Fraser Maywood – Chair @ Sustainable Energy Now

Advocating the Energy Transition

Climate Policy Lectures 2024

Thursday 22nd August 10-11am

Curtin University

Agenda

1. About SEN
2. How did SEN get started?
3. What are SEN's core objectives?
4. What do the SEN models suggest about the energy mix on the South West Interconnected System?
5. How does SEN advocate for change?

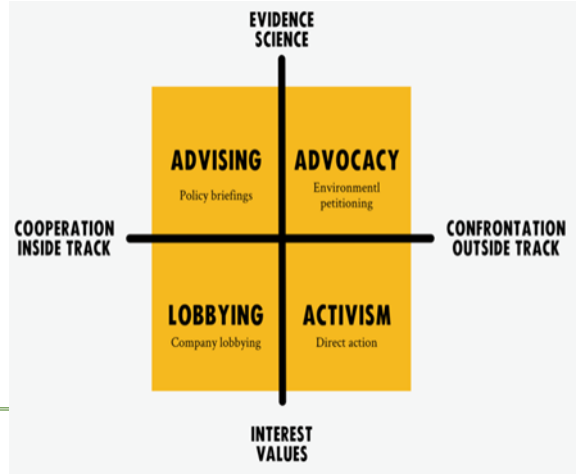
1

About SEN

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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How did SEN get started?

SEN History - Conception

The John Howard-led Coalition government went to the November 2007 federal election with a pro-nuclear power platform.

SEN formed in 2006 following 'Alarm to Action' Community Meeting in Perth

- widespread use of sustainable energy
- efficient energy use
- greater awareness of the economic and environmental benefits of sustainable energy
- sustainable energy research and technology
- a nuclear-free future
- a safe climate future

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SEN modelling on the WA South West Interconnected System (SWIS)

Acknowledgement to all SEN volunteers who contributed to the modelling including Gus King, Len Bunn, Rob Phillips, Paul Caston and others

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

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 need to be considered when arriving an overall system cost.

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

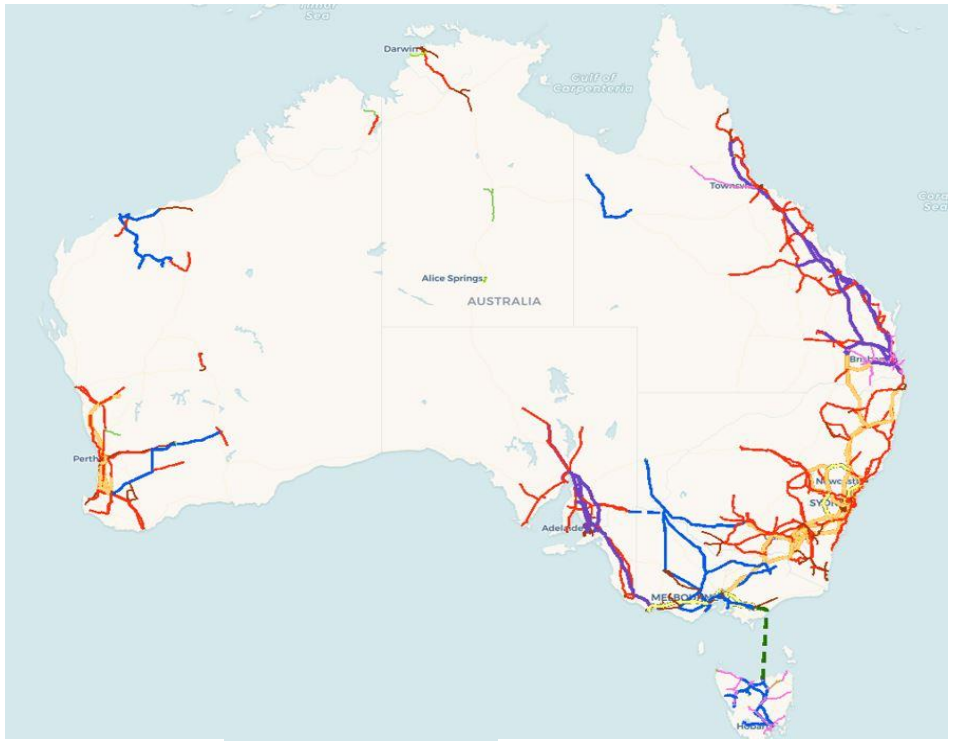
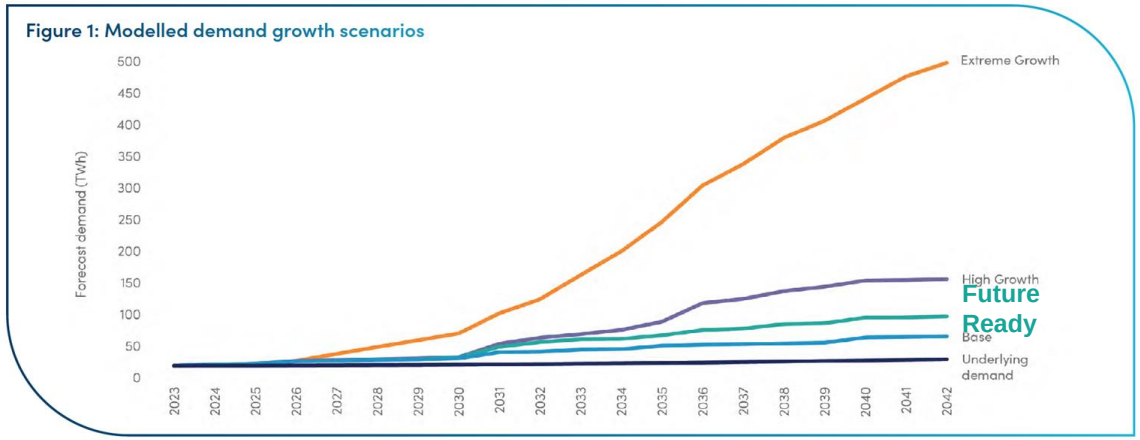
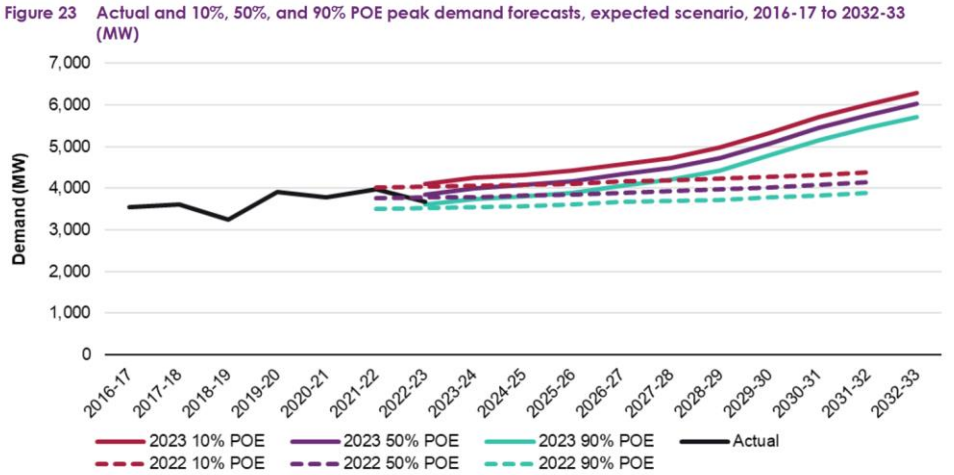


