

Advocating the Energy Transition:

2023 SWIS Modelling Results & Policy Implications

9th October 2023

"We'll go down in history as the first society that wouldn't save itself because it wasn't cost effective."
- Kurt Vonnegut.

Acknowledgement of country

Acknowledge all the SEN volunteers contributing thousands of unpaid hours to advance the cause

Acknowledgement of Country

We acknowledge the traditional custodians of the land (Boodja) we are meeting on, the Whadjuk people.

We acknowledge and respect their continuing culture and the contribution they make to the life of Perth and regionally in Western Australia.

We recognise elders past and present.

Sovereignty has never been ceded. It **always was** and **always will be**, Aboriginal land.



- Traditional owners have a very different way of looking at the world – seeking to understand the relationships within nature.
- Prevailing western culture deconstructs the world in order to grasp and manipulate it to our will and benefit.
- Interestingly these align with different attributes of the right and left brain hemispheres respectively
- So as we go about our work at SEN we need to stop and consider a much wider frame for the meta-crisis (**Daniel Schmachtenberger**) we find ourselves in, else we will stumble from one crisis to another caused by the solution to the last crisis.

Agenda

1. About SEN and SEN 2.0
2. How does SEN advocate for change?
3. What does SEN's modelling suggest about the energy mix on the **South West Interconnected System (SWIS)**?
4. Headwinds for the Clean Energy Transition
5. Questions and *how can we work together?*



- We'd like to give you a quick update on SEN and SEN 2.0 our organisational change process started last year
- Advocating for change is more than communicating facts and information in the mistaken belief that these will by themselves bring about change - we need to work with other organisations like yourselves
- SEN's Dr Emily Pereira will present a summary of the most recent modelling - updated to reflect the latest EPWA and AEMO data
- Like transitions around the world the clean energy transition is facing a number of challenges, to be expected given the scale and the context of the transition - we will outline some of those we consider most important in WA
- And finally questions at the end - we would appreciate that you hold any questions to the end of the talk and we will be prioritising questions from environmental NGOs



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About SEN

About SEN

What is our mission and what do we do?

- Grassroots NFP, individual member-based advocacy group promoting ***Sustainable Energy Now!***
- 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 promote practical, affordable strategies for the adoption of renewable energy toward a sustainable global future.
- We provide presentations, submissions and briefings to government agencies, corporations, media, schools, community groups, politicians and hold public events.



- We are a grassroots not-for-profit member based advocacy group promoting Sustainable Energy Now!
- Supported by the best science and our own modelling and simulation, we advocate on how Western Australia can make a swift and orderly transition to clean renewable electricity safely, reliably, and affordably with commercially proven technologies. **WE HAVE NO COMMERCIAL INTERESTS.**
- Our 2030 vision is to phase out the majority of fossil fuel-based energy sources in WA and transition towards 100% renewables for power generation and to enable the grid to decarbonise other sectors including transport, industry, commercial and domestic.
- Our mission is to model and promote practical, affordable strategies for the adoption of renewable energy toward a sustainable global future.
- We provide presentations, submissions and briefings to government agencies, corporations, media, schools, community groups, politicians and hold public events.

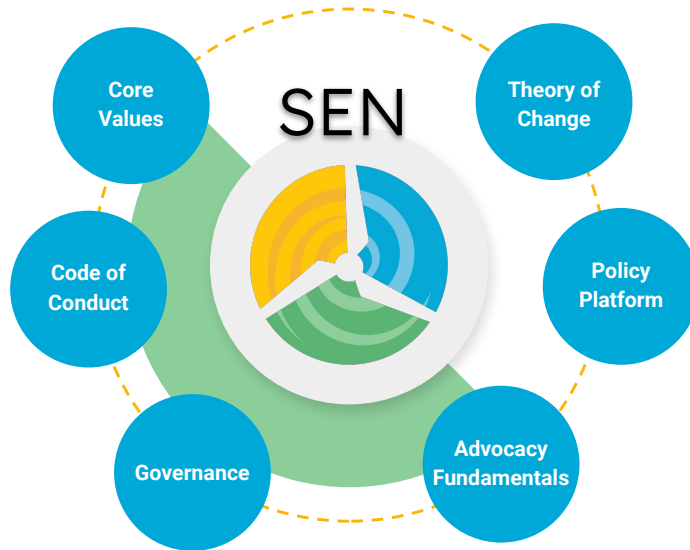
Our Management Committee



- Change in our operational context drove the need for additional diversity in our management committee with people from a range of disciplines, genders and cultural background
- Develop organisation to be a more effective advocate not just technical expertise

SEN 2.0

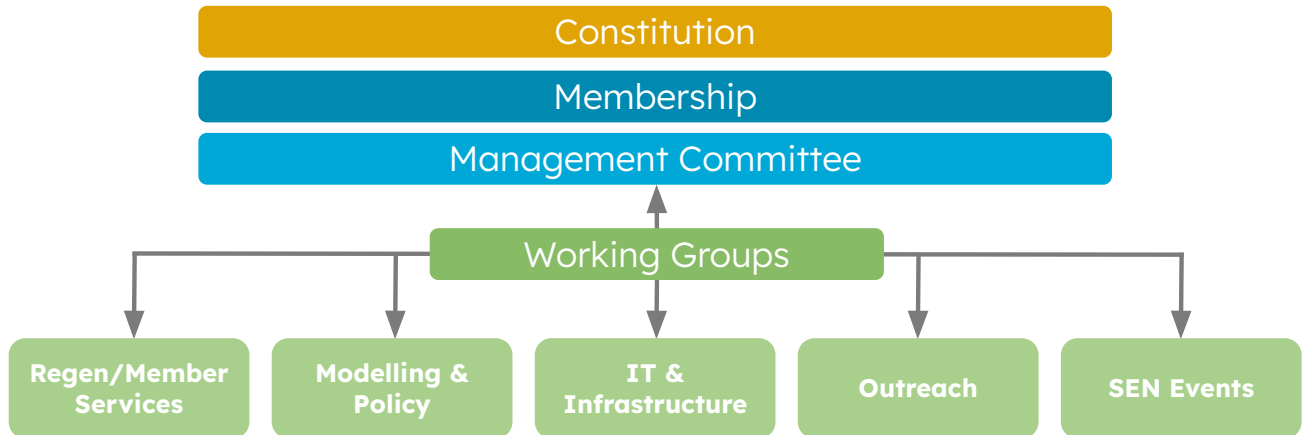
SEN has professionalised as an organisation to better advocate for change



- SEN 2.0 is our organisational change process to professionalise and develop organisation to be a more effective advocate not just our traditional technical expertise
- Key aspect driving the organisation is the development of a robust theory of change tailored to our operational context here in WA, the Captured State as 350.org and others have illustrated over the years

SEN's Organisational Structure

The Committee and Working Groups collaborate to work in line with the organisation's Constitution and working group mandates



- Similar to most incorporated associations we have a governance structure consisting of constitution, membership, and a management committee to serve the membership
- We've organised ourselves loosely into working groups to better advance our objectives - – important for volunteers to find a home a contribute

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How does SEN advocate for change?

