Fraser Maywood – Chair @ Sustainable Energy Now

Advocating the Clean Energy Transition

Barriers and Constraints

Tuesday 18th February 2025

ENGINEERS AUSTRALIA

Engineers Australia WA Division
Retired Engineers Group

Agenda

1. About me and SEN
2. Problem Solving Context
3. Solution Set
4. Barriers and Constraints
5. Making Renewables Work

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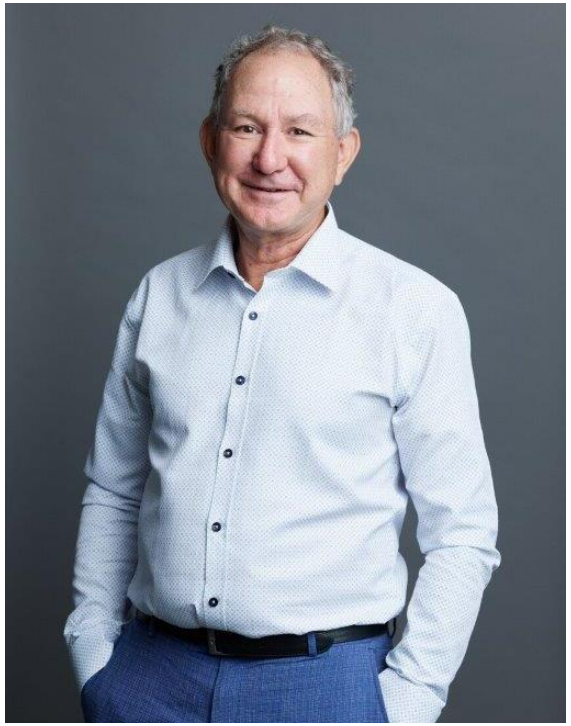
About SEN

About Me

Fraser Maywood MSc, GAICD

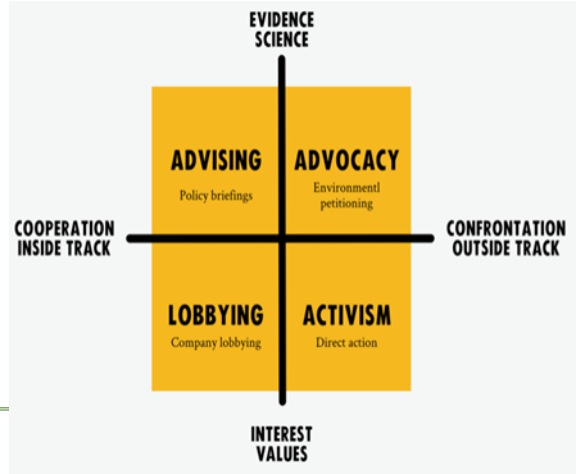


- 40 years experience in the international Oil & Gas industry, mining and power
- Clean energy transition advocacy – chair at Sustainable Energy Now
- Management and technical consulting services
- Strategic and operational business planning
- Quality and OHS management system design, accreditation preparation, audits and reviews
- Business development, bid management
- Audits and reviews (design, stage gate, third party, cold eye review)
- Project and study management
- Lecture content development and delivery

About SEN

What is our mission and what do we do?

- SEN is an **independent** Not For Profit, individual member-based advocacy group
- Our 2030 vision is to phase out the majority of fossil fuels and transition towards 100% renewables
- Our mission is to **model** the WA electricity grid and **advocate** on a swift and orderly transition to clean renewable electricity **safely, reliably, and affordably** with commercially proven technologies.
- We provide presentations, submissions and briefings to government agencies, corporations, media, schools, community groups, politicians and hold public events, to be a **trusted independent energy advisor**.



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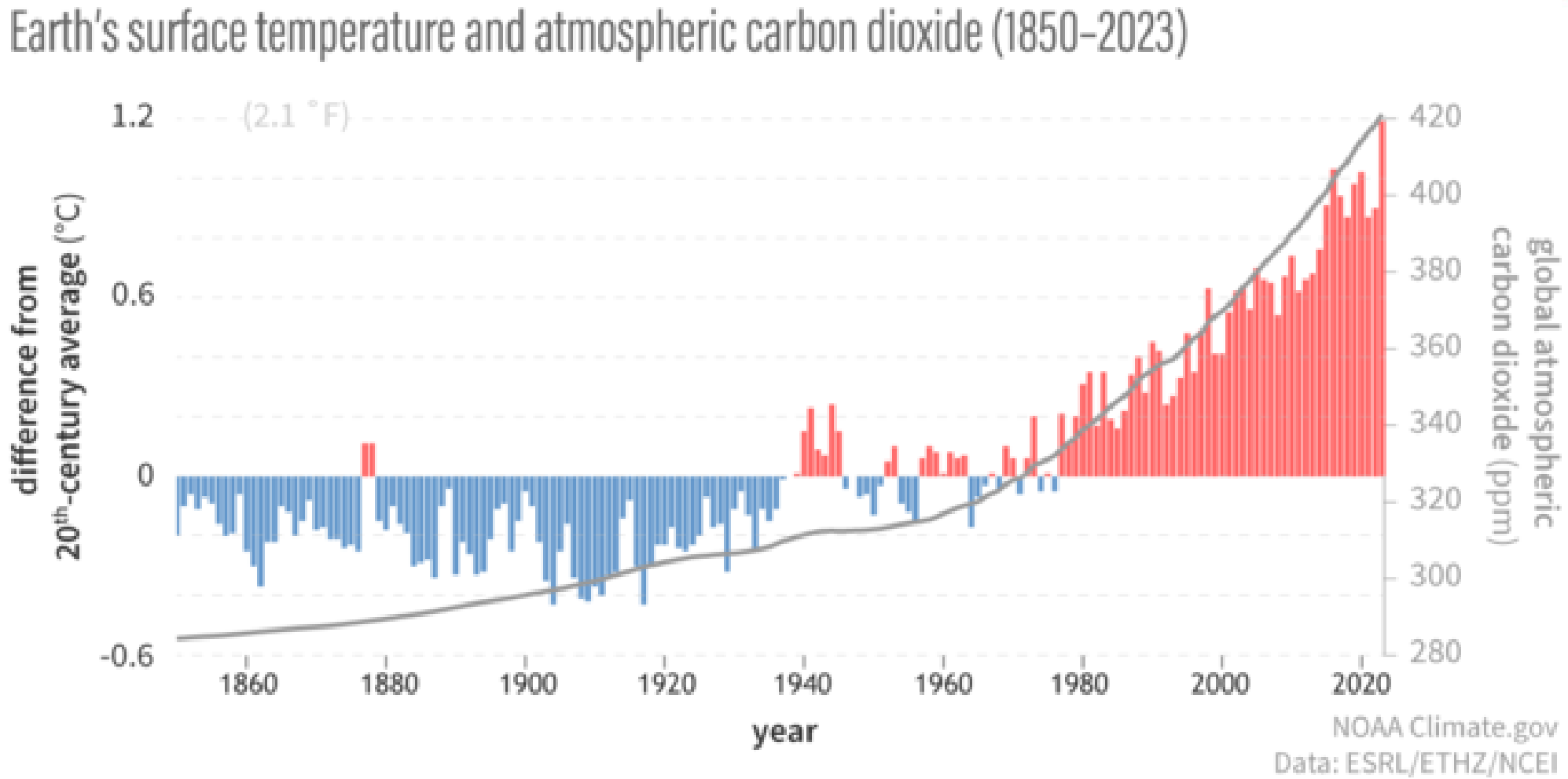
Problem Solving - Context

