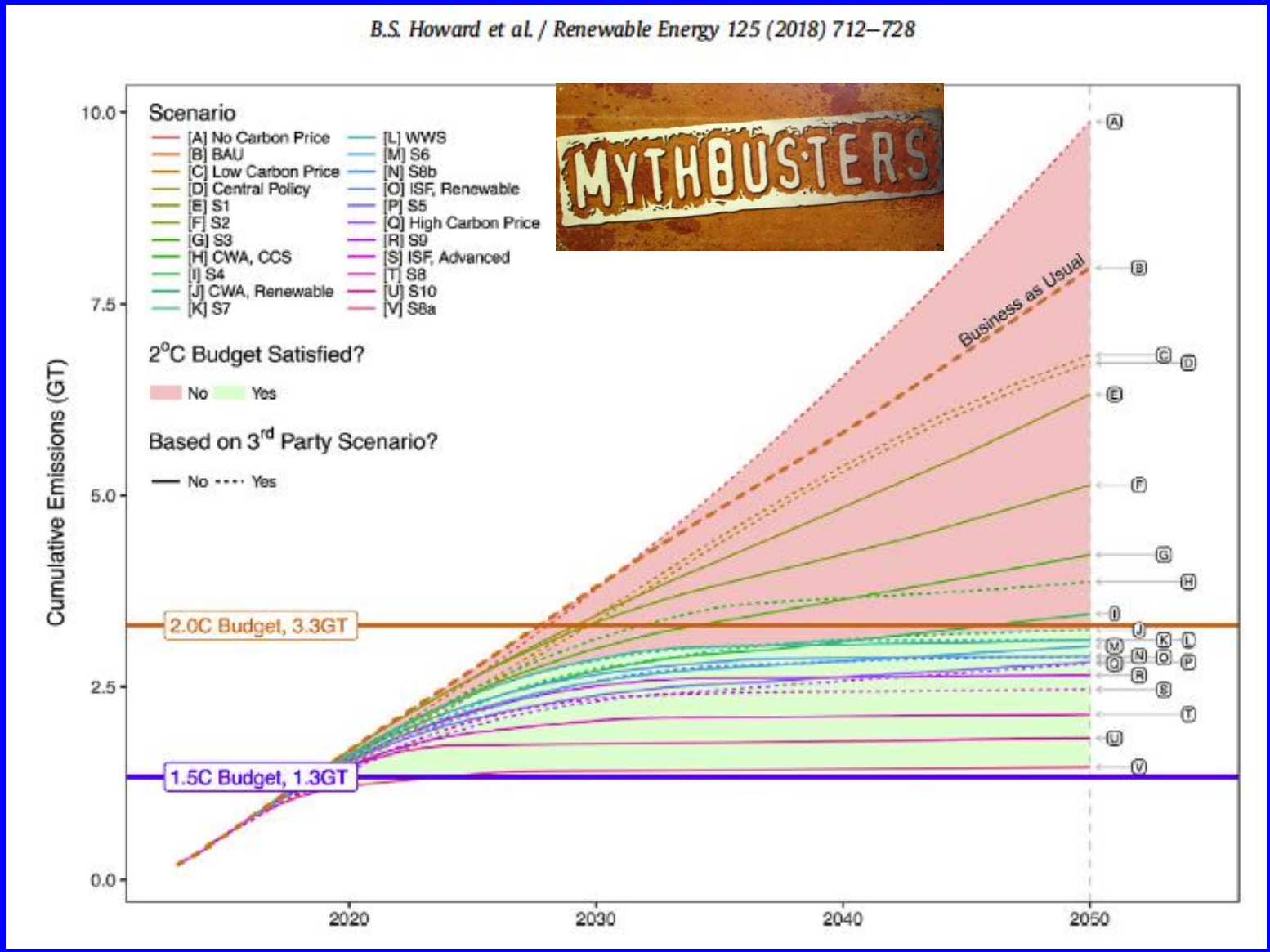
Supply & demand balanced continuously.
Highest bid determines price paid to all generators dispatched at that time