Image credit: Energy Policy WA

Modelling of the SWIS

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





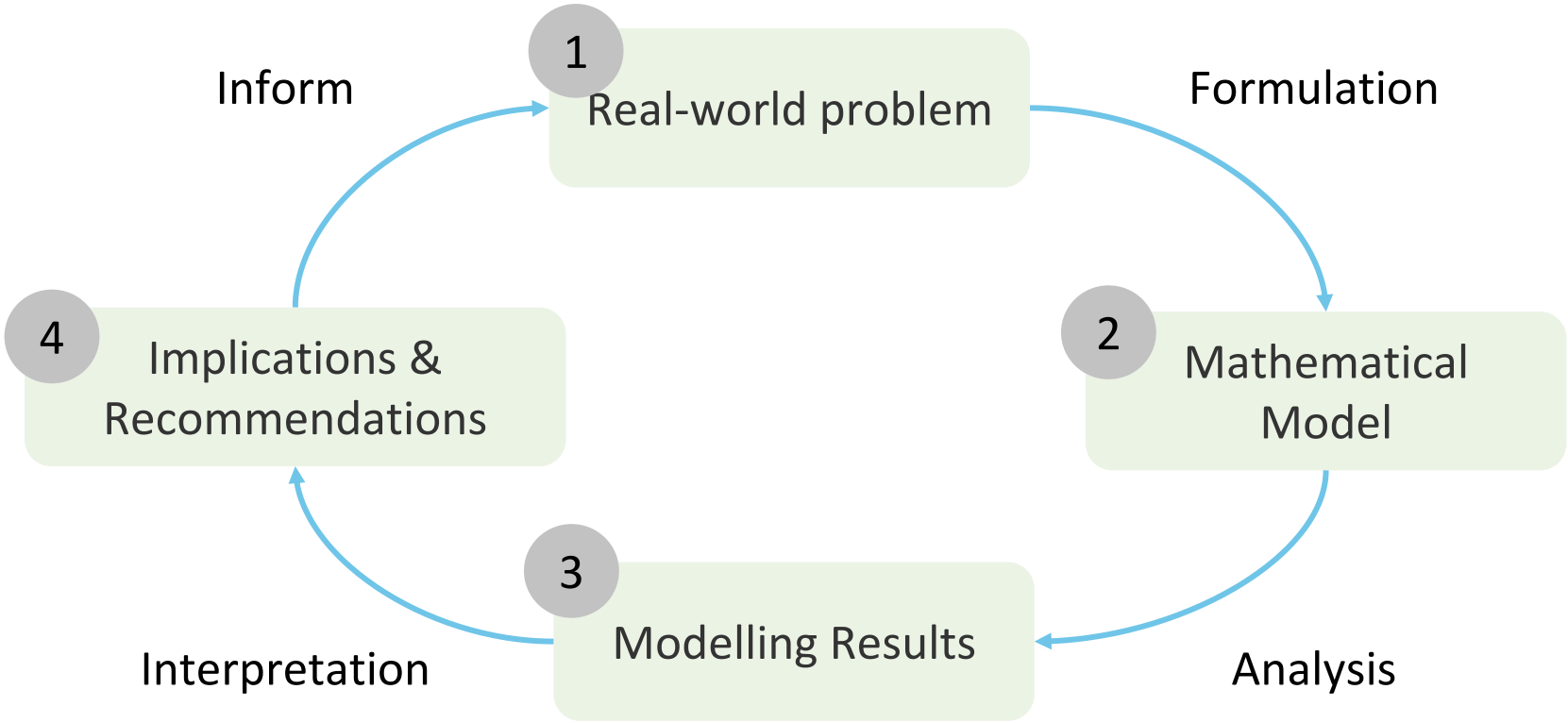
- **SWIS Demand Assessment** developed by Energy Policy WA, published May 2023
- Four demand scenarios constructed with focus on the **Future Ready** load growth scenario
- SWIS DA's modelled up 2042