Engineering problem solving method – about defining the problem context and the end state vision before considering potential solutions

Problem Solving 101 - Context

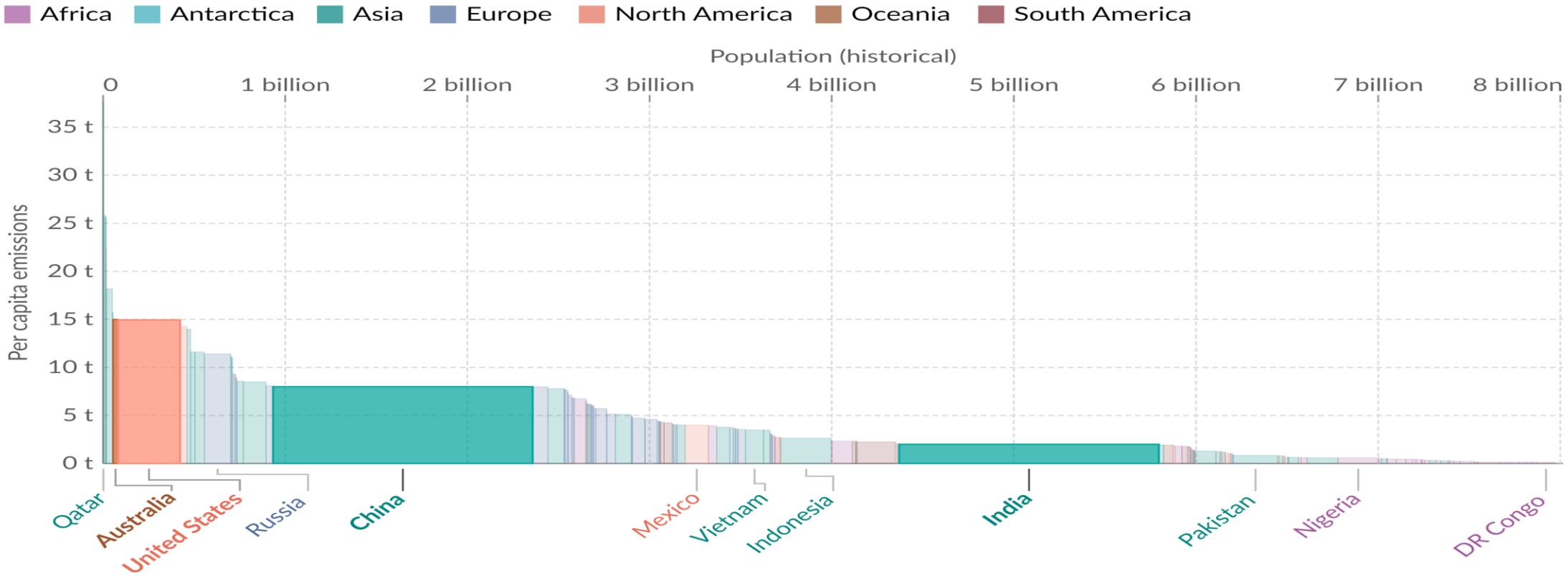


Yearly temperature compared to the twentieth-century average from 1850–2023. Red bars mean warmer-than-average years; blue bars mean colder-than-average years. (line graph) Atmospheric carbon dioxide amounts: 1850-1958 from IAC, 1959-2023 from NOAA Global Monitoring Lab. NOAA Climate.gov graph, adapted from original by Dr. Howard Diamond (NOAA ARL).

Problem Solving 101 - Context

CO_2 emissions per capita, 2022

The width of each bar shows countries scaled by population size. The height of each bar measures tonnes of per capita carbon dioxide (CO_2) emissions from fossil fuels and industry[1].