Navigating the Energy Transition

A successful way forward is actively engaging politics and policy

- Incumbents have a **stranglehold** on energy policy and **their interests are not aligned** to a **viable future**
- Current public conversations have a socio-technical focus and are missing the importance of power and politics
- WA net zero 2050 policy, Sectoral Emission Reduction Strategies, SWIS Demand Assessment, Perdaman Urea
- Technology is here right now! – solar, wind, batteries, LDES, communications, software - Lowest LCOE pathway
- Technology integration, policy, system planning and market regulation are key - not new technology - CCS, Direct Air Capture, hydrogen etc are planned distractions whilst nuclear power is party politics
- Leadership and investment needed for once in a lifetime transition

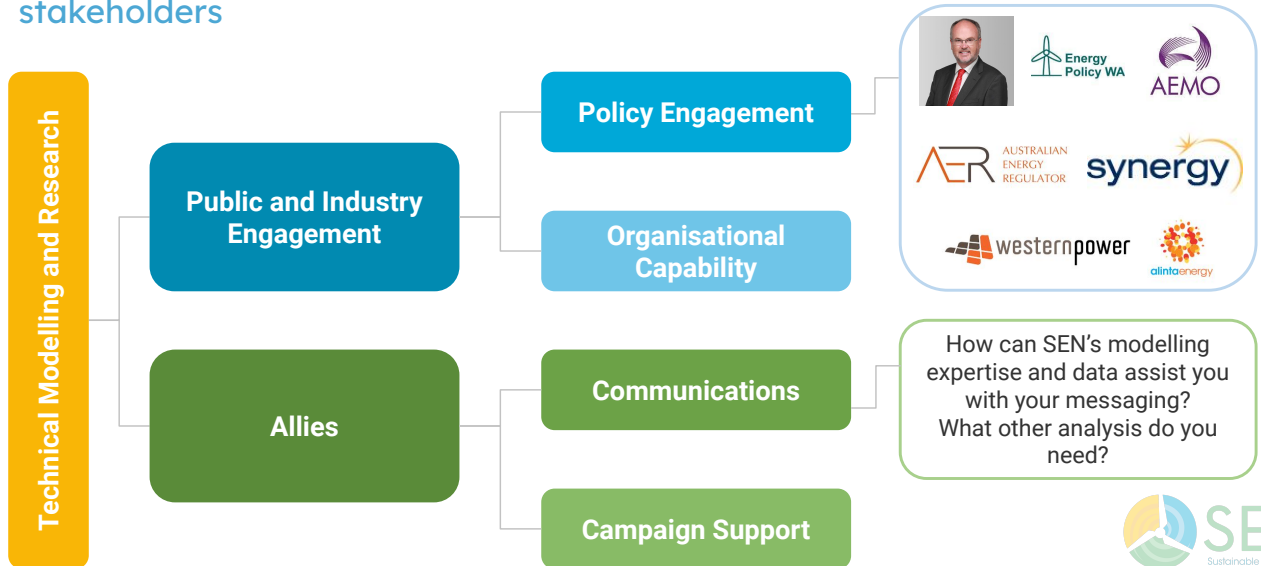


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- Energy tightly bound to economics, jobs and growth, rise and fall of empires, core to our modern lifestyle, controlled nominally by government – however Incumbents have a stranglehold on energy policy and their interests are not aligned to a viable future
- Governments around the world have the same objectives: energy security; energy costs; emissions reduction / environmental impacts
- Current public conversations have a socio-technical focus and are missing the importance of power and politics
- Series of mixed messaging - WA state net zero 2050 policy (Nov'21), Sectoral Emission Reduction Strategies whilst at the same time sanctioning the Pedaman Urea plan The facility will generate around 200 million tonnes (MtCO₂e) of greenhouse gas emissions over its lifetime including Scope 3 emissions. This is about the same as the total cumulative emissions savings from all facilities under the Australian Government's proposed reforms to the Safeguard Mechanism by 2030.
- Technology is here right now! – solar, wind, batteries, LDES, communications, software - Lowest LCOE pathway as recognised in government planning and independent agencies
- Technology integration, policy, system planning and market regulation are key - not new technology (CCS, Direct Air Capture, hydrogen etc are planned distractions) whilst talk of nuclear power is party politics
- Investment needed for once in a lifetime transition

How SEN advocates for change

SEN's modelling expertise facilitates engagement with some key policy stakeholders



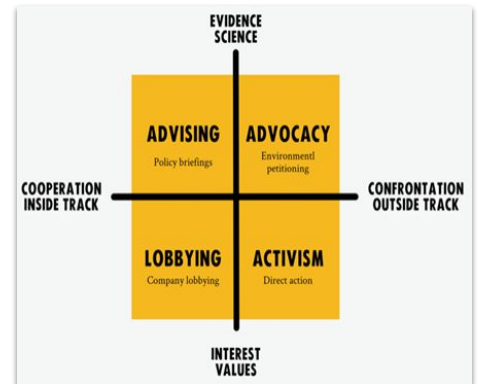
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- SEN's technical research and techno-economic modelling forms the basis for our public and industry engagement, policy engagement and organisational capability
- Allies, along with theory of change, credible alternatives and campaigns are key to effective advocacy and something we are keen to develop – hence tonight's meeting.
- During Emily's presentation we would like to hold some questions in mind:
 - How can SEN's modelling expertise and data assist you with your messaging?
 - What other analysis do you need to support your campaign?

