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‘Go for net zero’: the future of the National Electricity Market

April 2021

The report in one slide

We bust the following two myths:

- Renewables are unreliable; only coal can give us cheap, fair dinkum power
- A 100% renewable system is clearly the cheapest way forward

Governments should aim for net-zero emissions in the NEM for now, not 100% renewables, to meet their climate commitments at lowest cost

Governments should recognize the value of an interconnected NEM, and stop trying to ‘go it alone’

Outline

The NEM faces a transition

Grattan's modelling shows that low-emissions electricity can be affordable

100% renewables or net zero?

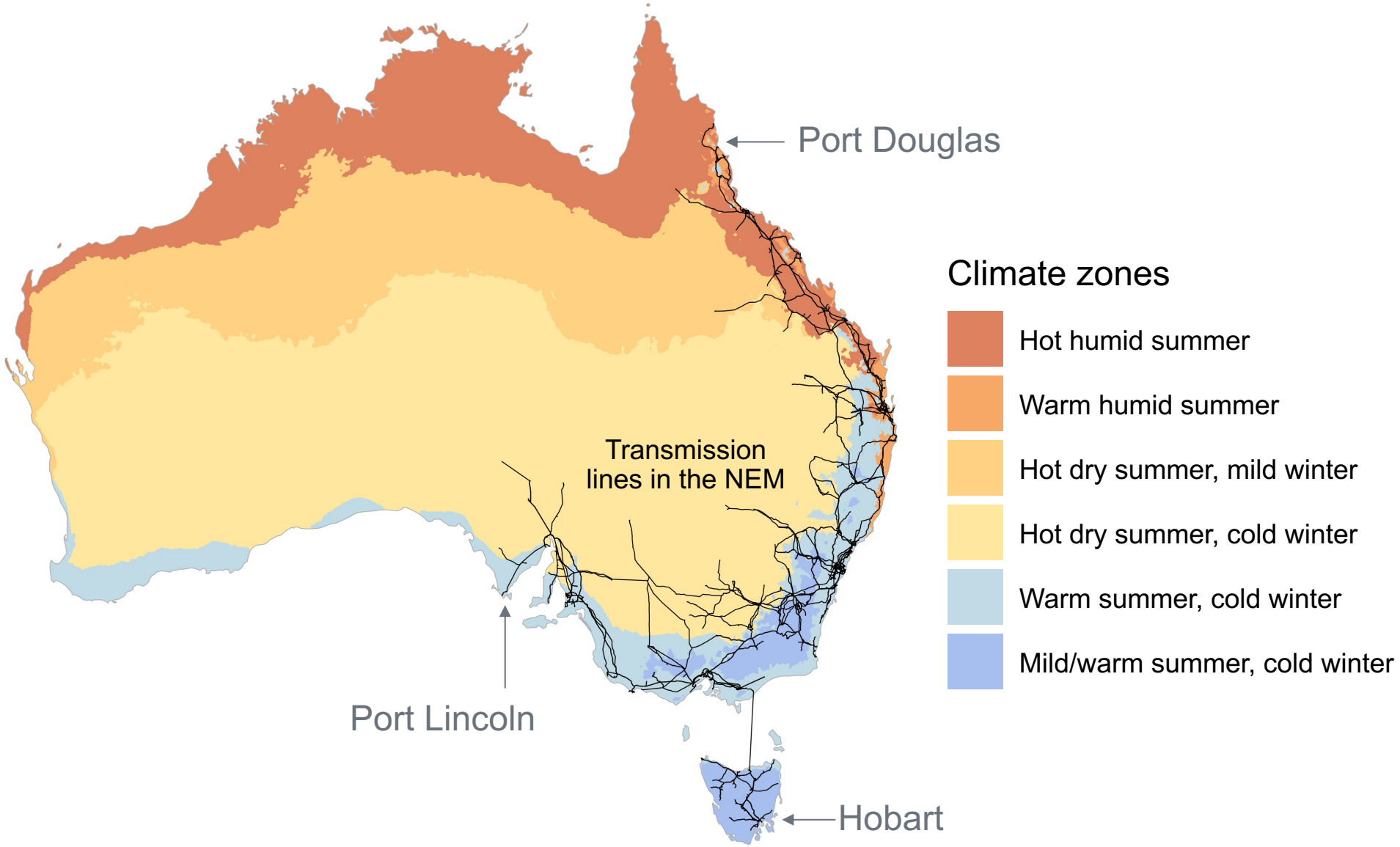
What governments should do

The NEM faces a transition

- Australia needs to reduce emissions to limit global warming in line with its commitment to the Paris Agreement
- All states and territories have committed to net-zero emissions economy-wide by 2050 at the latest
- Australia's coal-fired power stations are ageing, and are scheduled to be retired over the coming decades
- Variable renewable energy sources (wind and solar) have become the cheapest sources of bulk electricity, and are being deployed rapidly

- Decision makers disagree about how to get to a low-emissions electricity system while maintaining reliable, affordable supply

This is the NEM: it covers most of the population of Australia, and spans several different climates



Note: The NEM does not cover any part of WA or the NT. Source: Grattan analysis of BOM (2021) and Geoscience Australia (2015).

Most of Australia's coal-fired power stations are scheduled to be retired over the next few decades