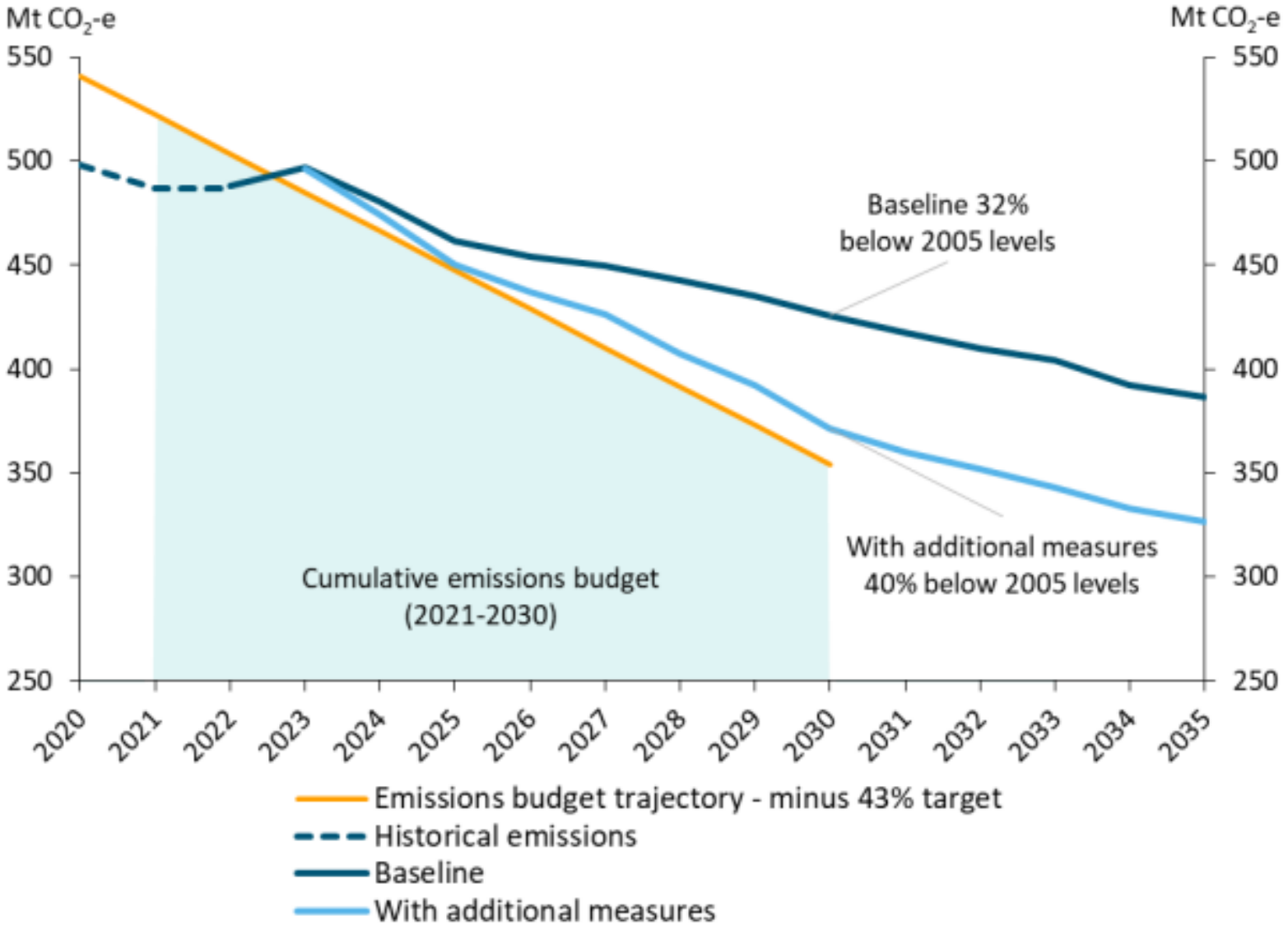


Data source: Global Carbon Budget (2023); Population based on various sources (2023)
OurWorldinData.org/co2-and-greenhouse-gas-emissions | CC BY

1. **Fossil emissions**: Fossil emissions measure the quantity of carbon dioxide (CO_2) emitted from the burning of fossil fuels, and directly from industrial processes such as cement and steel production. Fossil CO_2 includes emissions from coal, oil, gas, flaring, cement, steel, and other industrial processes. Fossil emissions do not include land use change, deforestation, soils, or vegetation.

Problem Solving 101 - Context

Figure 1 Tracking against the 2030 emissions target, 2020 to 2035, Mt CO_2-e



The Australian Government's Net Zero Plan

Problem Solving 101 - Context

Table 5 Emissions projections to 2035 in the baseline scenario, by sector, Mt CO_2-e[5]

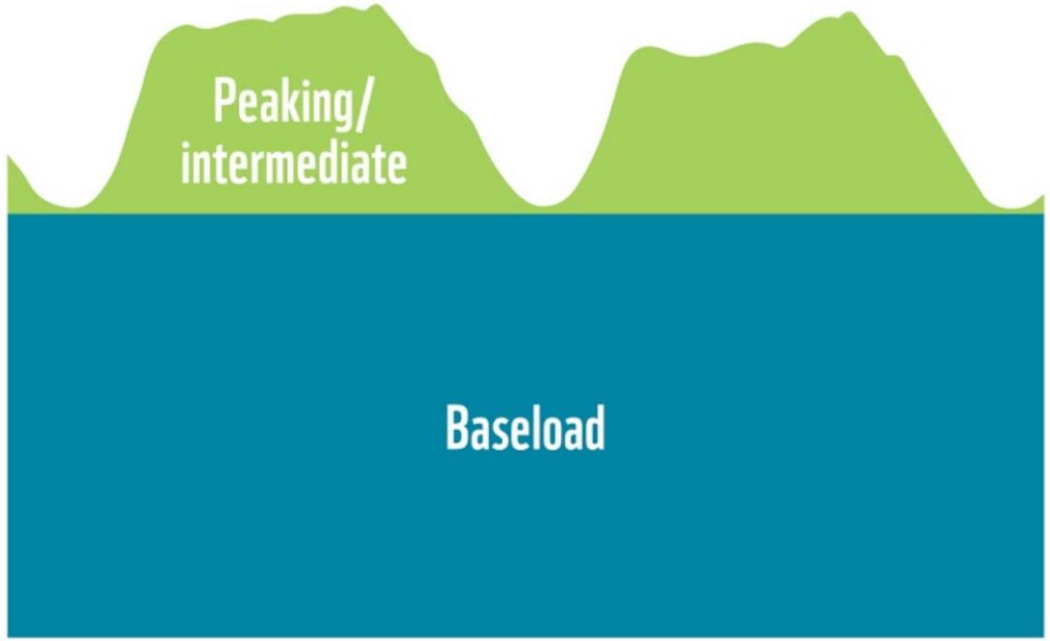
Sector	National Greenhouse Gas Inventory		Projection	
	2005	2020	2030	2035
Electricity	197	172	79	66
Stationary energy	82	101	101	94
Transport	82	93	103	99
Fugitives	43	53	55	55
Agriculture	86	73	79	78
Industrial processes and product use	30	32	28	25
Waste	16	13	11	10
Land use, land-use change and forestry	85	-39	-33	-44
Total	**621**	**498**	**422**	**383**