Civil society advocacy

Influencing and changing governmental policy comes about with changing public opinion

- Ability to influence and galvanise public opinion – political power
- Robust alternative solution – modelling and reports
- Recognised / professional / credible
- Well developed theory of change
- Stakeholder relationships (mutual respect, listening, understanding, trust, ability to compromise)

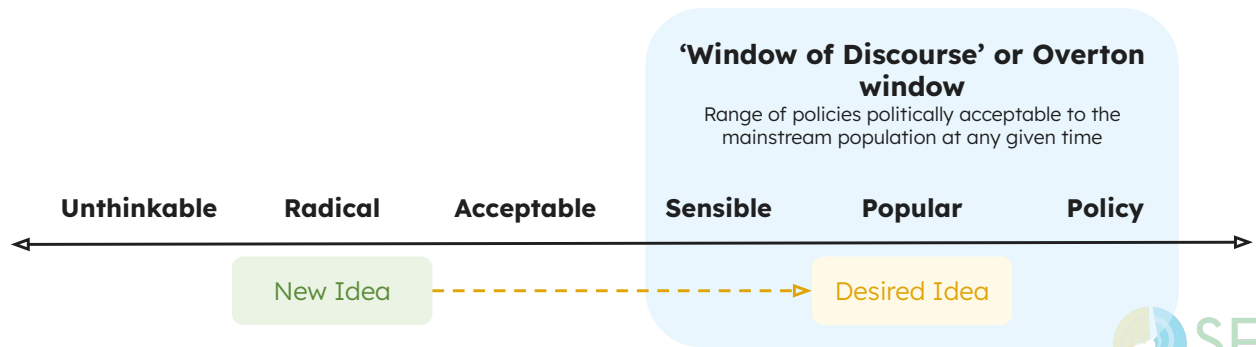


- Influencing and changing governmental policy comes about with changing public opinion – we seek to influence both policy makers and public opinion – the latter once galvanised has significant political power.
- We're an advocate – sit outside the fence and use evidence and science to support our argument
- We're not activists – we count activists as allies and recognise the need for non-violent demonstrations and other activist tactics to help bring about change
- We are NOT lobbyists – we are renewable technology agnostic and not promoting any one solution – all solutions need to be practical and scalable
- As an advocate you're OUTSIDE the fence and people are NOT always interested in what you've got to say – "enlightenment trap" that facts and information will bring about policy change
- Advocates need to have a number of attributes:
 - Robust alternative solution – modelling and reports
 - Recognised / professional / credible
 - Well developed theory of change
 - Stakeholder relationships (mutual respect, listening, understanding, trust, ability to compromise)
 - Allies

Civil society advocacy works

Change comes slowly from steadily applied pressure, then suddenly

- The adoption of previously unconventional ideas comes about with steadily applied pressure
- Promotion of RE from “8% maximum” to 95-100% “Unthinkable”



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SEN 2023 modelling on the WA South West Interconnected System - SWIS

Presented by Dr Emily Pereira with acknowledgement to all SEN volunteers who contributed to the 2023 modelling including Len Bunn, Rob Phillips, Angus (Gus) King, Paul Caston and others

- Emily is a medical doctor who has worked across multiple health services across WA.
- Emily is committed to supporting a cleaner energy future, particularly given the health impacts of climate-related extreme events.
- She is eager to carry the skills she has developed as a health professional and in her prior volunteering endeavours to become an effective advocate for productive change towards sustainable energy in WA.
- SEN values diversity and Emily has brought fresh ideas to SEN since joining in early August this year
- Hats off to Emily for taking on the task of presenting the SEN modelling data – Emily has immersed herself in the details in order to provide a pithy summary and increase the clarity of understanding for the audience – please welcome Emily.

Key Terminology

Electrical Power



Rate at which electrical energy is used or produced at any one time

Units: Joule/sec or Watt (kW, MW, GW)

Electrical Energy



Amount of electricity power used or delivered over time

Units: kWh, MWh, GWh, TWh

Battery Storage



Expressed in **power delivered** at any moment/**how long** that power can be delivered

E.g. 100MW 4 hr battery written as 100 MW/400 MWh

- Battery storage is expressed in both the power delivered at any one time, and how long that power can be delivered for. For example a 100MW 4 hour battery, can deliver 100MW at any time, for a duration of 4 hours and is expressed as 100MW/400MWh

Levelised Cost of Energy

LCOE is a metric to compare relative costs of generation technologies

Levelised Cost of Energy
(\$/MWh)



Calculated as the average total **cost of building and operating** the asset **per unit of total electricity generated over an assumed lifetime.**

SEN's LCOE based on CAPEX and OPEX from CSIRO's GenCost 2022-23.



Used to assess **investment feasibility** → the cost per MWh to be recovered for a new electricity generation investment to break even.

Renewable Energy Integration Costs will be addressed later in the presentation.



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- LCOE is a widely accepted metric to understand the **relative** costs of energy from **different generation technologies**
 - When we talk about energy in this context, we refer specifically to electrical energy
- CSIRO and AEMO (Australian Energy Market Operator) collaborate to produce an annual report on the projected cost of electricity generation in Australia
- LCOE informs relative investment feasibility

The NWIS and SWIS

WA's networks are isolated and unable to benefit from energy from other States including their long duration electricity storage

North-West
Interconnected
System

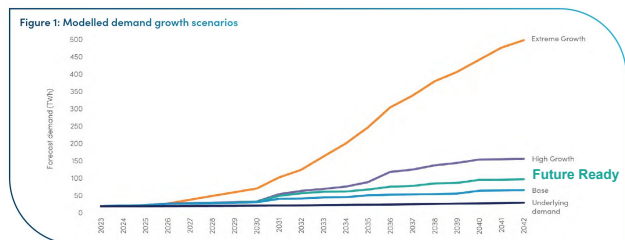
South-West
Interconnected
System



- These networks are isolated from those in other states, and also not connected to each other
- These networks are unable to benefit from energy from other states including their long duration electricity storage

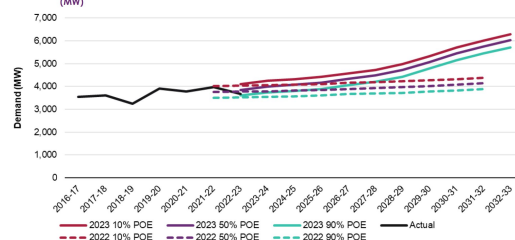
Modelling of the SWIS

Future demand scenarios have been modelled by Energy Policy WA (SWIS Demand Assessment) and Australian Energy Market Operator (AEMO)