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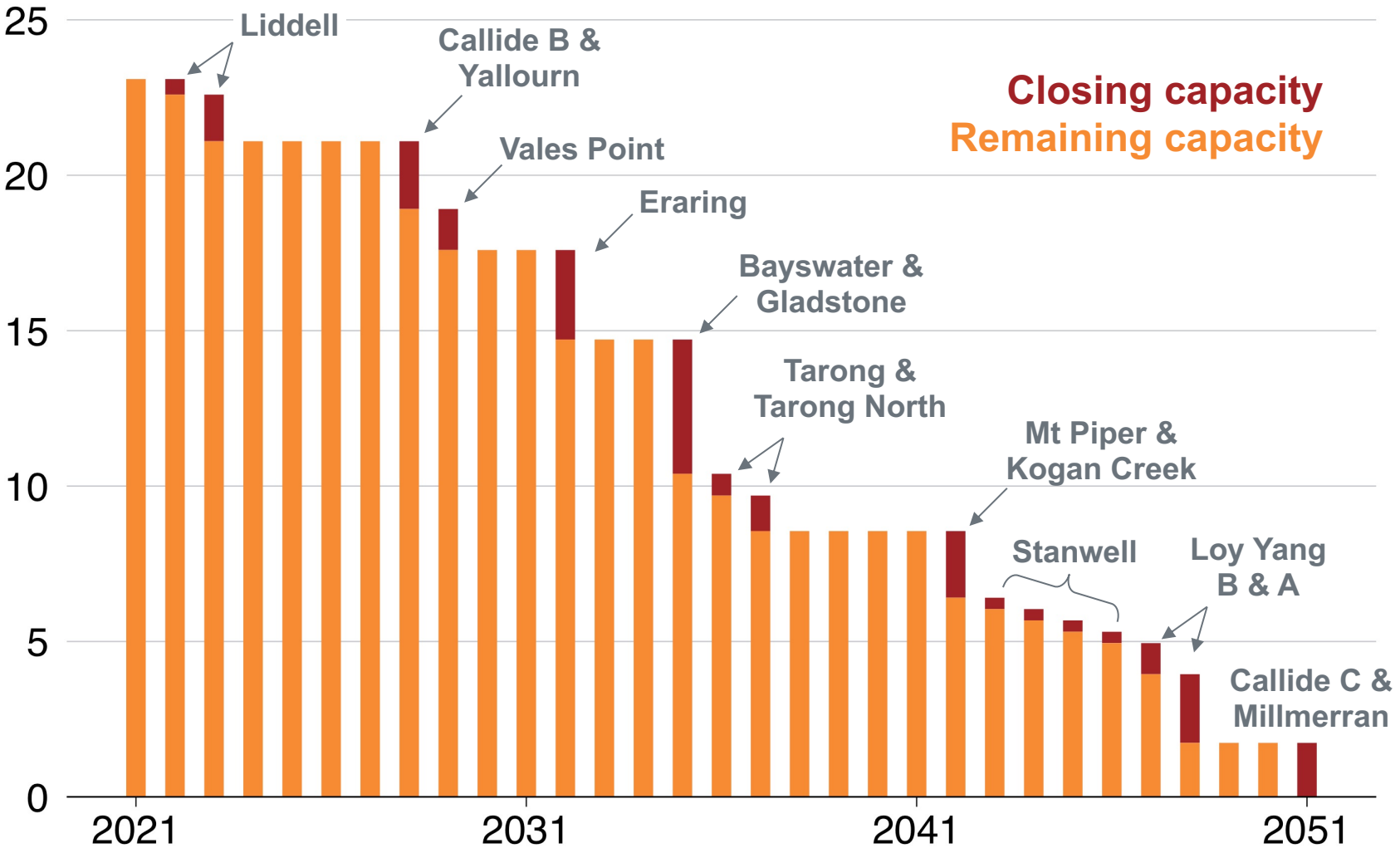
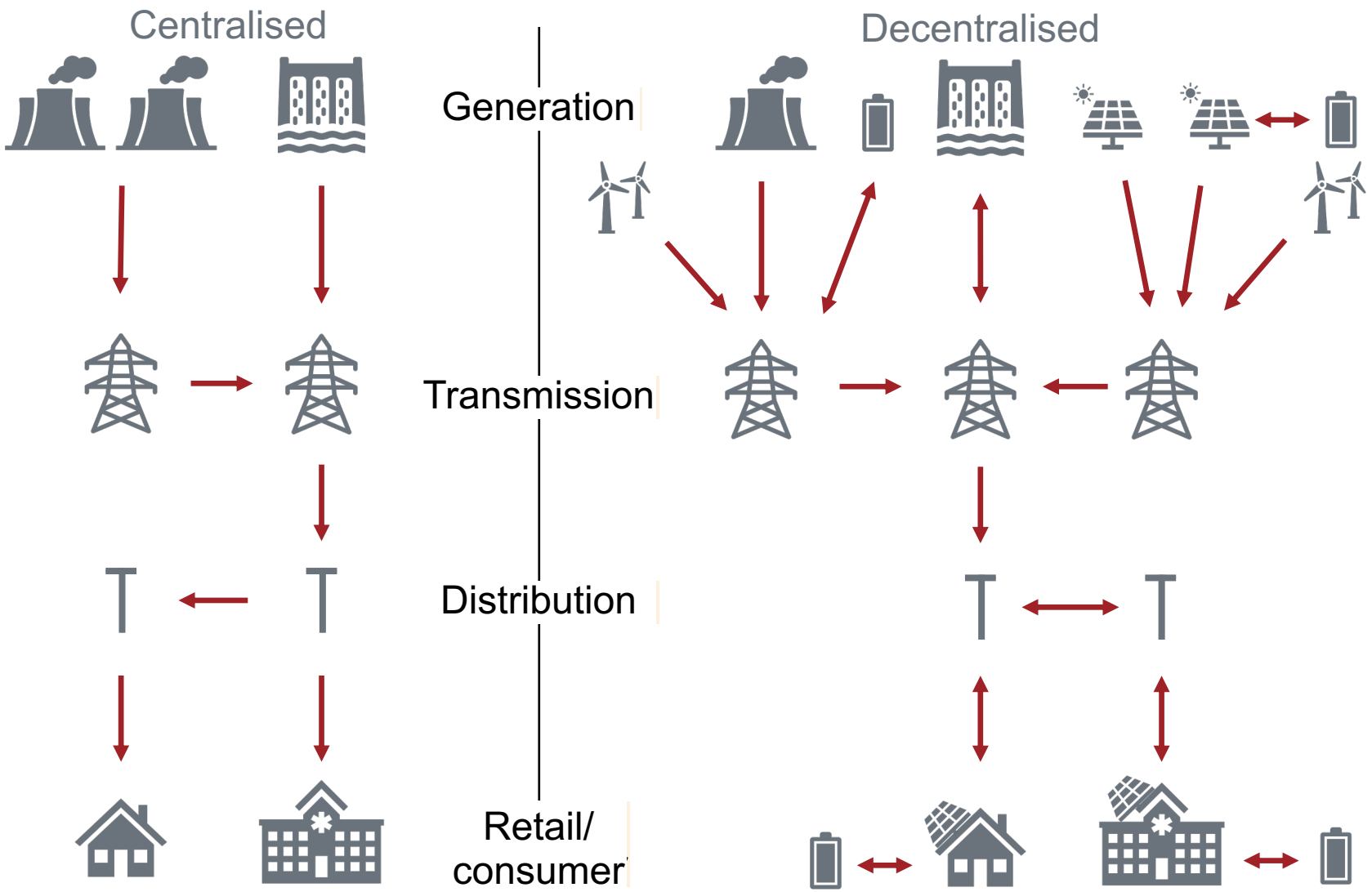
Scheduled capacity, gigawatts (GW)



Note: No closure date has been announced for Callide C, but the Australian Energy Market Operator (AEMO) estimates it will close in 2051, based on the technical life of the plant: AEMO (2020a).

The way electricity gets to consumers is becoming less centralised, due to renewables and energy storage



Governments and political parties lack a clear vision of the NEM's future

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Within the Coalition

Federal Govt: 'Gas-fired recovery'; 1GW 'dispatchable' target for NSW Hunter region by 2023

The Nationals: "Australia needs to build modern coal fired power stations to help manufacturing industries"

NSW Govt: Electricity Infrastructure Roadmap, 12GW renewables + 2GW storage by 2030

SA Govt: "a net 100 per cent renewable energy generator during the 2030s"

Tas Govt: Target to be 100% self-sufficient in renewable energy by 2022, and to generate 200% of current needs by 2040

Governments and political parties lack a clear vision of the NEM's future

Other parties

Federal Labor:

- committed to net-zero emissions by 2050
- took a 50% renewable energy target by 2030 to the 2019 election
- $20b in low-cost finance to build out the transmission grid

Victorian Govt: 50% renewables by 2030; creating VicGrid to deliver transmission projects outside of usual process

Qld Govt: 50% renewables by 2030

ACT Govt: (net) 100% renewables by 2020

The Greens: 100% renewables nationally by 2030, and eventually aiming for '700% renewables'

Outline

The NEM faces a transition

Grattan's modelling shows that low-emissions electricity can be affordable

100% renewables or net zero?

What governments should do

Grattan's modelling shows that low-emissions electricity can be affordable

- We developed an economic model of the NEM to test the cost of supplying reliable electricity to meet future demand, with a range of technology mixes
- We tested many technology mixes against nine years of demand, wind, and solar data, to check their robustness to a range of conditions
- We determined approximate least-cost technology mixes that met different coal capacity/renewable share criteria

- A mostly-renewable NEM can deliver reliable electricity at similar cost to a coal-based NEM, but with much lower emissions
- An almost-fully renewable NEM would cost slightly more, but slash emissions to levels at which the remainder could be plausibly offset