The Australian Government's Net Zero Plan

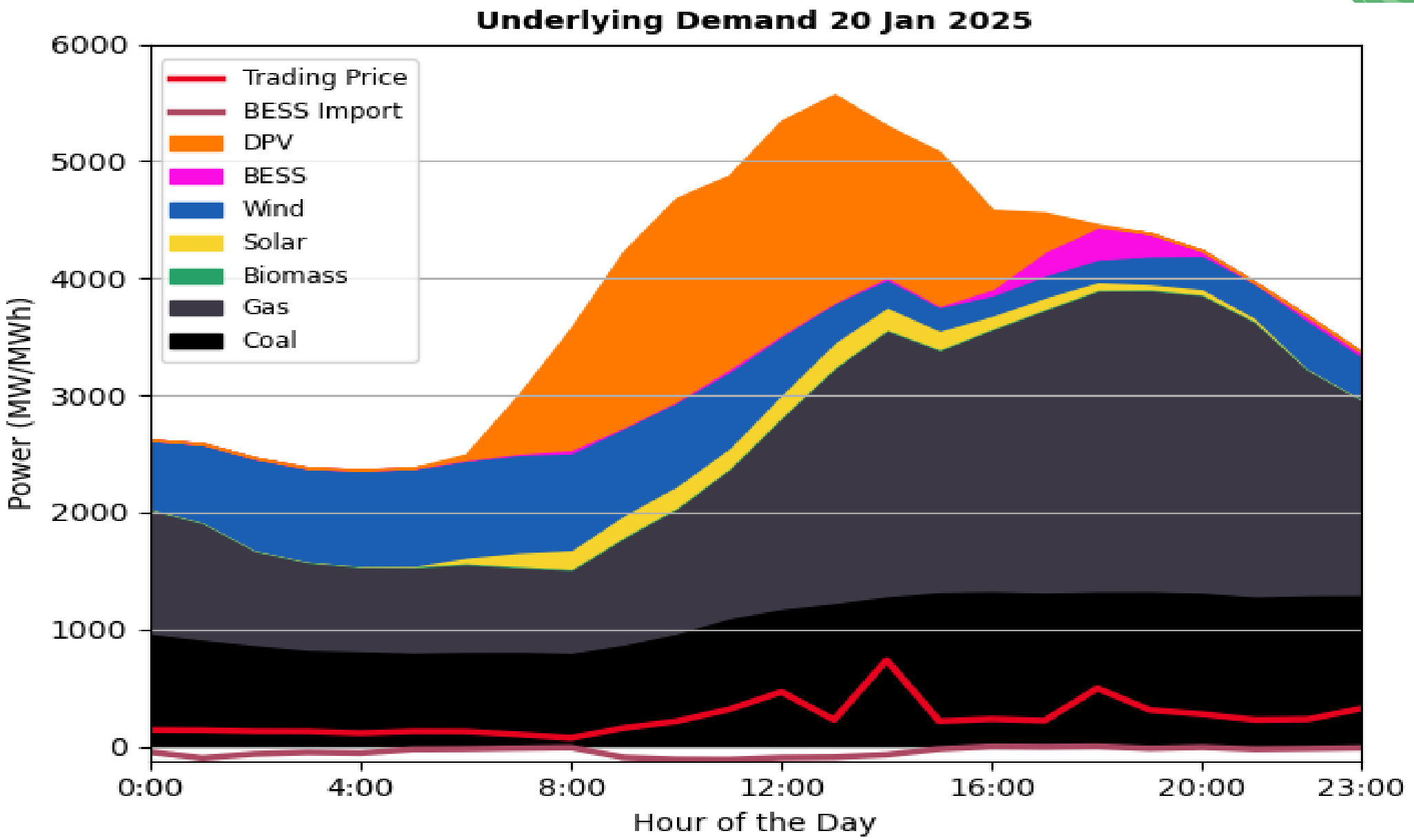
Problem Solving 101 - Context

Baseload - lowest electricity load during a typical day.

Baseload generators were the cheap but inflexible generators that ran 24/7 to meet that baseload. Depending on the country, typically coal, gas or nuclear. Baseload was then augmented by more expensive flexible ‘peakers’ (often gas) that addressed demand over and above the baseload.



Problem Solving 101 - Context

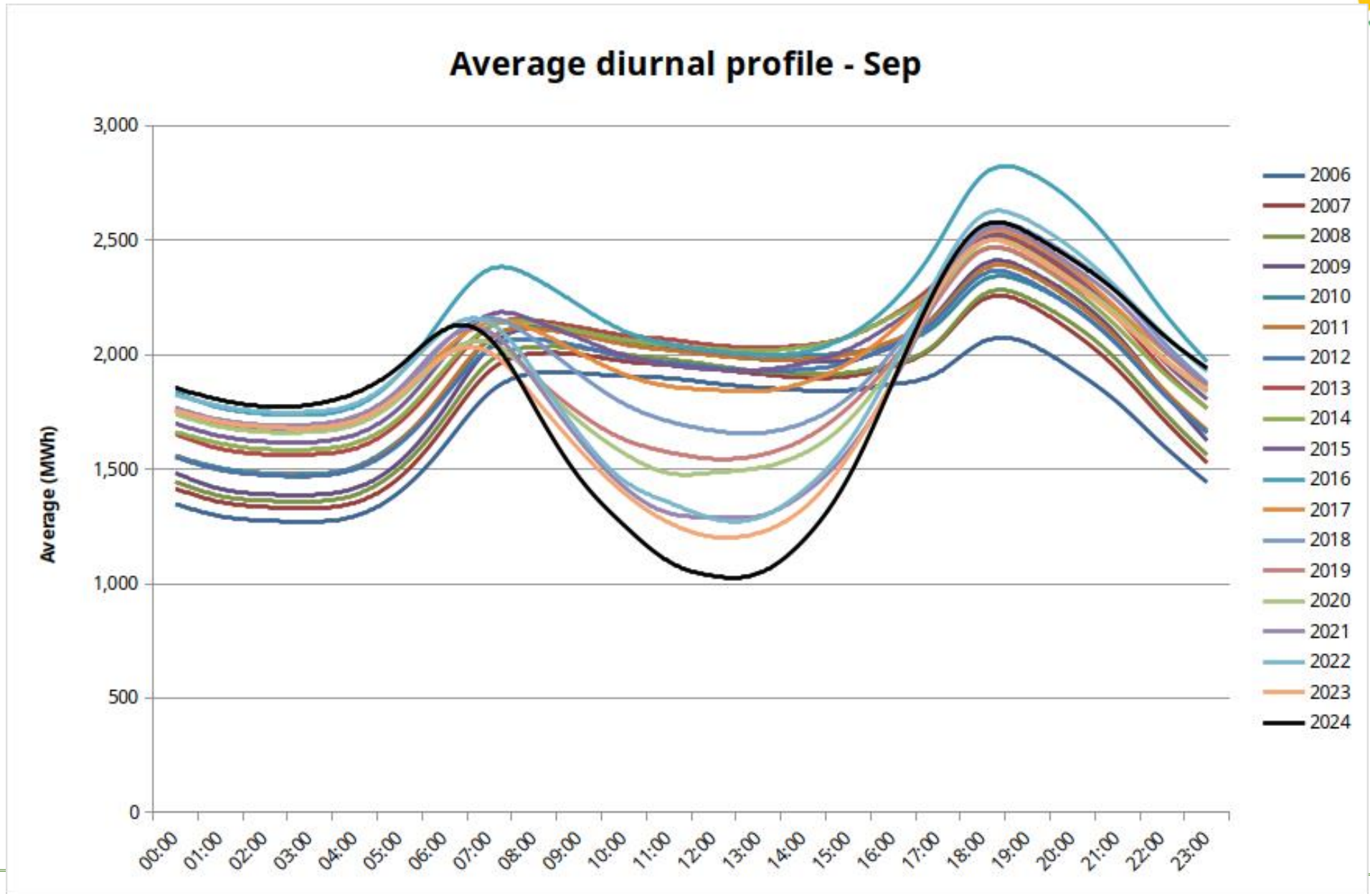


renewable records continue to fall … reaching a new high of 84 per cent in the 1030-1100 interval on Monday, December 12

84% renewables, with 59% from rooftop solar 19.5% from wind and 5.5% from large scale solar.

Not surprisingly the balancing price was negative for most of the daylight hours.