- **SWIS Demand Assessment** developed by Energy Policy WA, published May 2023
- Four demand scenarios constructed with focus on the **Future Ready** load growth scenario
- SWIS DA's modelled up 2042

Figure 23 Actual and 10%, 50%, and 90% POE peak demand forecasts, expected scenario, 2016-17 to 2032-33 (MW)

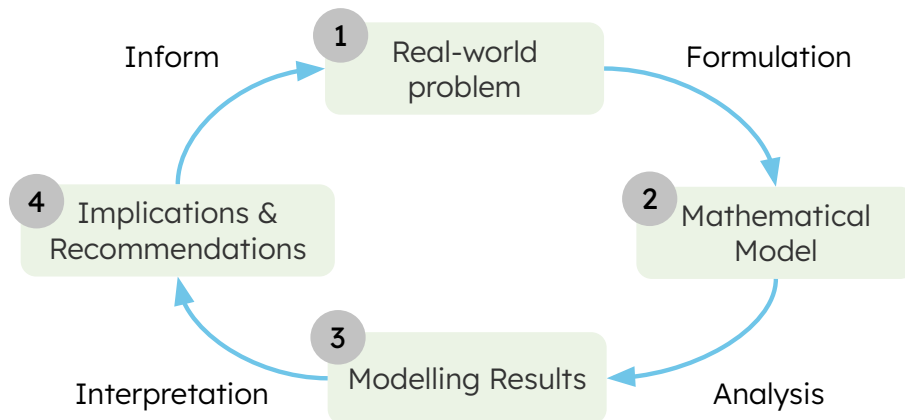


- **AEMO ES00** (Electricity Statement of Opportunities) modelled to 2032
- SEN's modelling is for all coal exit up to 2029 using AEMO's demand forecast - Expected Case