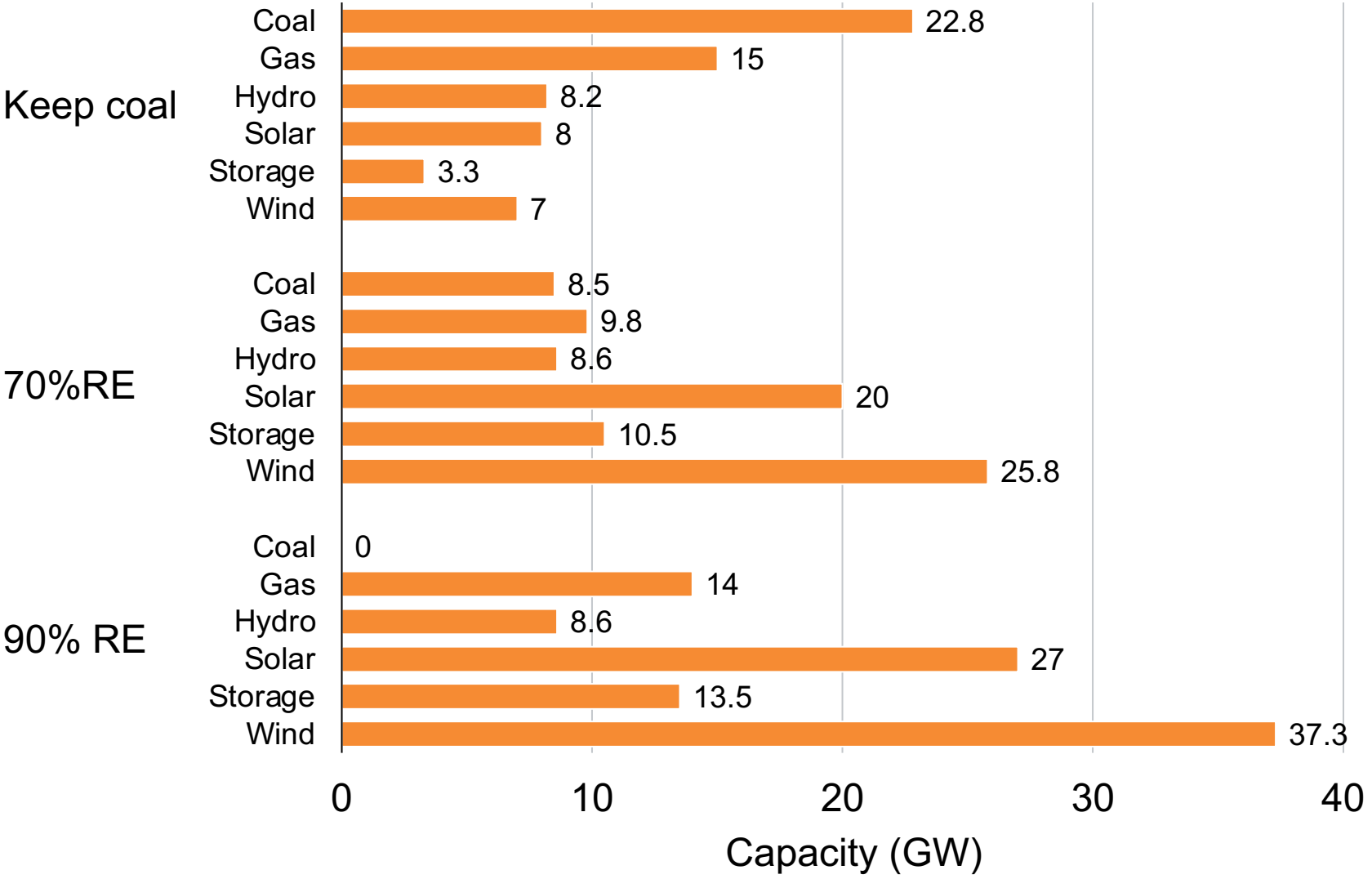
We modelled three scenarios to analyse the cost of reliable electricity supply as the renewable share grows

Scenario	Coal capacity	Renewable share
Keep coal	23GW (same as today)	< 30%
70% renewables	8GW (as per 2040 schedule)	~70%
90% renewables	0GW	> 90%

- Each system has enough capacity to reliably meet all demand projected by AEMO for 2040
- Robust to a range of weather/demand patterns (used 9 years of data from across the NEM, provided alongside the AEMO Integrated System Plan)

The three scenarios have different balances between coal, renewables, and other technologies

Capacity by scenario



Notes: Coal includes both black and brown coal. Gas includes both CCGT and peaking gas.

Less coal capacity means less coal generation; wind and solar fill the gap, firmed by other technologies

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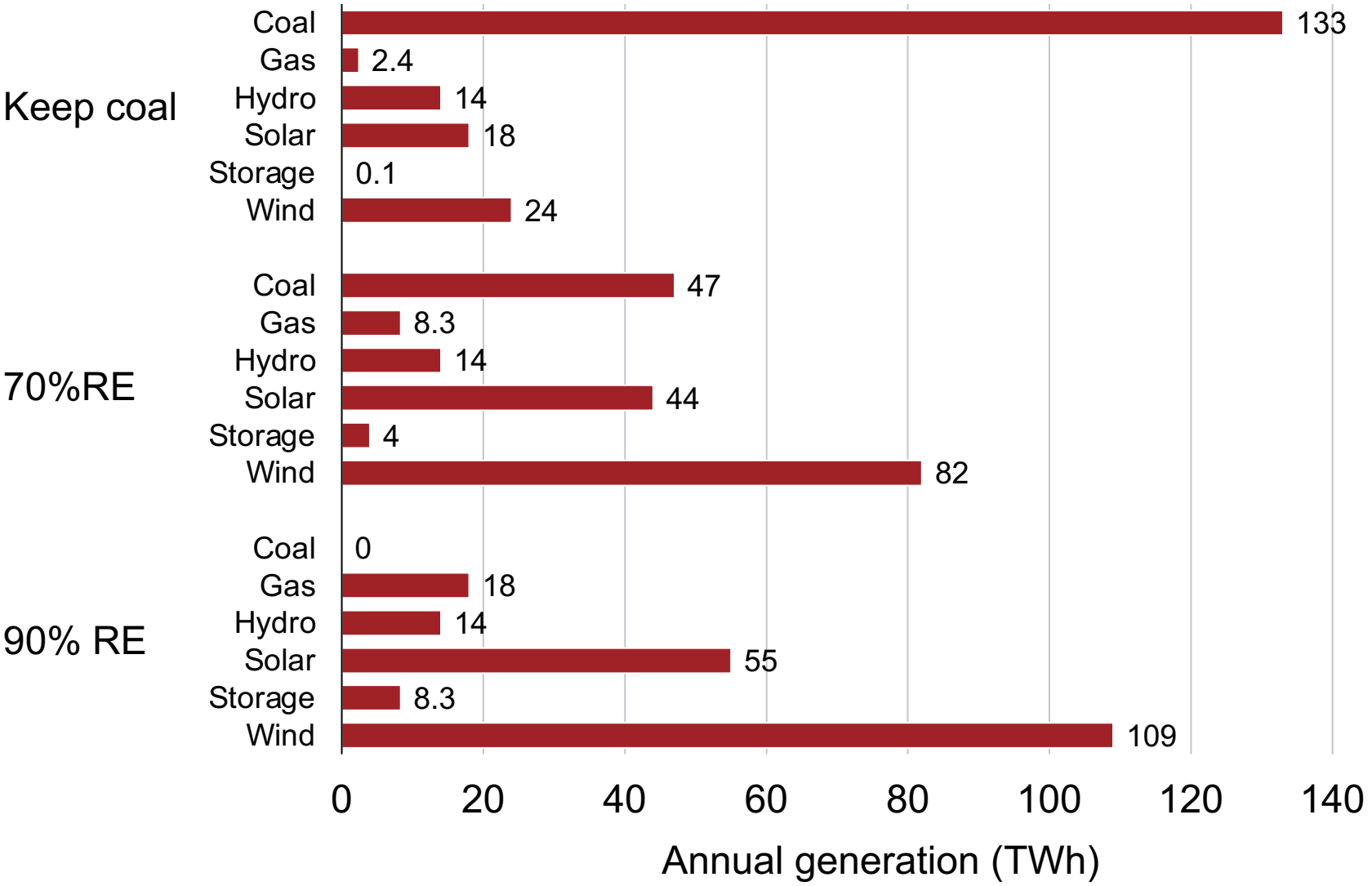

Notes: Coal includes both black and brown coal. Gas includes both CCGT and peaking gas.