Yesterday: no variable RE

Today: Wind & solar shift stepped curve to the right, so demand is met with less gas & coal, and wholesale price is reduced

Sustainability Myth: Emissions from Transition

Cumulative life-cycle GHG Emissions, Australia 2011-2050, from 22 Electricity Transition Scenarios (Howard, Hamilton, Diesendorf, Wiedmann 2018)



Conclusions from Life-Cycle CO_2 Scenarios

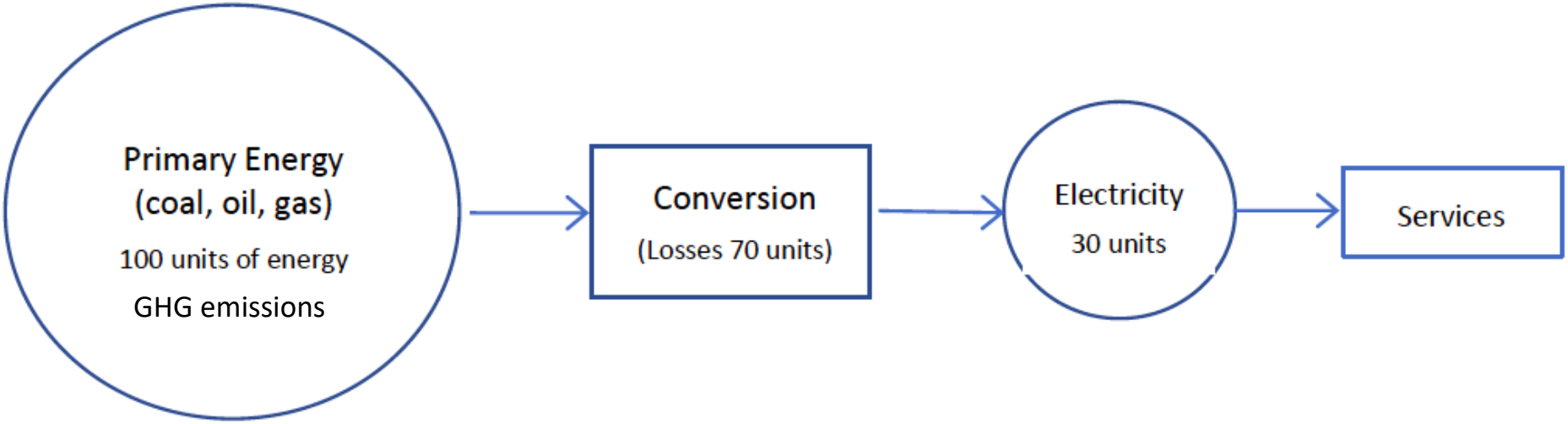
- Rapid transition to 100% renewable electricity starting now is essential for Australia to meet its share of global carbon budget for electricity
- Specifically, Australia needs 100% renewable electricity and demand reduction of 35% below BAU by 2030; i.e. increased energy efficiency must offset growth in electricity in transport & heat sectors
  - Aside: By 2030, 100% RE credible for SA & Tas well before 2030; 50-75% RE credible for Vic. & Qld if current policies continue
- Emissions from building the RE technologies << emissions saved by substituting for operation of fossil fuel technologies
- Renewable energy ‘breeding’ helps; i.e. RE used to mine raw materials & construct RE technologies

Does RE transition need long 'historical' timescale?

Smil (2017): 'Most of the RE targets defined apply only to electricity generation'.
Response: That's OK because an RE future will be mostly electrical.

Smil (2017): 'Changing the sources of electricity is much easier than changing the makeup of primary fuel supply'.

Response: Changing electricity automatically reduces primary fossil fuel combustion for electricity generation, and hence GHG emissions, by a factor of 3-4; changing energy services by increased energy efficiency further increases the factor.



Does RE transition need long 'historical' timescale?