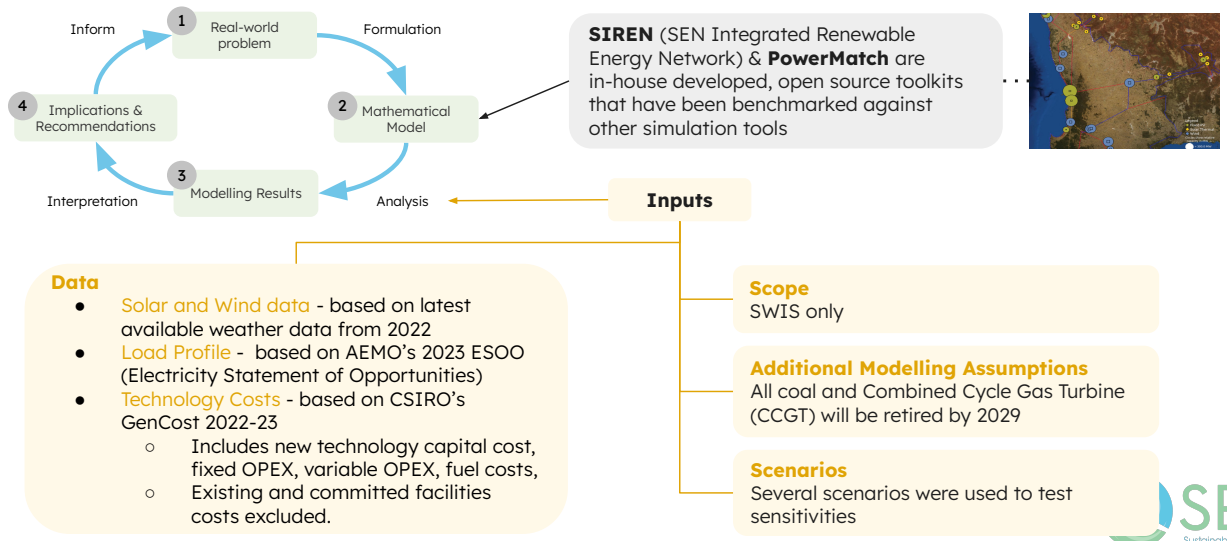
SEN's modelling methodology

SEN uses its in-house modelling software, SIREN and PowerMatch



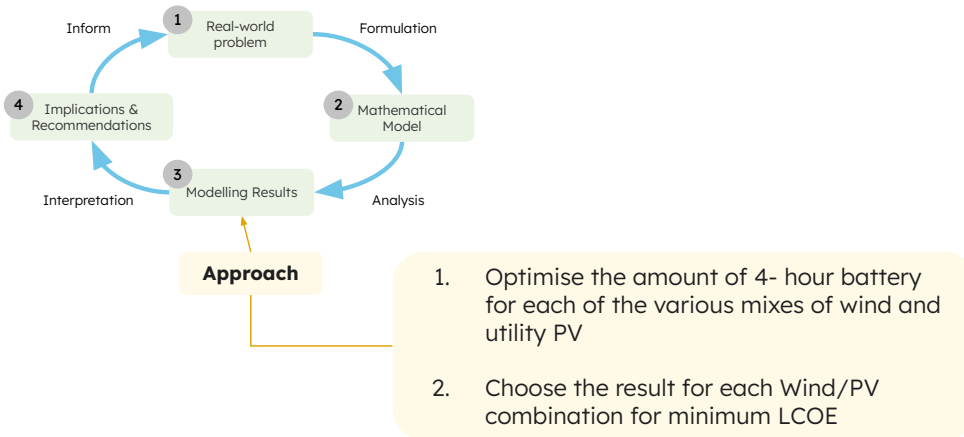
SEN's Energy Modelling Methodology

SEN uses its in-house modelling software, SIREN and PowerMatch



SEN's modelling methodology

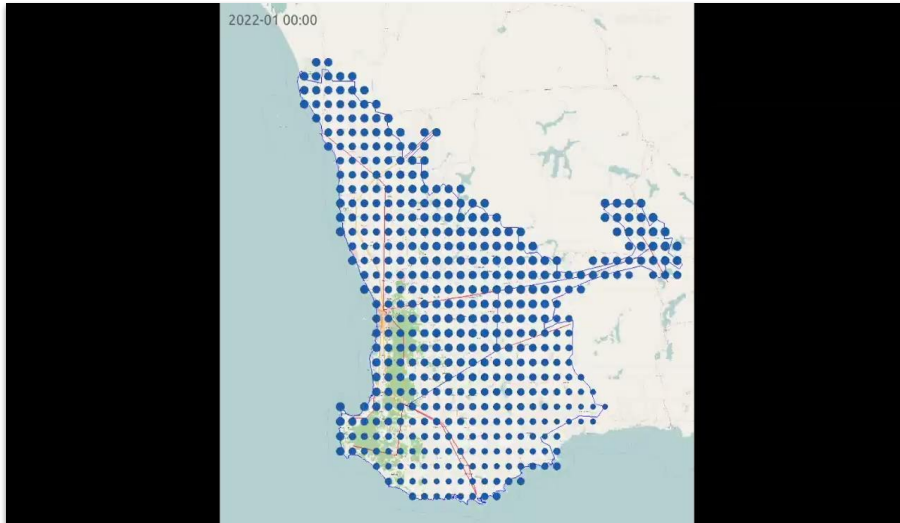
SEN uses its in-house modelling software, SIREN and PowerMatch



- 4 hours chosen as that is what Synergy is building

Wind Variability across SWIS & Seasons

Low geographical variability in inland wind means wind farm locations can be flexible hence reduce network infrastructure costs



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- **Hour to hour wind power generation across the SWIS averaged over one day** for each month in 2022
- Size of the circles reflects wind power generation
- Low geographical variability in inland wind means flexibility in where wind farms are located - this could mitigate significant infrastructure costs for building transmission lines

Key questions for Energy Modelling

1

Is increasing contribution of variable renewable energy (VRE) use economically attractive for the SWIS?

2

How sensitive is investment feasibility to the mix of VRE? Is there an 'optimal' combination of VRE?

3

Can we meet demand in the short to medium-term with VRE alone? Why or why not?

4

How effective is increasing VRE contribution in reducing carbon emissions?

Simplified Summary

Year modelled to: 2029

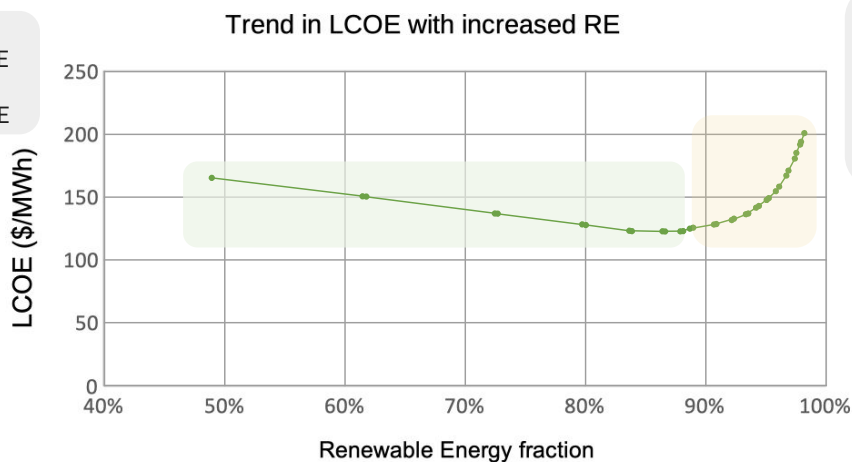
Peak demand (2029)	5.3 GW
Assumed existing OCGT capacity (2029)	1.8 GW
Announced new reciprocating gas generation capacity	3.9 GW
Total gas generation capacity (2029)	5.7 GW
Gas generation capacity required to meet peak demand	5.3 GW

Existing or committed battery storage	5.2 GWh
Existing VRE (2023) excluding rooftop	1.3 GW
New renewable energy capacity required	6.3 GW
RE contribution (annualised)	84%

Levelised Cost of Energy with increasing RE

Current circumstances and limitations in technology have determined a 'sweet spot' in VRE contribution

Expected reduction in LCOE with increasing contribution of RE



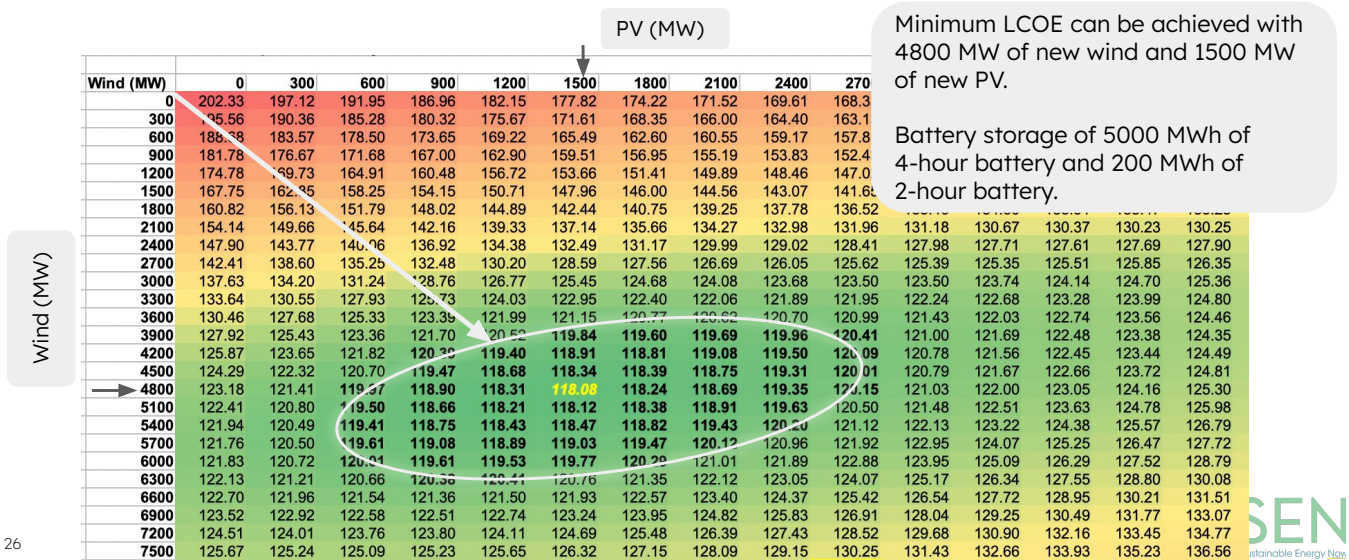
Remaining ~10% of RE contribution is expensive as it requires extensive overbuild with limited return