Higher-renewable systems tend to have more excess capacity, to ensure supply during poor conditions

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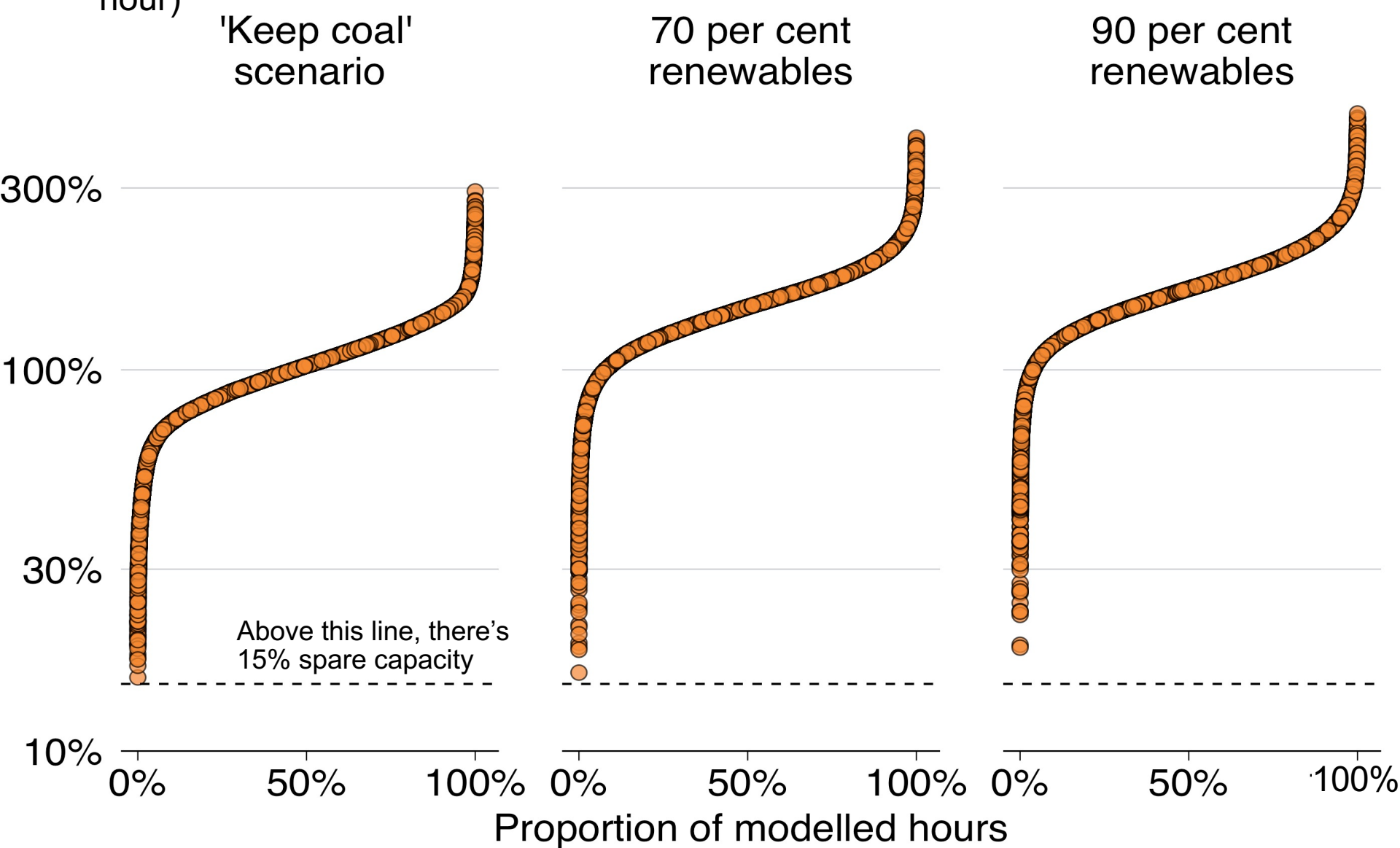
Extra available capacity relative to demand, log scale (one dot is one modelled hour)



A renewables-based NEM would be cost-competitive with a coal-based NEM, even without a price on carbon

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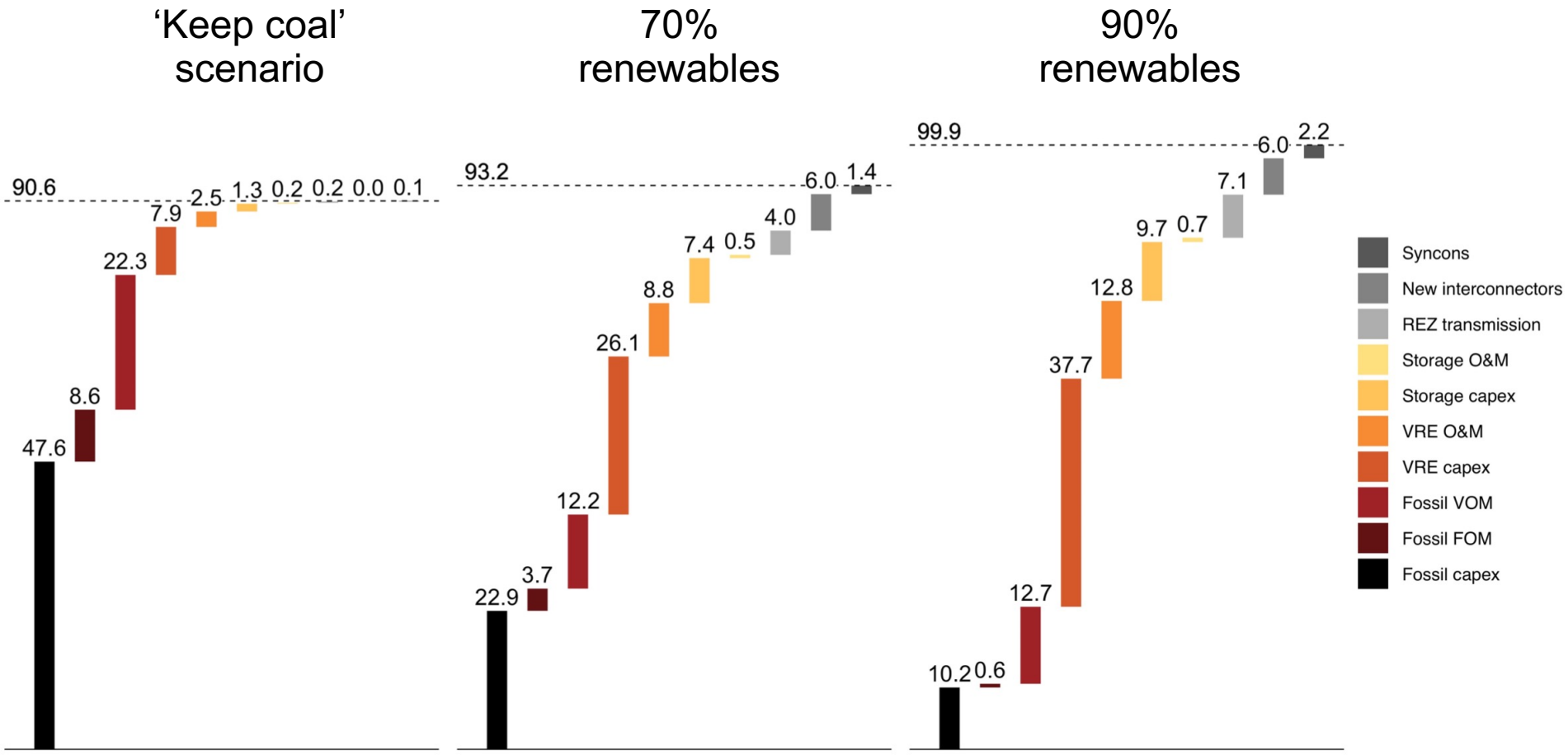
System unit cost ($/MWh)



Notes: 'Syncons' are synchronous condensers, which are increasingly used to provide system strength and inertia as the renewable share in the NEM increases (see Appendix A.3 on page 55). 'REZ' is a renewable energy zone – all wind and solar plant are built in REZs in this model. 'O&M' is operations and maintenance. 'VRE' is variable renewable energy. 'VOM' and 'FOM' are variable and fixed operations and maintenance costs respectively. VOM includes the cost of fuel.