Smil (2017) paraphrased: Wind and solar must be scaled up by increasing the size of generating units, but size limits are being reached.

Response: The continuing cost reductions of wind and solar technologies are primarily the result of increasing mass production in factories and improvements in supply chains. Scaling up unit sizes plays a significant but minor role for wind turbines and negligible role for PV.

Smil (2017) paraphrased: Producing '3.8 million 5-MW wind turbines, 40,000 300-MW central solar plants, 40,000 300-MW solar PV plants, 1.7 billion 3-kW rooftop PV installations' is unthinkable.

Response: Over one billion motor vehicles are on the road today and annual sales of cars and light commercial vehicles alone were 88 million in 2016. Building wind & solar is not like building coal & nuclear power stations.

Security

The ability of a power system to tolerate disturbances – e.g. failure of a major generator or transmission line; sudden change in demand – causing an imbalance between supply & demand, changing frequency and voltage of alternating current.

Previously, stability maintained by inertia of heavy rotating machinery of baseload power stations. Alternatives:

Technology	Speed of response	Cost
Contracted demand response	Very fast (<< 1 sec)	Very low
Battery	Very fast	High but decreasing rapidly
Off-river pumped hydro	Fast (# secs)	Low-medium
Conventional hydro; CST	Fast	High
Synchronous condenser	Fast	Medium
Open-cycle gas turbine (jet engine)	Slow (10 min.) if cold; fast if hot	Low capital cost; high operating cost under current market rules
New major transmission line	Slow to build; fast to respond	High
Coal; nuclear	1-2 days if cold; # hours if hot	Coal: high; nuclear: very high
Wind & PV: dispatchable downwards	Fast	Low

Former ‘Policy’: The National Energy Guarantee (NEG)

Designed to placate this politician & his followers →

Would actually prolong coal power and slow the growth of RE

But rejected by the politician because it pays lip service to the climate threat and no policy would placate Tony

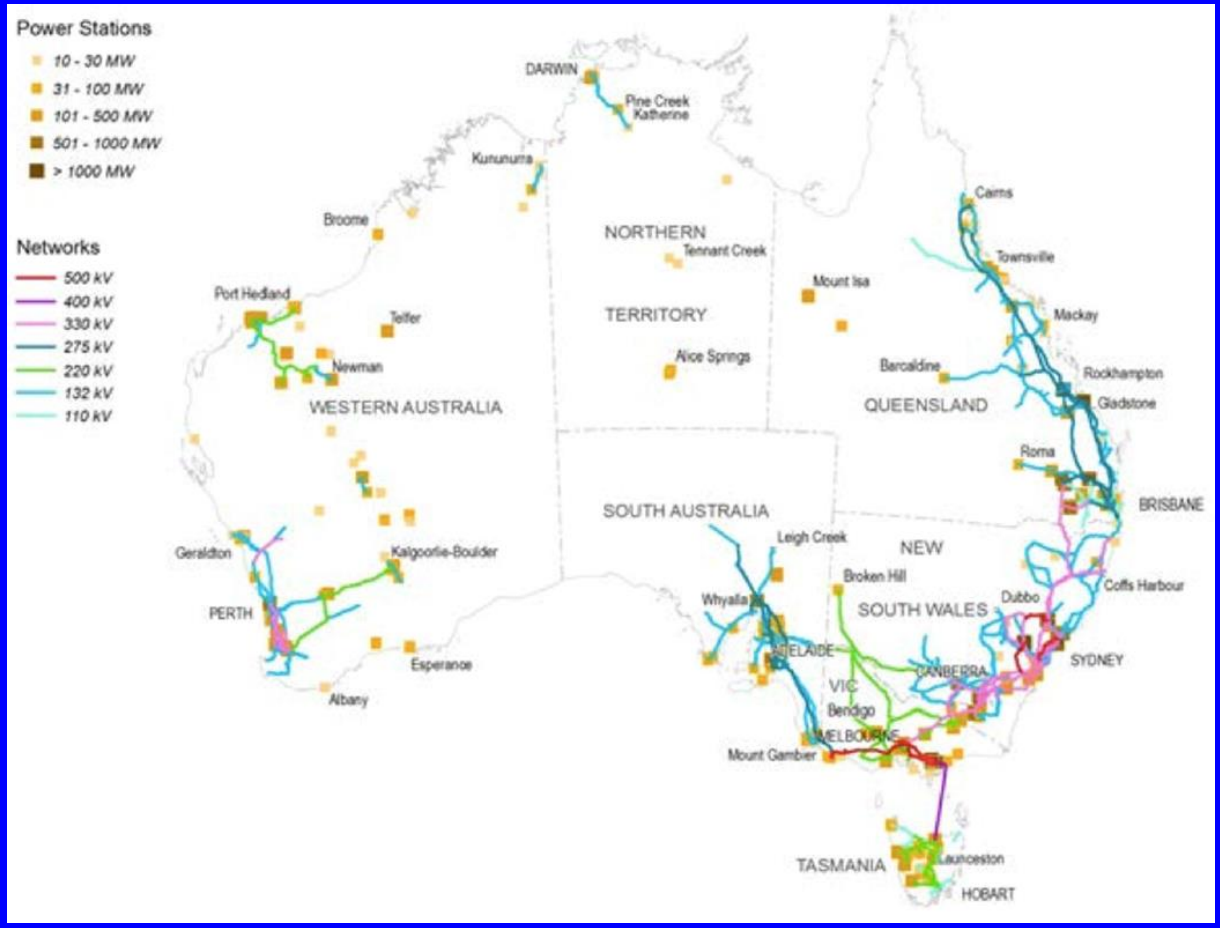
The mythbusting ‘honest government ad’ on its RE policy: https://www.youtube.com/watch?v=sitPeRITdNs