- Output from our modelling demonstrating LCOE with increasing fraction of renewable energy in our mix **for the best case scenario**
- Reduction in LCOE with increasing fraction of renewable energy
- Reason for this?
 - WA does not have access to inter-state interconnectors nor large amounts of long duration energy storage like pumped hydro
 - Additional infrastructure incur extensive overbuild with limited return
- Our common goal and objective is to reduce overall emissions whilst managing cost and security

LCOE across a range of Wind and PV mix

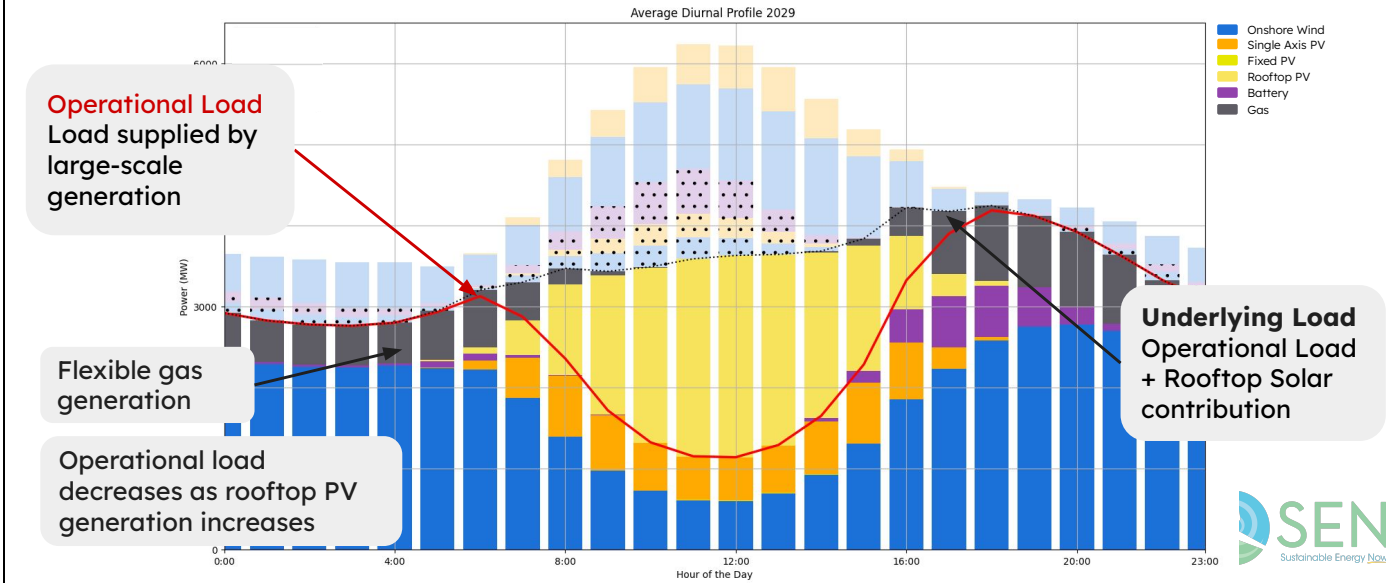
Significant flexibility in the mix of wind and solar



- Minimum LCOE across a **range of new** utility-scale solar and Wind, in addition to the projected growth of rooftop solar.
- Range of optimal solutions within 2% of the minimum LCOE which is shown in **BOLD**
- LCOE is relatively insensitive to total amount of wind and solar installed
- Can increase RE percentage without increase LCOE by much
- Flexibility and optionality for RE roll-out planning

Average Diurnal Profile for 2029

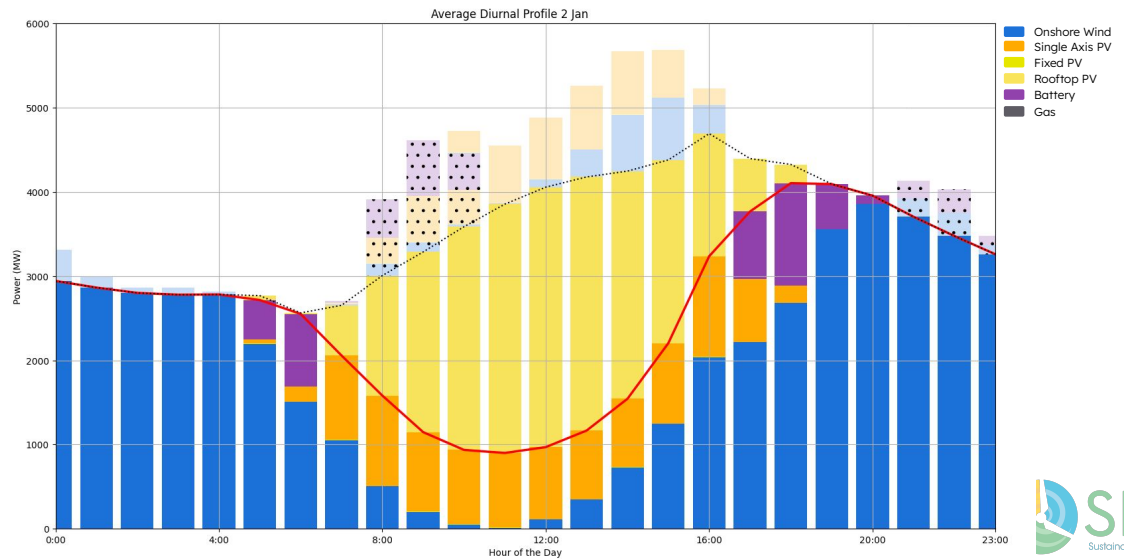
Variability of RE occasionally requires gas to meet load