And the emissions of high-renewable systems are dramatically lower than continuing to rely on coal

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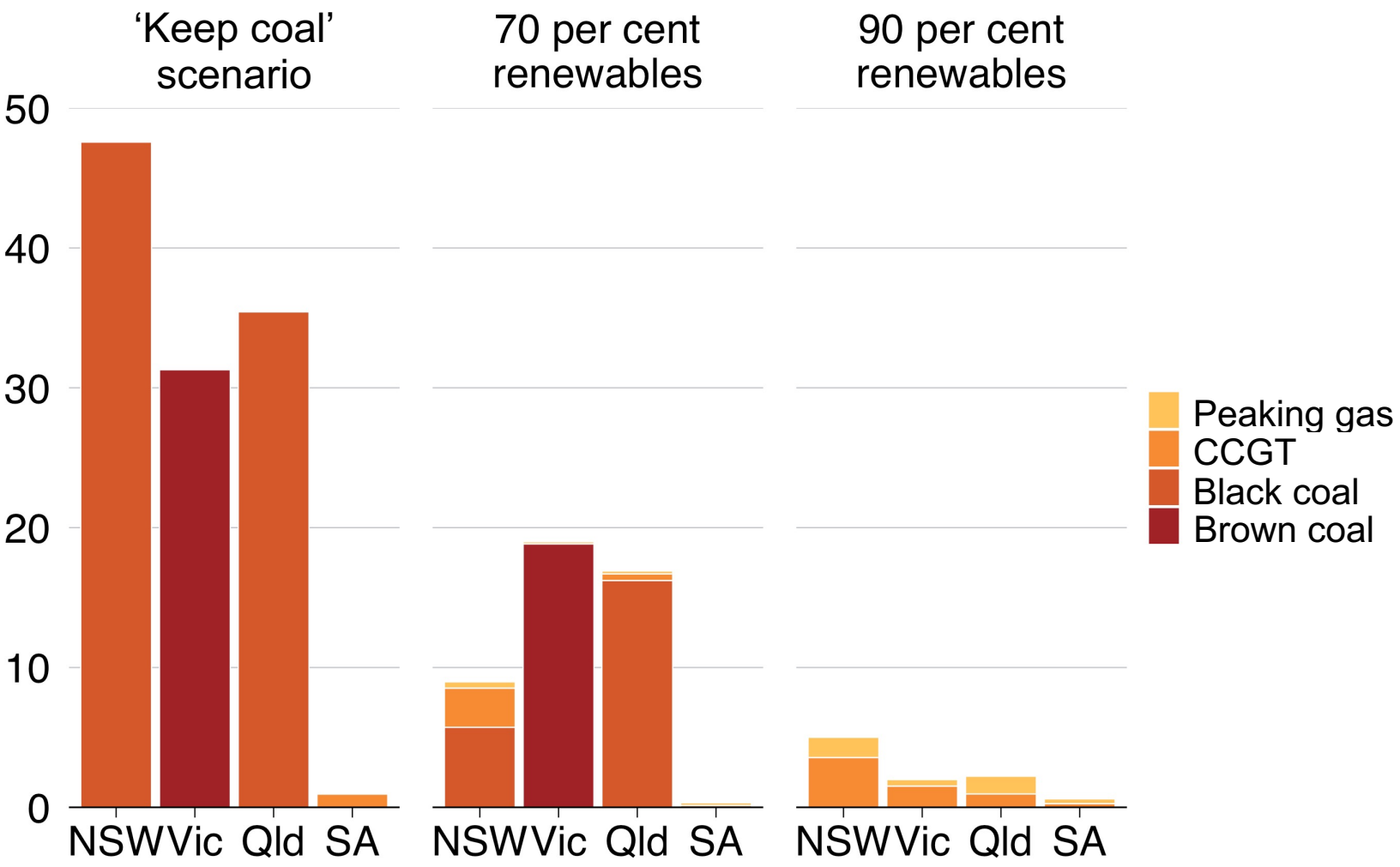
Annual emissions by source (Mt)



Moving to greater renewable shares and less coal is a low-cost way to bring down emissions

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We estimate cost using the Greenfields method, which includes:

- Capital cost for all plant + new transmission, amortised over plant life with a real 6% WACC, plus
- Fixed O&M per year, plus
- Variable O&M (including fuel costs) per year, all divided by
- The total demand (MWh) met by the NEM each year (excluding behind-the-meter supply from rooftop solar or home batteries)

Scenario	System unit cost ($/MWh)	Average emissions per year (Mt)	Marginal abatement cost ($/t$CO_2$-e)
Keep coal	90.6	115	-
70%RE	93.2	45	7
90%RE	99.9	10	36

This is a low-cost abatement opportunity: the Federal Govt pays $16/t today
EU carbon credits have traded at A$60/t
Canada carbon tax to reach A$180/t by 2030

Note: Emissions in the NEM today are about 142Mt; they fall in the 'Keep coal' scenario due to greater renewable share and lower emissions-intensity for the modelled coal- and gas-fired generators than the existing plant in the NEM today.

More transmission reduced system cost in the high-renewables scenarios, despite the additional capex

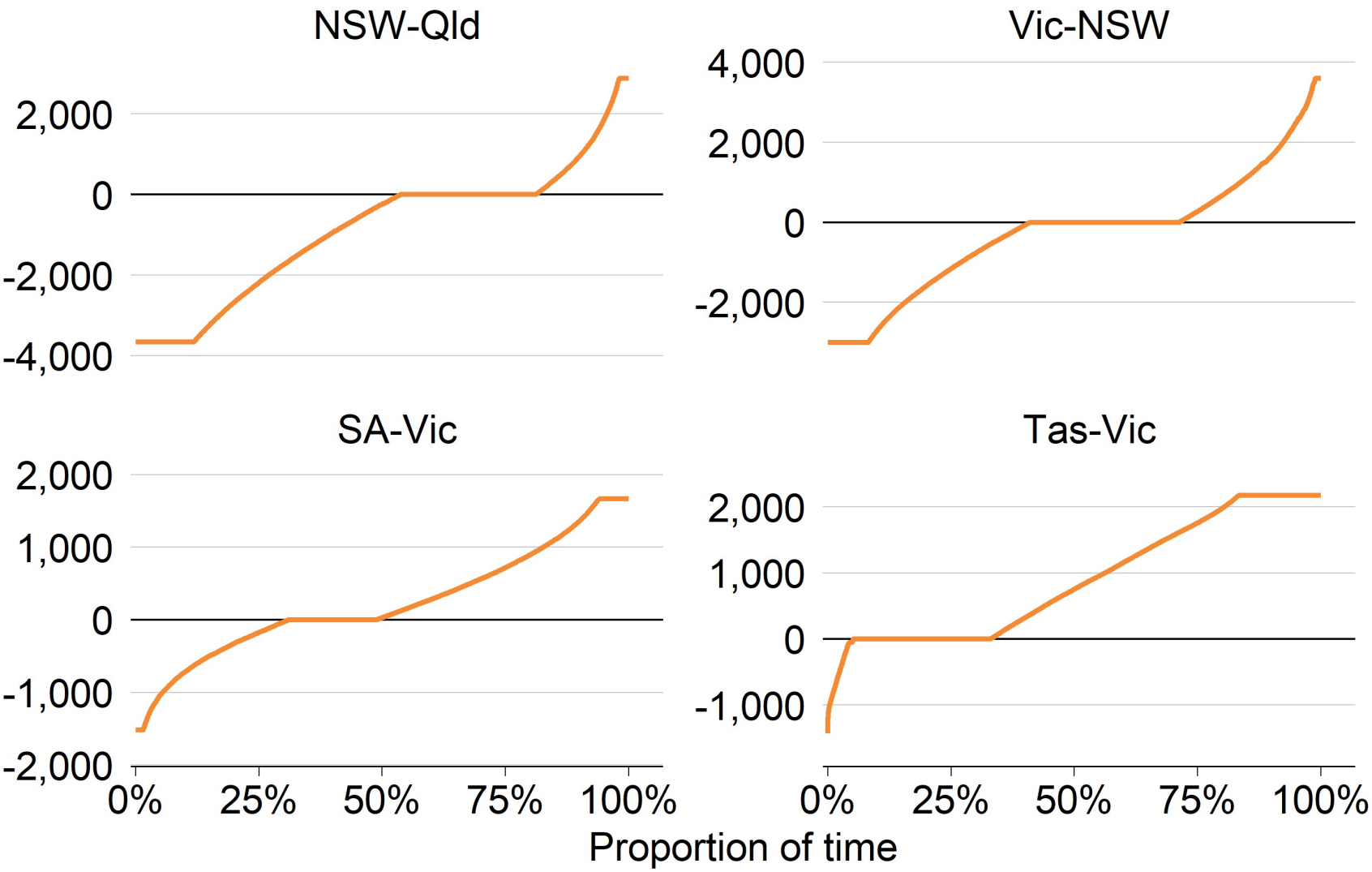
Two transmission configurations tested:
Same as today or with the ISP interconnector upgrades from ISP Step Change
Upgraded network reduced system unit cost by <$1/MWh for 70%RE scenario, but reduced cost by about $5/MWh for 90%RE scenario