Problem Solving 101 - Context



Animated Operational Envelope [duck_annual.avi]

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Solution Set

Solution Set

Power Generation Technologies	Energy Trilemma			Other Considerations			
	Security	Cost	Enviro Impact	Public Support	Policy Support	Lobby Support	Time to deploy
Fossil Fuels							
Coal, Oil, Gas, Diesel							
Nuclear							
Various							
Renewables							
WA context - Rooftop Solar, Utility Solar, Wind (onshore, offshore), Battery Storage							

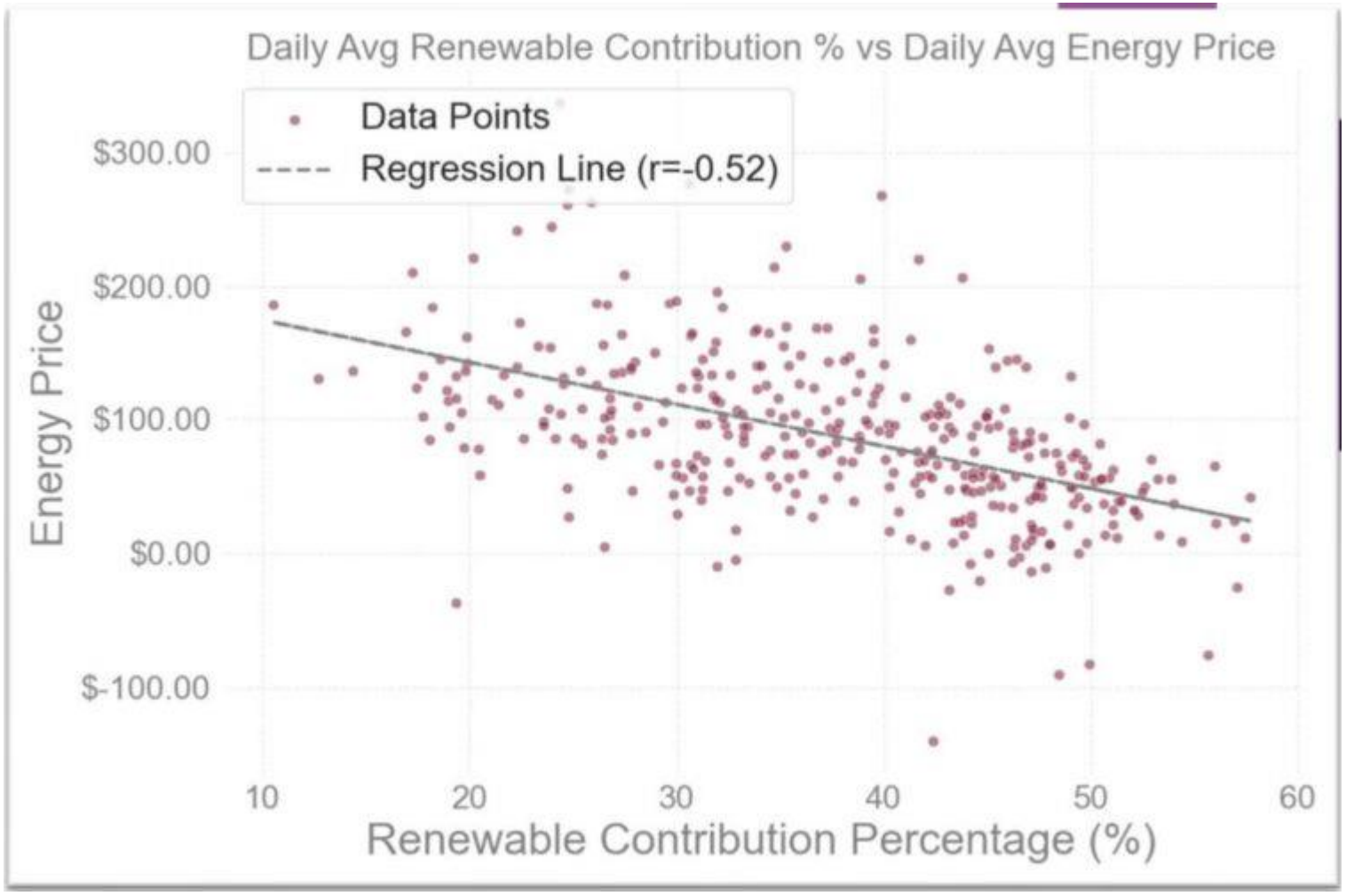
The role of batteries will continue to grow, with more than 2000 megawatts of capacity expected to be installed by the end of 2026.

Solution Set – WA Renewables Application Area

Renewable Energy Systems / Application	Roof top solar	Behind the meter battery	EV / VTG	Main Grid connected	Diesel / Gas Back-up	Large Scale Solar	Wind Turbine Generator	Large Scale Battery
Domestic	✓	✓	✓	✓				
Commercial / Industrial	✓	✓	✓	✓				
Rural property, small community	✓	✓	✓	N/A	✓		?	?
Remote mine site				N/A	✓	✓	✓	✓
Regional town	✓	✓	✓	?	✓	✓	✓	✓
Large grid (SWIS, NWIS)	✓	✓	✓	N/A	✓	✓	✓	✓