- Certain hours in the day where gas is occasionally required to meet load

One day in summer: 2nd January

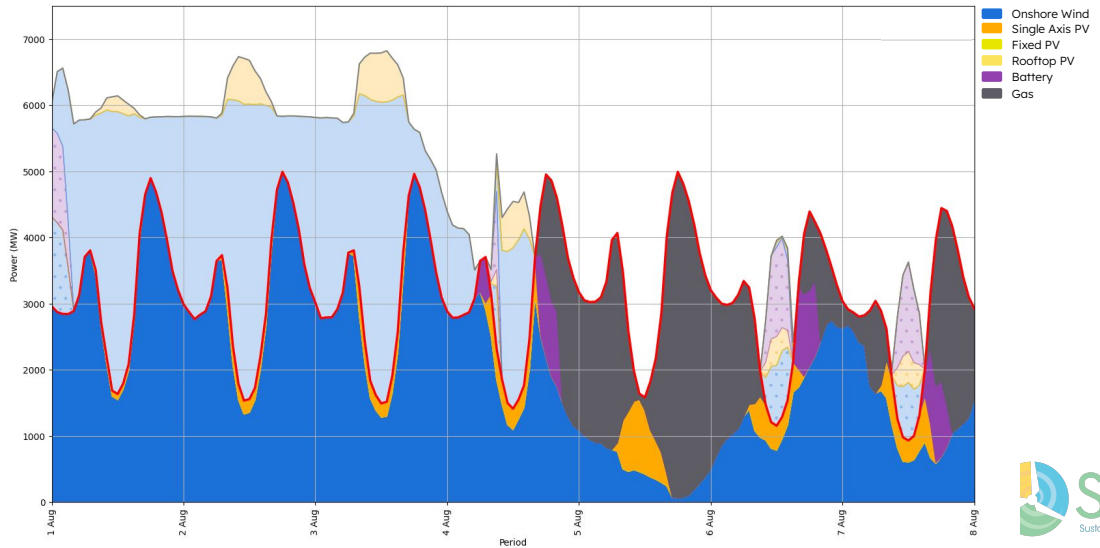
Sufficient wind and PV to meet load profile on this day in Summer



- Wind and solar is sufficient to meet load profile

Dunkelflaute winter week: 1st to 8th Aug

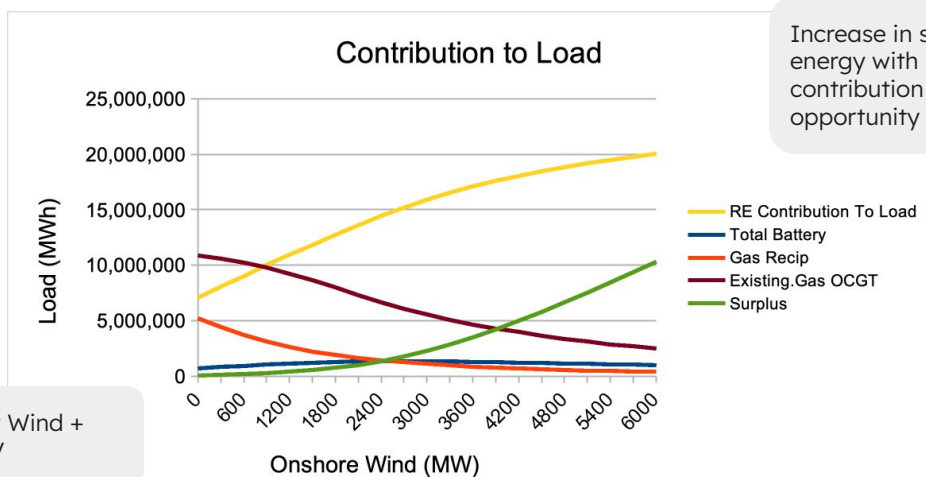
Seasonal variations necessitate gas for short periods of time to meet load



- This circumstance necessitates gas until other renewable energy sources are available

Energy Mix - Contribution to Load

Falling gas demand with increased RE contribution



Increase in surplus spilled energy with increasing RE contribution presents an opportunity

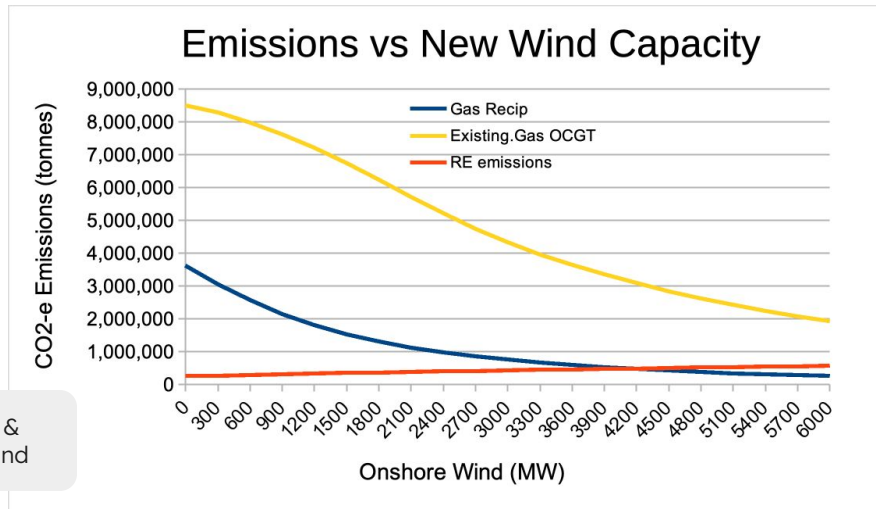
4800 MW of New Wind +
1500 MW New PV



- This combination of new wind and new PV is used as an example to demonstrate that with increased RE contribution, the demand for gas declines

Carbon emissions with increasing new wind

Falling emissions with reduced gas use and increased RE contribution



New PV 1500 MW &
Increasing new wind

- Relationship between carbon emissions with increasing new onshore wind in best case scenario

Reduced carbon emissions

Coal and Combined-Cycle Gas Turbine (CCGT) Exit

Nett 2020/21 (t CO2e)	Synergy	Other	Total	Percentage of total emissions 2020/21	Synergy	Other	
Coal	4,804,769	2,317,859	7,122,628	Coal	49.9%	24.1%	74% + 9.9% = 83.8%
CCGT	188,178	761,070	949,248	CCGT	2.0%	7.9%	
OCGT	850,856	706,322	1,557,178	OCGT	8.8%	7.3%	
Total	5,843,803	3,785,251	9,629,054	Total	61%	39%	

If all SWIS coal and CCGT is closed, this reduces 2020 emissions by 83.8%.