Origin	Destination	Today's capacity (MW)	Upgraded capacity (MW)	Upgrade capex ($m)
Qld	NSW	1,302	3,664	3,260
NSW	Qld	657	2,877	
NSW	Vic	1,350^	3,000*	5,820*
Vic	NSW	1,600^	3,600*	
Vic	SA	870	1,520*	-
SA	Vic	765	1,665*	
Tas	Vic	594	1,978	3,155
Vic	Tas	478	1,728	

Note: (^) The Vic-NSW interconnector capacity is reduced when the Snowy Hydro scheme is generating (see Appendix A.1.2). (*) The modelling in this report sums the capacity of each interconnector between regions. The planned SA-NSW Project EnergyConnect link is modelled as two separate links, one between SA and Victoria, and one between Victoria and NSW. The cost is included in the cost of Vic-NSW upgrades. The capital cost of upgrades is assumed to be the same cost as used in AEMO's modelling for the 2020 ISP; see Appendix A.4.3 for sensitivity analysis.

In a high-renewables future, it makes economic sense for states to trade more with each other

Interconnector forward flow in 90%RE scenario
(negative values mean reverse flow)



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100% renewables or net zero?

- The biggest long-term challenge for a near-100% renewables system is the cost of ensuring reliable supply during rare, sustained periods of high demand, low solar, and low wind
- These conditions usually occur in winter due to higher average demand and lower average solar output, and vary in severity year-to-year
- These periods, lasting days-to-weeks, require a very large amount of dispatchable energy to meet consumer demand
- It does not look economic to meet this need entirely with storage – either battery or pumped hydro – nor demand response
- A dispatchable fuel – such as gas – and a flexible, low-capex power station are the natural solution
- To reach net zero quickly, offsetting the emissions from gas looks to be a cheaper option, at least until zero-emissions alternatives (such as hydrogen) become competitive

In each modelled hour of the 90%RE scenario, wind and solar supply could be vastly more or less than demand

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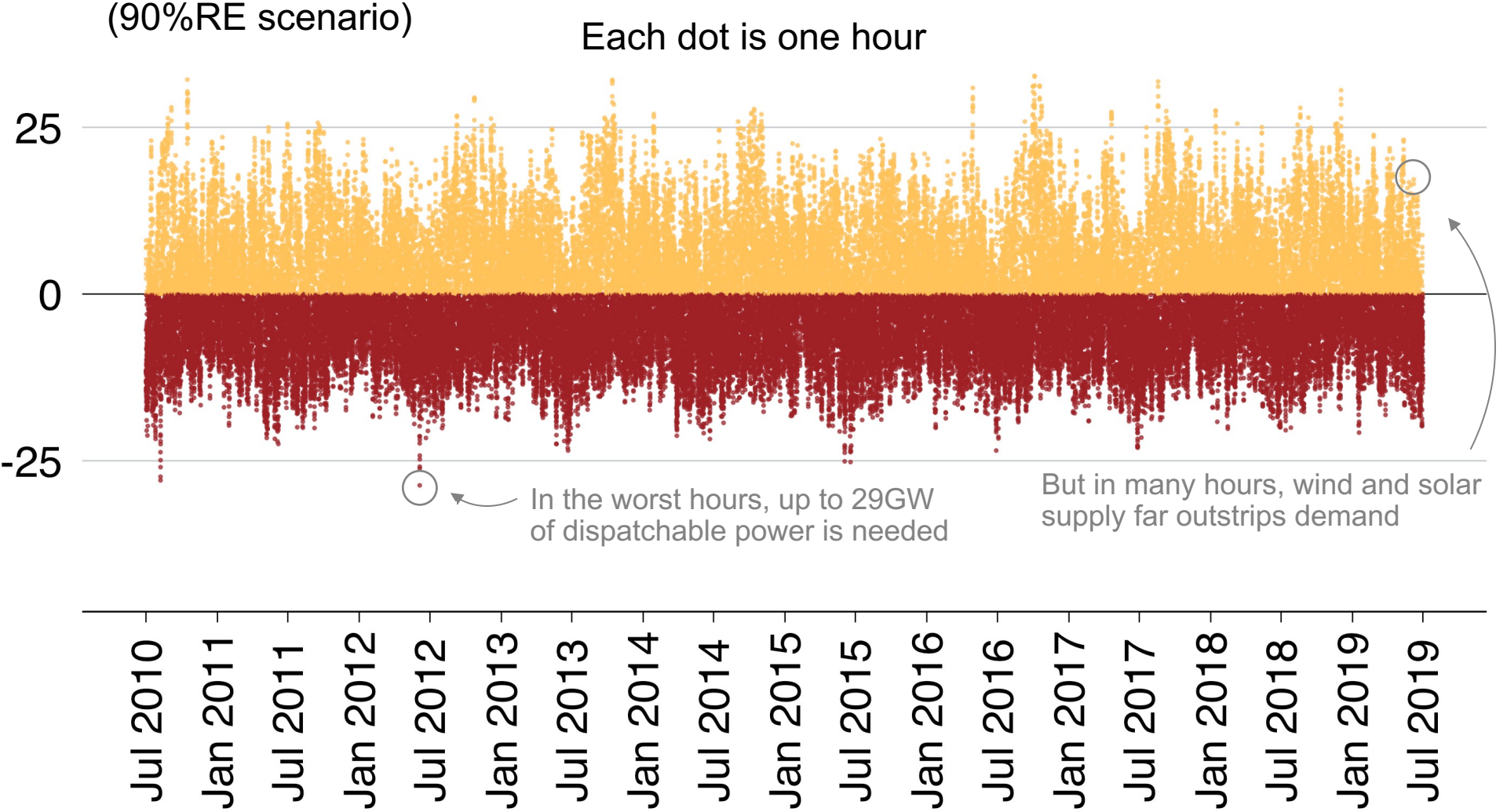
Surplus/deficit (GW) of wind and solar supply to demand across the NEM (90%RE scenario)



Historical data on which modelled 2040 data is based

But a pattern emerges in winter: higher demand and lower solar output leave the system vulnerable to wind lulls