Renewables and WEM Prices

Higher contributions of RE result in lower wholesale electricity prices

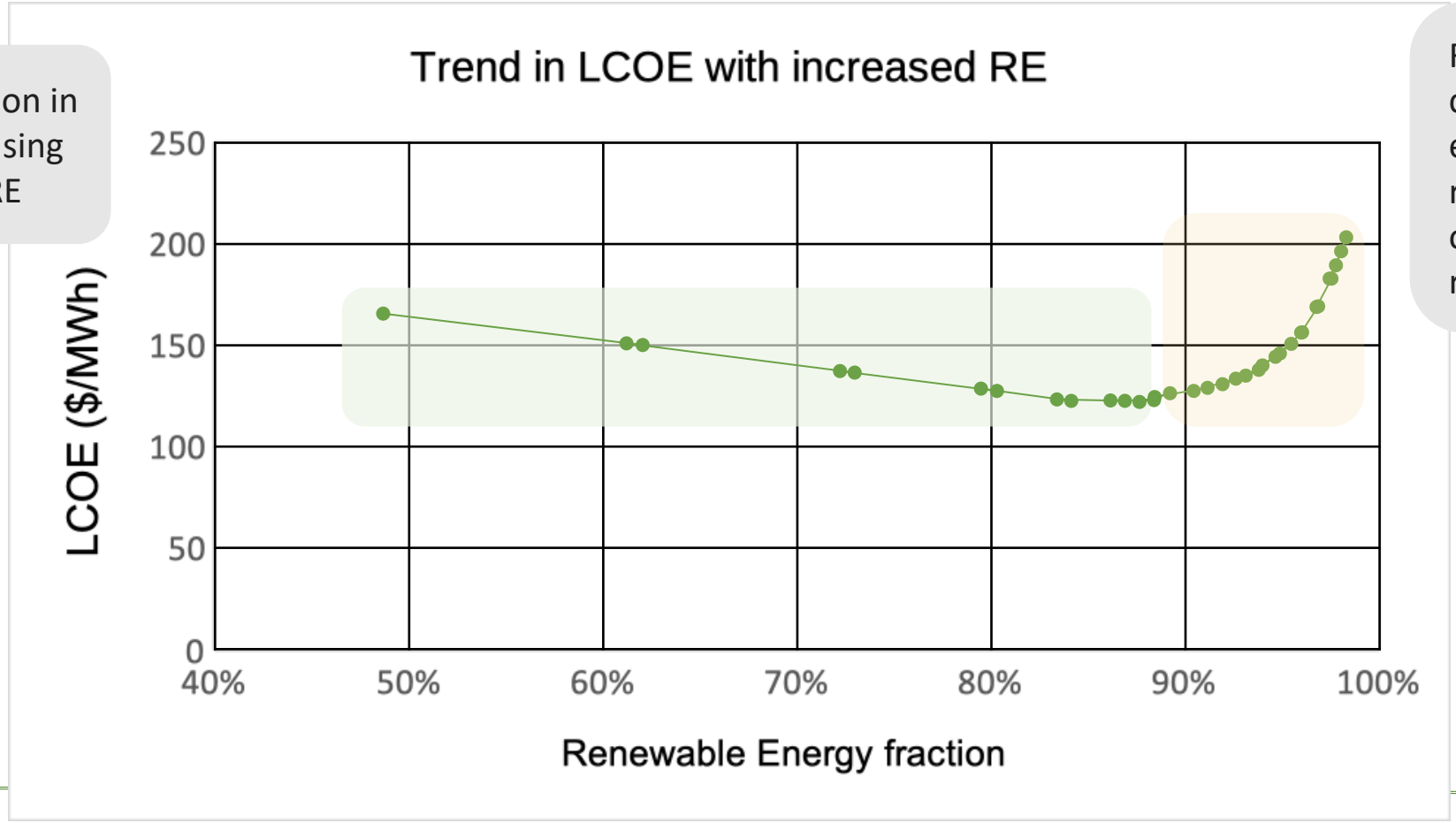


Source: AEMO

System LCOE with increasing RE

Current circumstances and limitations in technology have determined a ‘sweet spot’ in Variable Renewable Energy contribution

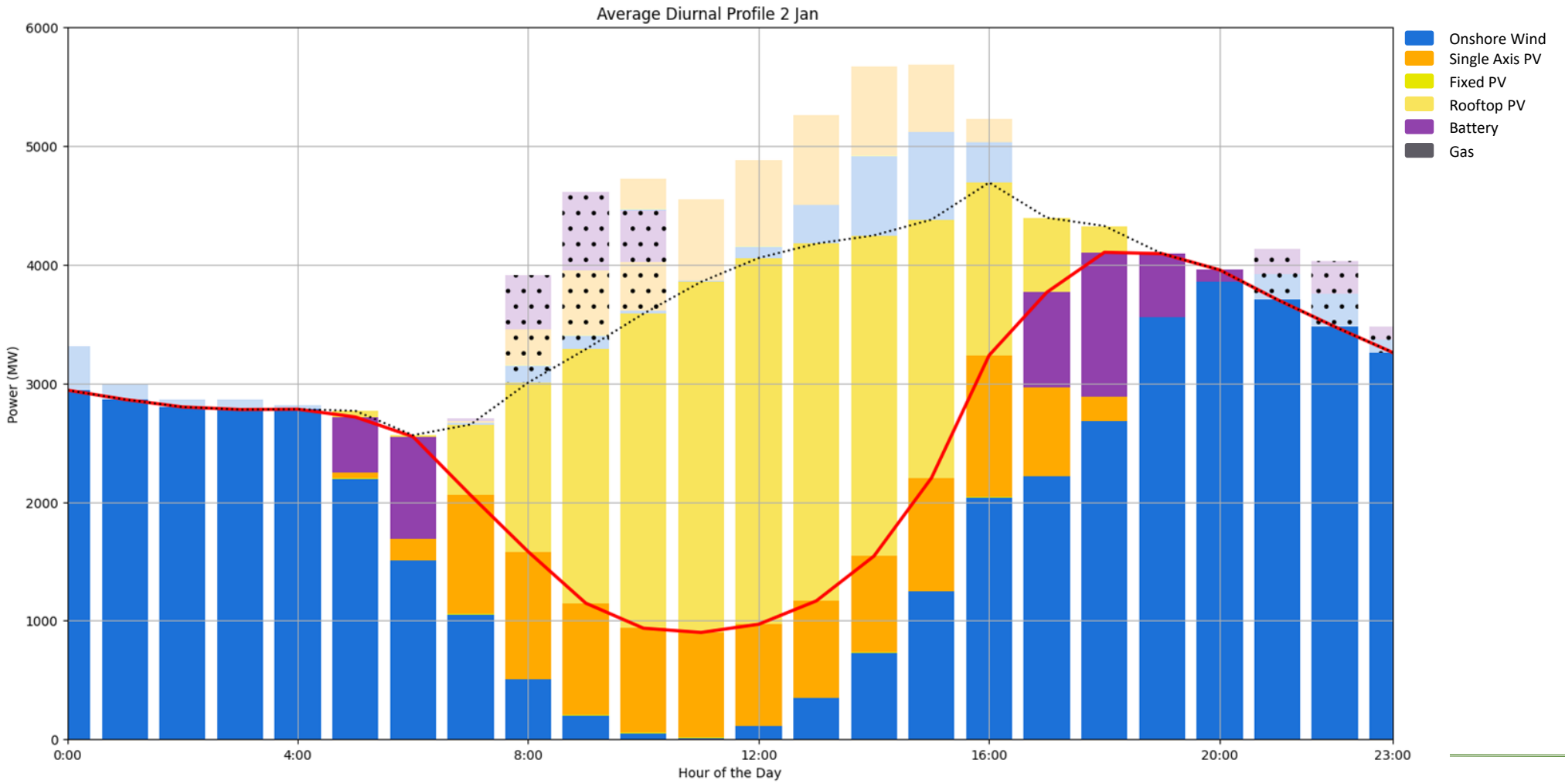
Expected reduction in LCOE with increasing contribution of RE



Remaining ~10% of RE contribution is expensive as it requires extensive overbuild with limited return