Phasing out coal-fired power means Synergy's carbon emissions will be reduced by 80 per cent by 2030, including a 40 per cent emissions reduction on the SWIS, compared to 2020-21 levels. WA State Government 14-Jun 2022

Renewable Energy Integration Costs

When including RE integration costs, still cheaper than viable alternatives

- LCOE is a widely accepted means of comparing technologies and complements capital cost estimates and business case development
- SEN's new wind and solar is not location-specific; transmission costs not included
- Typical transmission and frequency control costs from CSIRO's GenCost 2022-23:

LCOE (\$/MWh)	Current	Optimum
LCOE \$0 Carbon Price	\$202.33	\$118.08
Transmission	\$0.00	\$12.50
Frequency Control	\$0.00	\$2.00
LCOE Integrated	\$202.33	\$132.58
LCOE \$75 Carbon Price	\$249.43	\$129.13



- SEN's LCOE does not include transmission cost a:
 - Low geographical variability in RE, notably wind
 - SEN's data not location-specific, it is challenging to make assumptions re: RE hub locations and consequently the costs of transmission networks
- Even with inclusion of transmission costs, best case scenario LCOE is still attractive

What does this all mean?



Is increasing contribution of variable renewable energy (VRE) use economically attractive for the SWIS?

High contribution of RE is **feasible, practical and financially attractive**.

Surplus from RE overbuild is an opportunity and resource for industry innovation.



How sensitive is investment feasibility to the mix of VRE?

Several optimal solutions can be achieved with a range of new RE capacity and combinations.



Can we meet demand in the short to medium-term with VRE alone?

Long-duration energy storage (LDES) technologies remains important for addressing the final 10%. Gas is not a “transition fuel” nor a “partner” for renewables but rather a long duration energy source that we must manage during the transition.



How effective is increasing VRE contribution in reducing carbon emissions?

Gas used in decreasing amounts in the transition thus reducing emissions.



4

Headwinds for the Clean Energy Transition

Clean Energy Transition

SWIS Demand Assessment EPWA May 2023



New renewable generation hubs in the north, east and south of the SWIS:

1. *achieve a significantly** higher capacity factor than other areas; or*
2. *have wind output that is relatively uncorrelated with wind output in other areas (it generally blows at different times of day/year to other parts of the SWIS).*

SWIS network augmentation (risk based)

Stage 1: up to 2027 - This stage would unlock existing renewable generation capacity, and allow the addition of new renewables to facilitate the orderly retirement of coal-fired generation.

Stage 2: 2027 to 2034 – further phased expansion

Stage 3: 2034 to 2040+ – further phased expansion

** SEN modelling indicates otherwise



- SWIS Demand Assessment released in May 2023 as an interim step towards the next Whole of System Plan must be delivered by 30 September 2025 at the latest
- Produced by EPWA it provides a 20 year outlook and produced at least every 5 years . WoSP 1 was launched in October 2020.
- Overall SEN thought this 12-page document was useful and served a purpose.
- EPWA refer to it as the vision.
- Introduces renewable generation hubs (not zones) in the north, east and south of the SWIS.
- It also recognises the need for significant network augmentation on a risk-based approach across three main phases.

Headwinds for the Clean Energy Transition

Overcoming headwinds requires a concerted effort

- Building the new quickly before the old falls over - wind and solar projects are stalling
- **Leadership and** clearly communicated **vision** with hard state legislated RE targets
- **Detailed plans** and on-going planning and coordination required
- **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 essential infrastructure for coal exit and RE generation hubs
- Major customer network **connection delays** need to be overcome
- **Network capacity constraints**, curtailment and high loss factors
- **Permitting and approvals** hurdles need to be overcome: long and arduous process
- Resistance from vested interests, media, politics of power, 'state capture'



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- So the SWIS DA combined with the Energy Transformation Task Force and associated regulatory reforms, the DER roadmap, project eagle, changes to regulations, additional funding for WP, and introducing a bill covering interim emissions reduction targets the state government is doing a lot to advance emissions reduction RE – however, significant progress there do appear to be some significant headwinds – especially in context of the scale of the task ahead (building 6.3 GW of RE and associated transmission and storage).
- Some headwinds like supply chain pressures, consents and approvals, social licence and resistance from incumbents are universal, there are some that are unique to WA.
- Building the new quickly before the old falls over (including Griffin and Premier coal mines as noted in the news over the past 18 months). We are seeing a reduction in final investment announcements for new wind and large-scale solar projects.
- A clearly communicated vision is needed – whilst the SWIS DA was launched by the Energy Minister at the energy conference in August'23 he made a statement at a later press conference that the bulk of the transmission augmentation would not be paid for by the taxpayer, other than the \$127million that has been allocated to WP as part of Phase 1 – that detracts from the vision.

- Lack of state wide interim emissions reduction targets that apply to whole of industry and interim RE targets signal lack of Government commitment to the clean energy transition. Hard WA state legislated interim RE targets would provide planning targets for the various agencies, financial incentives and investor confidence.
- Lack of detailed plans - the current WoSP is not a plan rather a set of scenarios to test a range of different potential outcomes.
- There needs to be policy and regulation certainty, especially around the funding and building essential infrastructure for coal exit and RE generation hubs - securing private capital under these conditions will be challenging, especially where state owned enterprises have market dominance.
- When undertaking a significant change in an area managed by multiple agencies and affected stakeholders it is usual to appoint a transition authority with planning accountability, risk, governance, coordination oversight to steward and accelerate the clean energy transition.
- Major customer connection delays to the transmission network – these delays are far greater than the notice period that generators need to give the energy market operator when retiring generation
- Network capacity constraints, curtailment and loss factors
- Regulatory and permitting hurdles: long and arduous process to get projects through EPWA, Western Power / AEMO / AER / Synergy / State Government / WEM Rules, land access, approvals / social licence / Aboriginal heritage / public engagement and community support etc. Transition authority or facilitation body would assist in this – we are talking with EPWA shortly on this topic.
- Resistance from vested interests, media, politics of power, 'state capture'. We are in a tug of war over public opinion on the energy transition – we are seeing some positive movement here in WA.

5

Summary & Questions

Summary

- Civil society advocacy works, albeit slowly.
- 85%+ renewable energy future for WA – building blocks are here – SEN report to follow in Mar'24.
- SEN supports domestic, commercial and industry decarbonisation via electrification.
- Significant coordinated advocacy work to be done to help overcome the clean energy transition headwinds.

We need to work together



Thank You

The very best solutions will require many minds – across many disciplines – over many years – working together.
- Dr Ron Ben-David