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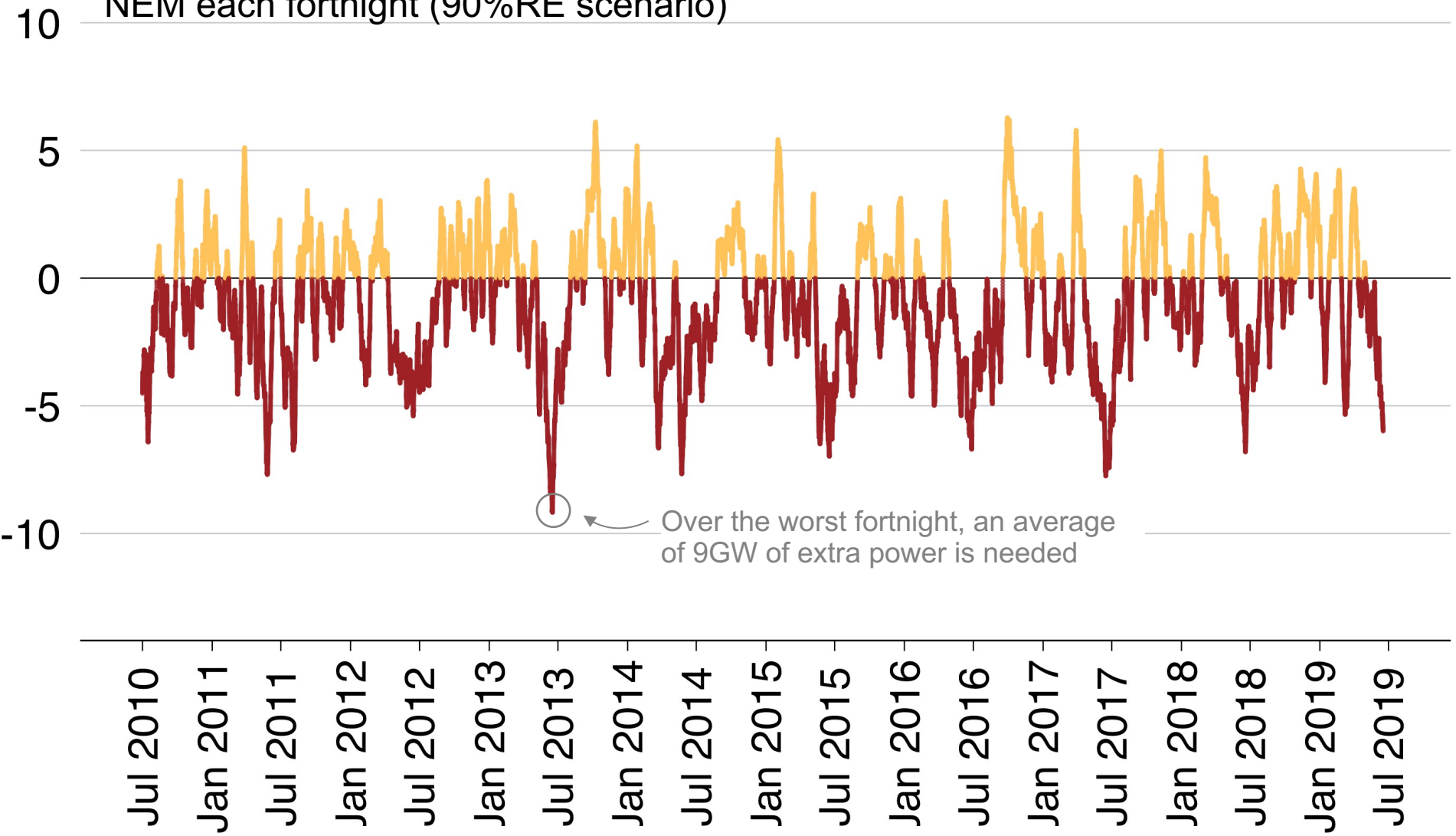
Average surplus/deficit (GW) of wind and solar supply to demand across the NEM each fortnight (90%RE scenario)



Historical data on which modelled 2040 data is based

In our 90% scenario, gas helps to balance higher demand and lower solar output in winter

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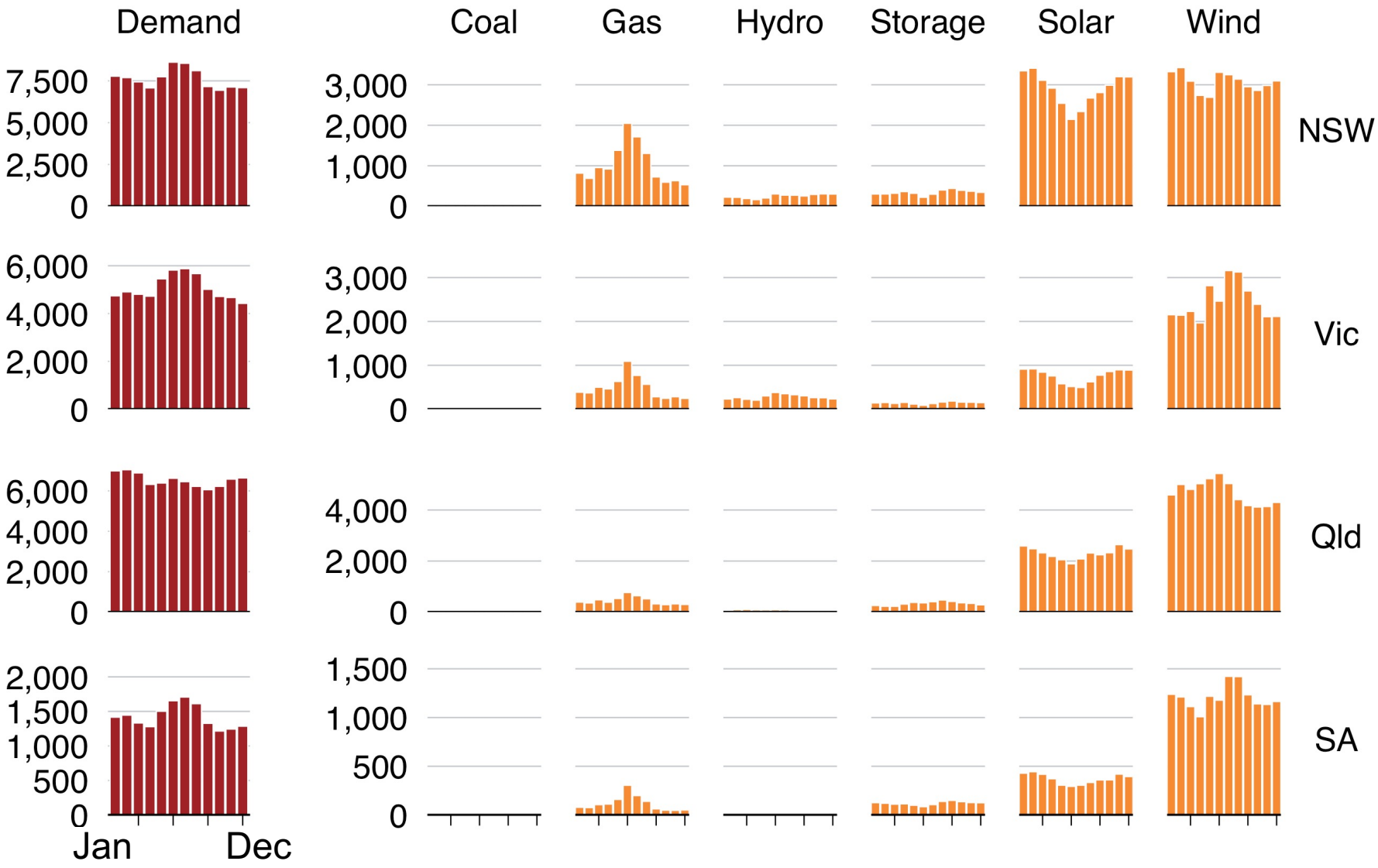
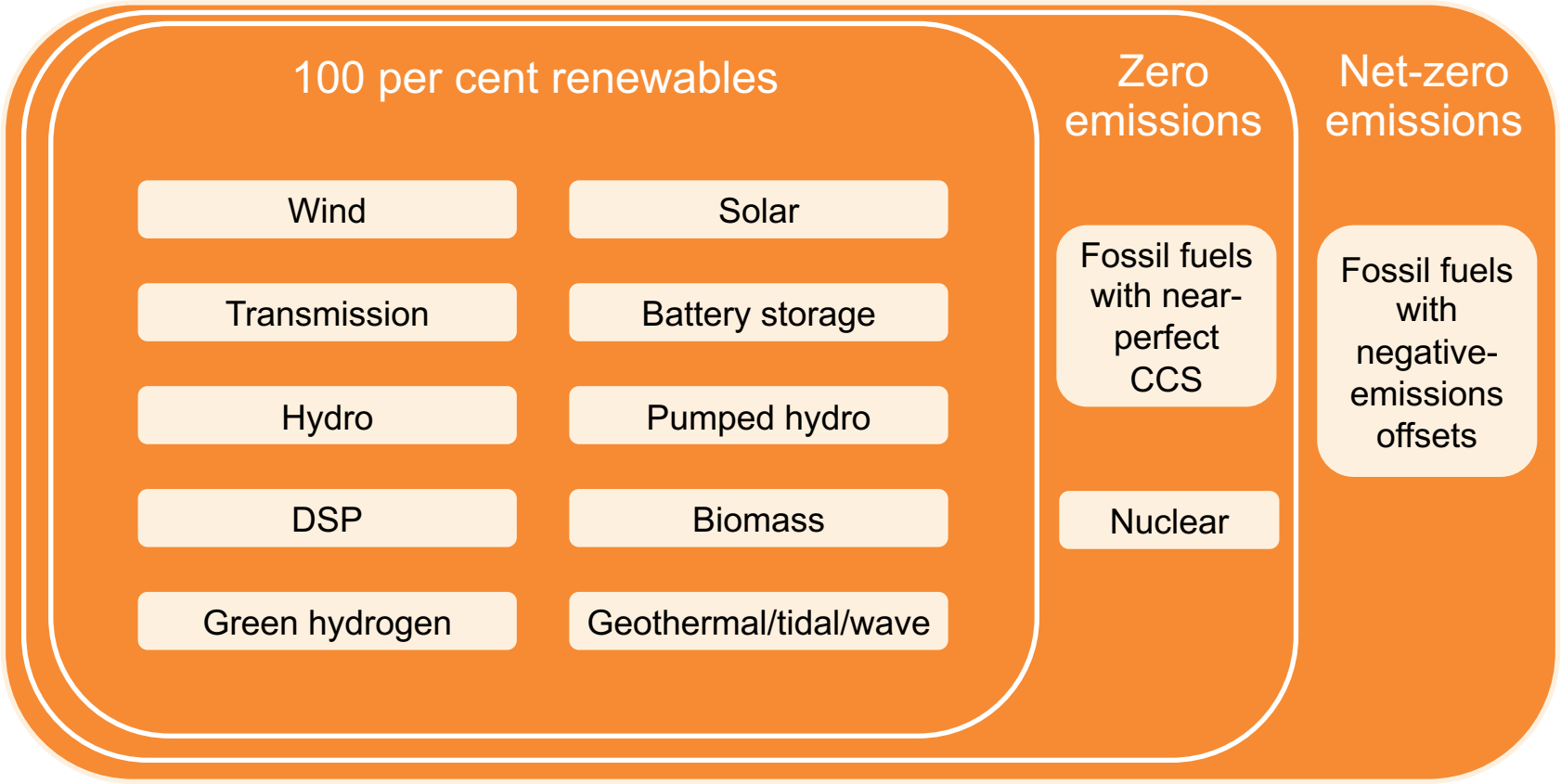
Average monthly electricity demand (MW) and output (MW) by generation source in the '90%RE' scenario