Simple, transparent RE Policies needed from a Future Federal Government

- Get out of the way – stop undermining investor confidence
- RE Target for 2030: 60% for starters, but science suggests 100% by 2030
  (LNP: 25%; ALP: 50% by 2030; Greens: 100% ASAP)
- CEFC: specific additional loan funding funding for dispatchable RE & other storage – $4 billion over 4 years
  (LNP: close CEFC; ALP: make it 'technology neutral' – a dangerous, backward step)
- ARENA: specific tranche of additional grant funding for dispatchable RE & other storage – $4 billion over 4 years
  (LNP: close ARENA; ALP: $207M over 4 years specifically for CST)
- Partial funding for a few new interstate transmission lines

Transmission needed urgently

- New SA-NSW direct link
- Upgrade existing Qld-NSW links
- Upgrade transmission in N-W Vic



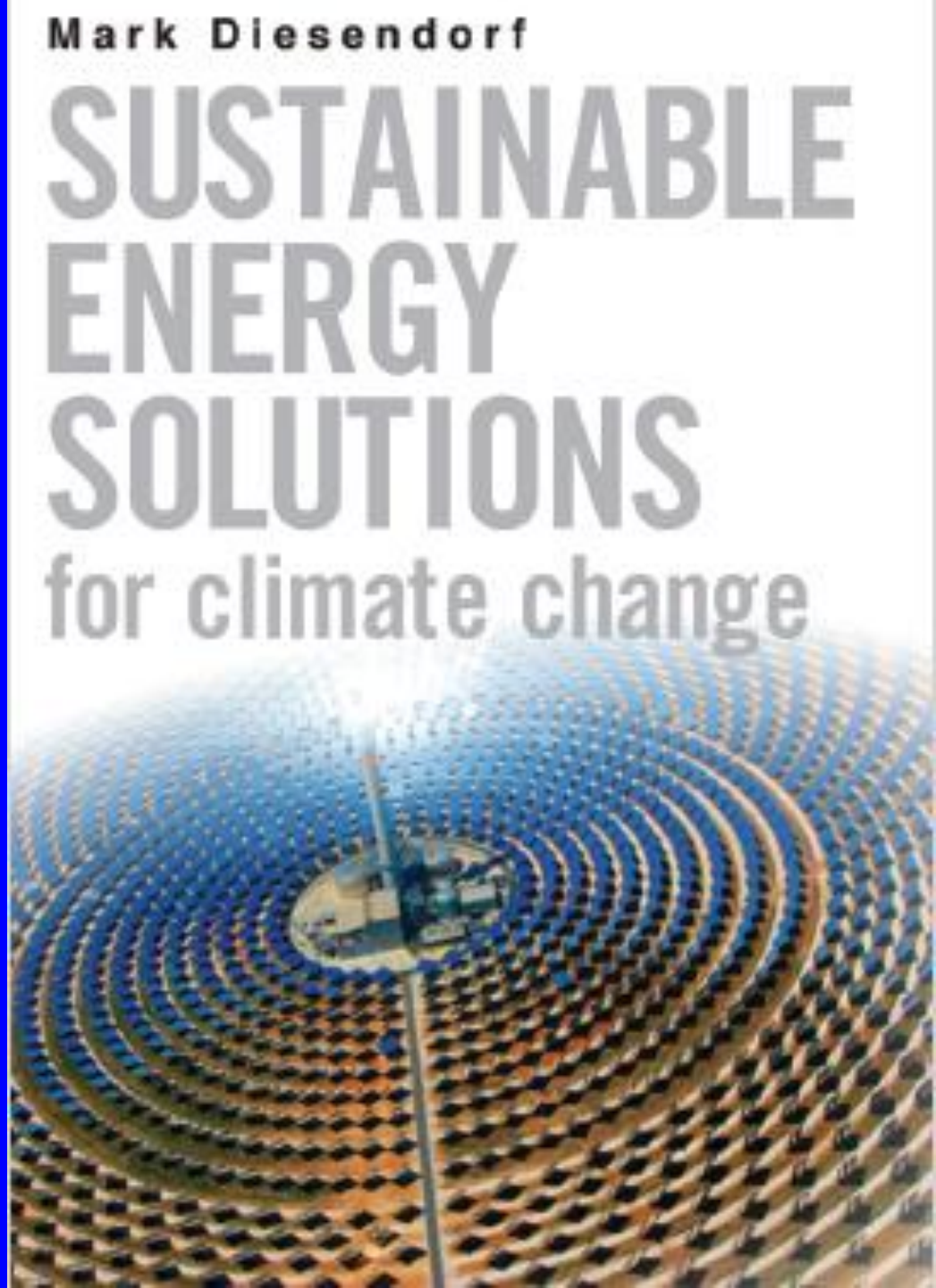
Thank you, & further information

Research paper

Mark Diesendorf & Ben Elliston 2018. *Renewable & Sustainable Energy Reviews* 93:318-330.

Background info: book

Mark Diesendorf 2014. Sustainable Energy Solutions for Climate Change, Routledge & UNSW Press, 2014



Appendix: ACCC Report

- ✔ Recognises that “National Energy Market must be reset”, in particular, that excessive market power of the few main generators and retailers, and gold-plating by network owners must be stopped
- X Creates false impression that *currently available* feed-in tariffs are subsidies to solar owners. They are actually so low that they are subsidies to electricity retailers.
- X Accuses solar customers of paying less for grid electricity (true), but ignores fact that most pay the fixed daily supply charge that should cover infrastructure
- X Accuses RET of “distorting the market” by encouraging non-dispatchable wind and solar PV -- now solved by AEMO’s requirements & SA strategy to encourage storage
- X Recommends market distortions that could be used to subsidise base-load coal & gas, e.g. low fixed-price energy off-take agreements
- X Implies incorrectly that, during the transition, base-load gas (subsidised) should replace base-load coal, when wind & PV + storage can do it more cheaply
- X Ignores Economics 101 principal that external (environmental, health & economic) costs should be included in prices (otherwise market is distorted) and so ACCC fails to accept the need for carbon price or equivalent