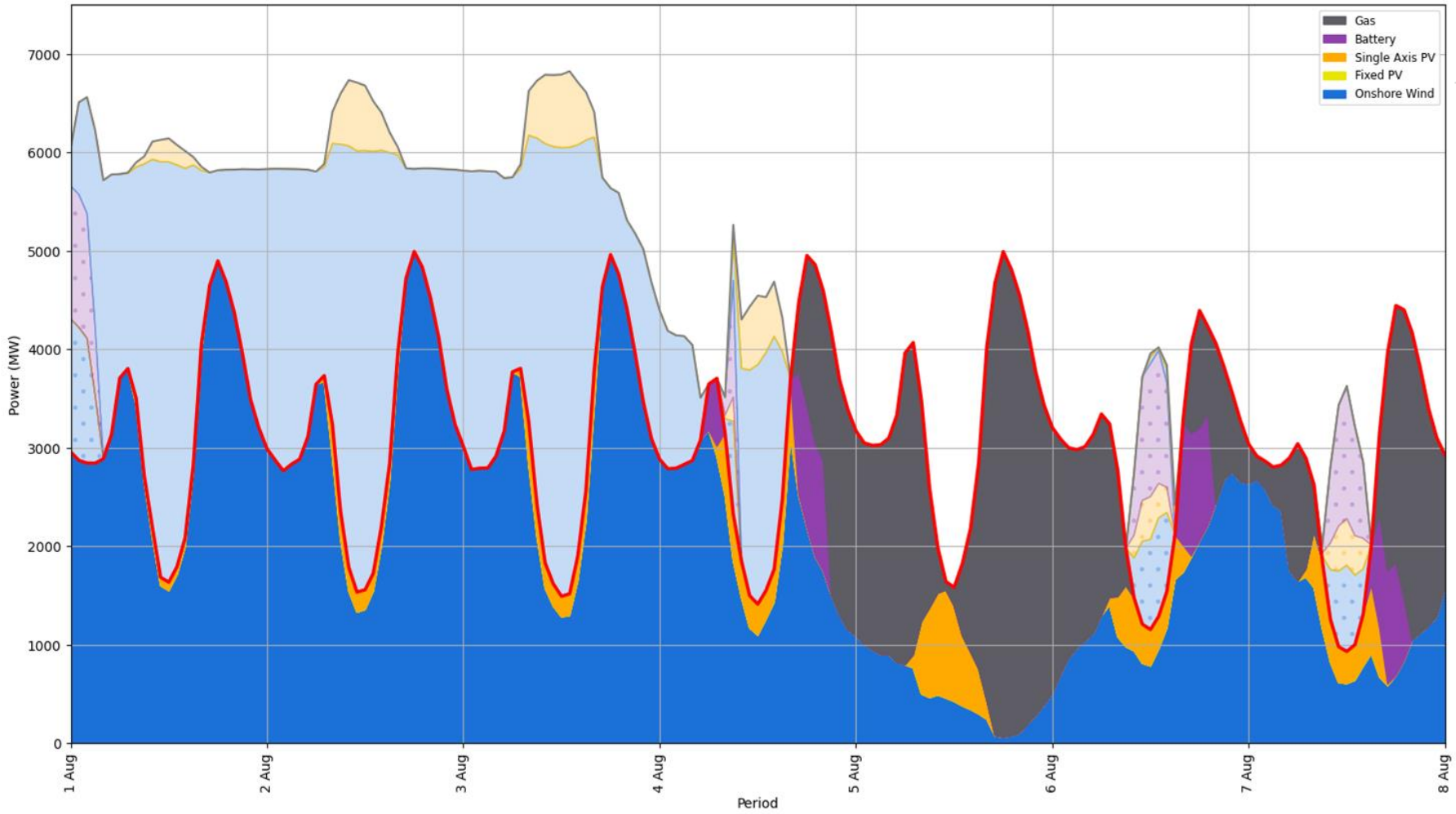
One day in summer: 2nd January

Sufficient wind and PV to meet load profile on this day in Summer



Dunkelflaute winter week forecast: 1-8th Aug 2029

Seasonal variations necessitate gas for short periods of time to meet load



Onshore Wind
Single Axis PV
Fixed PV
Rooftop PV
Battery
Gas

Consider inter-seasonal, inter-annual and inter-decadal weather patterns when selecting and sizing LDES

SEN modelling - SIREN

Nuclear Power: A WA Option?

- Robust 1950s technology with a poor track record of cost and schedule delivery in Western countries
- Stiff public opposition + nuclear bans
- Baseload generator – inflexible wrt dominant rooftop solar and energy model requirements
- Large scale renewables requires large scale back-up
- Rising demand and rapid deployment required
- Wholesale Energy Market (WEM) operation and investor risk
- Push up energy prices
- Emissions reduction delay
- Not a timely solution

SEN submission to the parliamentary inquiry (#073) + witness statement

Role of Gas in the Energy Transition What may change?

- Everything and rapidly
- WA government policy on transmission investment unlocking more utility scale renewables
- More customer owned energy resources in the energy mix – e.g. rooftop solar and behind the meter storage, including in the commercial and industrial sector. Democratise energy and optimise large scale investment, including taxpayer investment
- Battery chemistry, performance and cost all continue to improve – reduces the need for fossil gas still further
- Other technologies mature and deployable at scale – again reducing gas usage. No one single 'silver bullet' technology

Potential Technologies: Energy efficiency, Demand Side Management (DSM), Customer Energy Resources optimisation, Improved / New battery storage, Virtual Power Plants, Offshore Wind, Rooftop solar inverter control and management, Vehicle to Grid, Pumped Hydro Energy Storage, Hydropower. Thermal storage – heat transfer, Thermal storage – power generation, Geothermal, Bio-gas, bio-fuels, multi-sector fuels, Wave and tidal energy, Compressed air storage, Liquid air storage, Concentrated Solar Power, Gravity storage (very unlikely), Hydrogen (unlikely)

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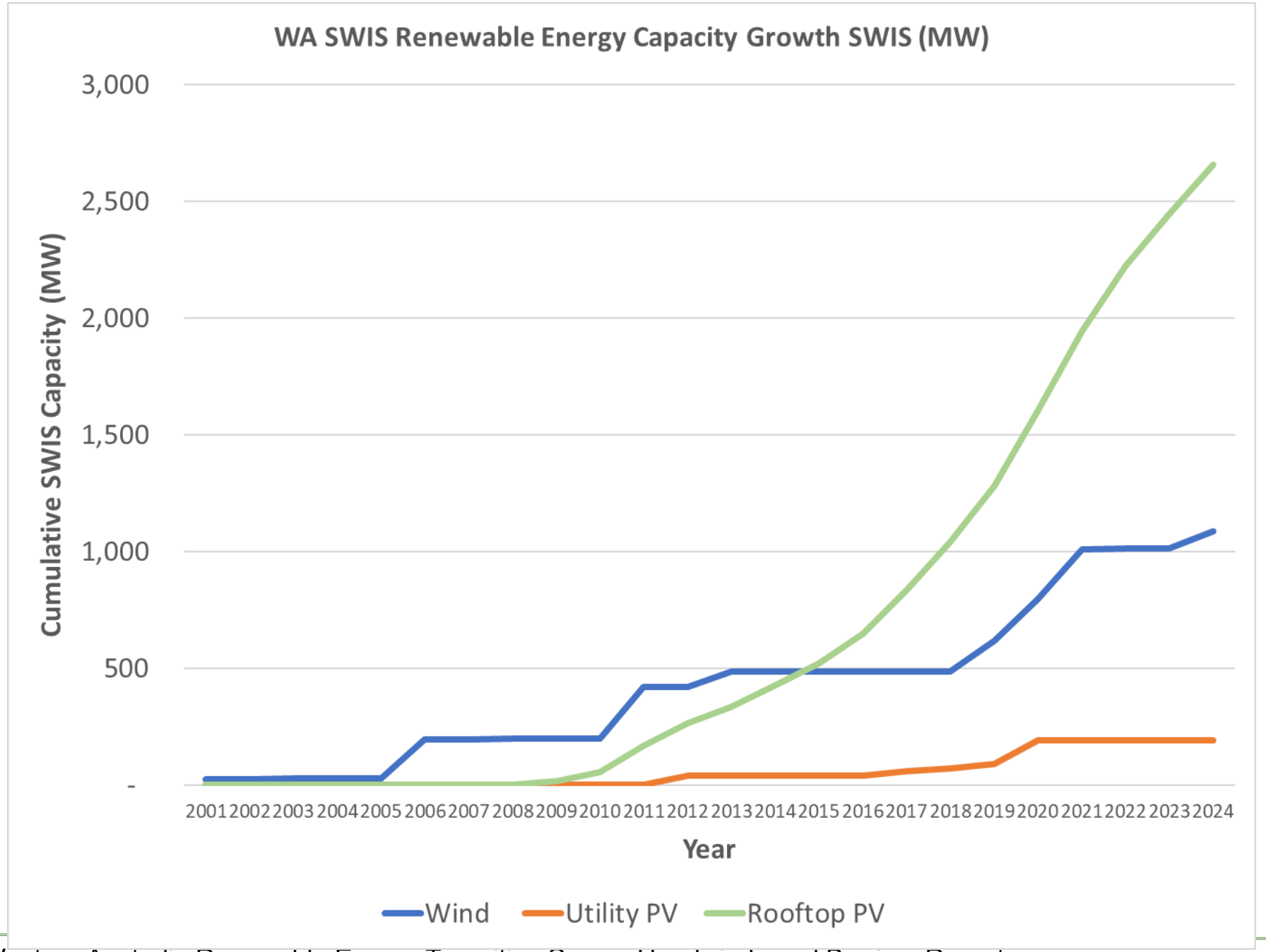
Headwinds and Barriers