A 100 per cent renewable target would rule out some potentially lower-cost ways to reduce emissions



The cost of offsets will determine the lowest-cost way to reach net zero

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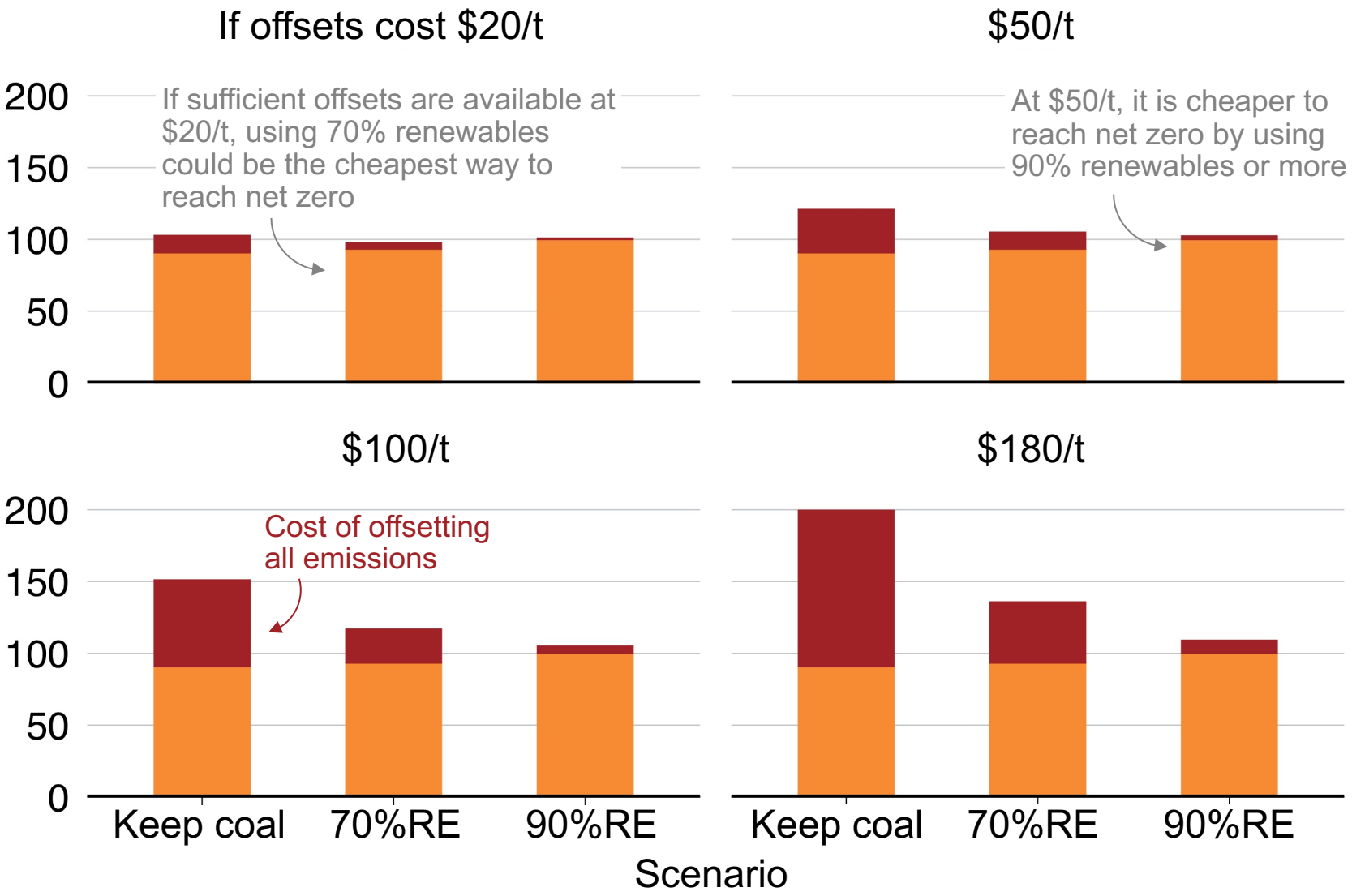
System unit cost ($/MWh), including the cost to offset all emissions



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Recommendations for governments (state and federal)

Do:

- Aim for net-zero emissions in the NEM by the 2040s at the latest, to ensure low-emissions electricity is available for decarbonising other sectors
- Re-commit to the NEM, recognising the value of a well-connected market
- Work with the ESB to resolve transmission cost disputes and implement a common framework for REZs

Don't:

- Subsidise new coal-fired generators or try to prolong the life of existing ones
- Legislate a 100% renewables target, because this may not be the lowest-cost way to reduce emissions in the electricity sector

Ideally: Implement an economy-wide emissions price to meet climate goals efficiently

More realistically: Sector-specific approaches will continue; allowing tradable ACCUs between sectors will reduce the cost of this second-best approach