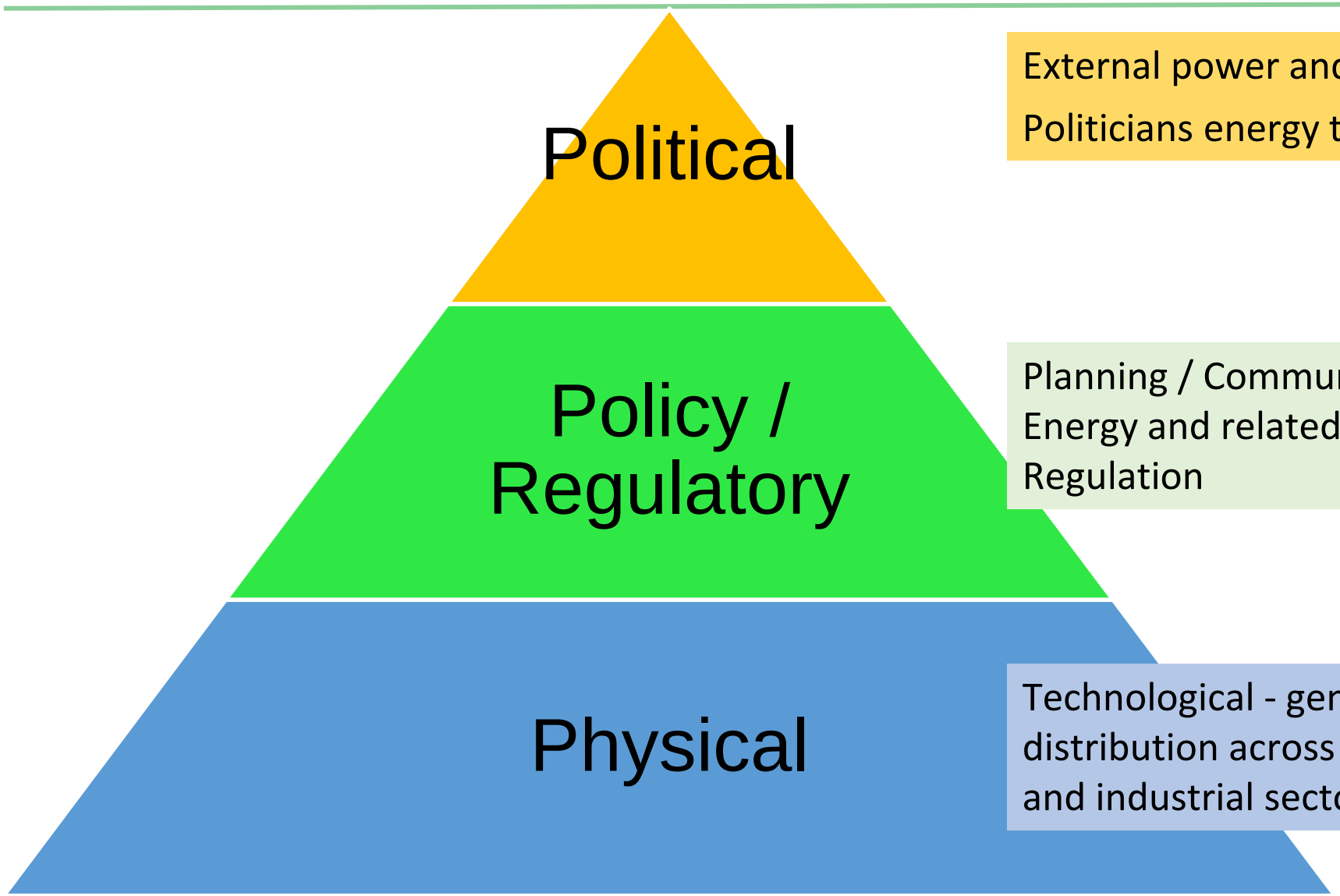
Headwinds for the Clean Energy Transition

Overcoming headwinds requires a concerted effort

- Resistance from vested interests, media, bad faith actors, politics of power, ‘state capture’
- Building the new quickly before the old falls over - wind and solar projects are stalling
- **Leadership and** clearly communicated **vision** with hard state legislated targets
- **Transition authority** required to plan, coordinate and accelerate the clean energy transition with accountability, risk and governance, oversight
- **Policy and regulation certainty** required especially around funding and building common user infrastructure for coal exit and RE generation hubs – **investor confidence**
- **Detailed plans** and on-going planning and coordination required
- Major customer network **connection delays**
- **Network capacity constraints**, curtailment and low capacity factors
- **Permitting and approvals** hurdles: EPBC long and arduous process


WA SWIS Renewable Energy Capacity Growth SWIS (MW)
Cumulative SWIS Capacity (MW)
3,000
2,500
2,000
1,500
1,000
500
-
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024
Year
Wind
Utility PV
Rooftop PV

Simplified 3Ps Energy Advocacy Model



External power and influence

Politicians energy trilemma

Planning / Community engagement

Energy and related services markets

Regulation

Technological - generation, transmission, distribution across domestic, commercial and industrial sectors

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Making Renewables Work

Making Weather Variable Renewables Work

- Renewables are weather variable rather than “intermittent”
- Weather can be forecast and weather variations managed: minute-to-minute, daily, seasonal, inter-annual, inter-decadal
- Power systems design needs to manage variability and volatility inherent in VRE - the power system needs more flexibility
- Power systems changes from demand following to supply following
- Energy (and capacity) markets modified to manage variability and nature of RE generation and battery storage
- Technology and innovation is an unstoppable force for change – customer energy resources
- Government commitment and communications
- Politics (of power) and policy will:
  - Govern the speed of change
  - Influence technology pathways
  - Decide winners and losers

What is SEN Advocating For?

- Summarised in a recommendations letter to decision makers in Sep'24

Thank You

Q & A