- **AEMO ESOO** (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

Image credit: Energy Policy WA - SWIS DA May 2023; AEMO - Electricity Statement of Opportunities (ESOO) August 2023

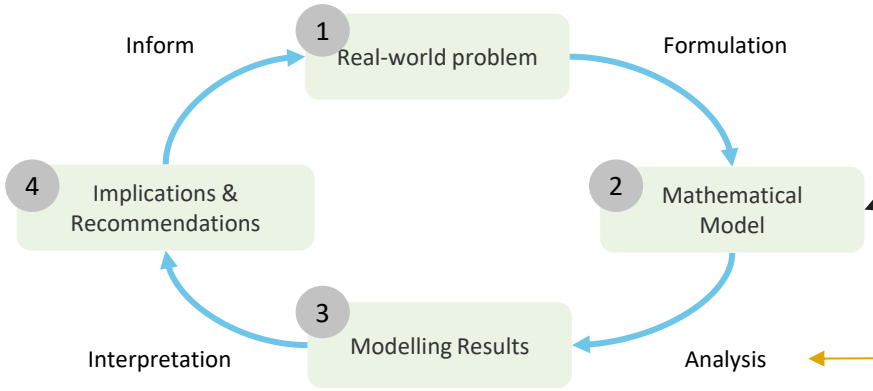
SEN's modelling methodology

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



SIREN (SEN Integrated Renewable Energy Network) & **PowerMatch** are in-house developed, open source toolkits that have been benchmarked against other simulation tools

Inputs

Data

- Solar and Wind data - based on latest available weather data from 2022
- Load Profile - based on AEMO's 2023 ESOO (Electricity Statement of Opportunities)
- Technology Costs - based on CSIRO's GenCost 2022-23
  - Includes new technology capital cost, fixed OPEX, variable OPEX, fuel costs,
  - Existing and committed facilities costs excluded.

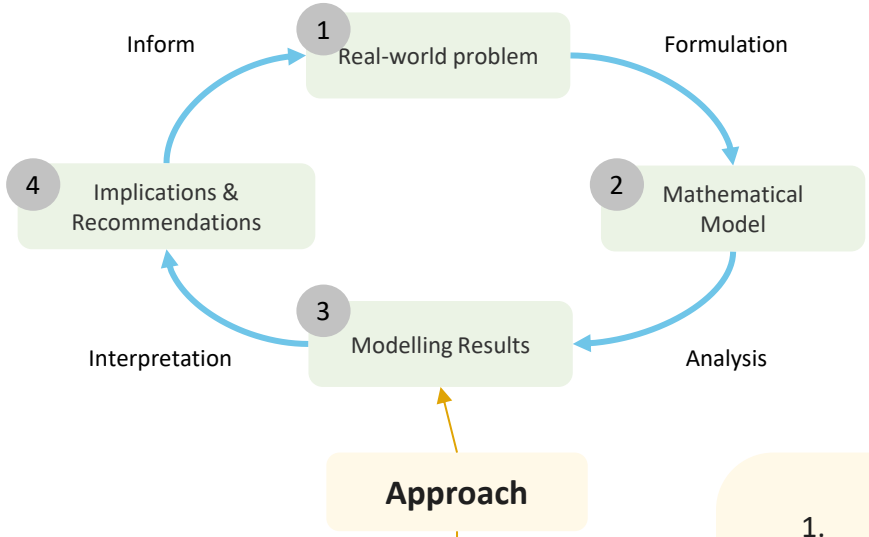
Scope
SWIS only

Additional Modelling Assumptions
All coal and Combined Cycle Gas Turbine (CCGT) will be retired by 2029

Scenarios
Several scenarios were used to test sensitivities

SEN's modelling methodology

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



1. Optimise the amount of 4- hour battery for each of the various mixes of wind and utility PV
2. Choose the result for each Wind/PV combination for minimum LCOE

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 RE capacity required (1.5GW PV + 4.8GW Wind)	6.3 GW
RE contribution (annualised)	84%

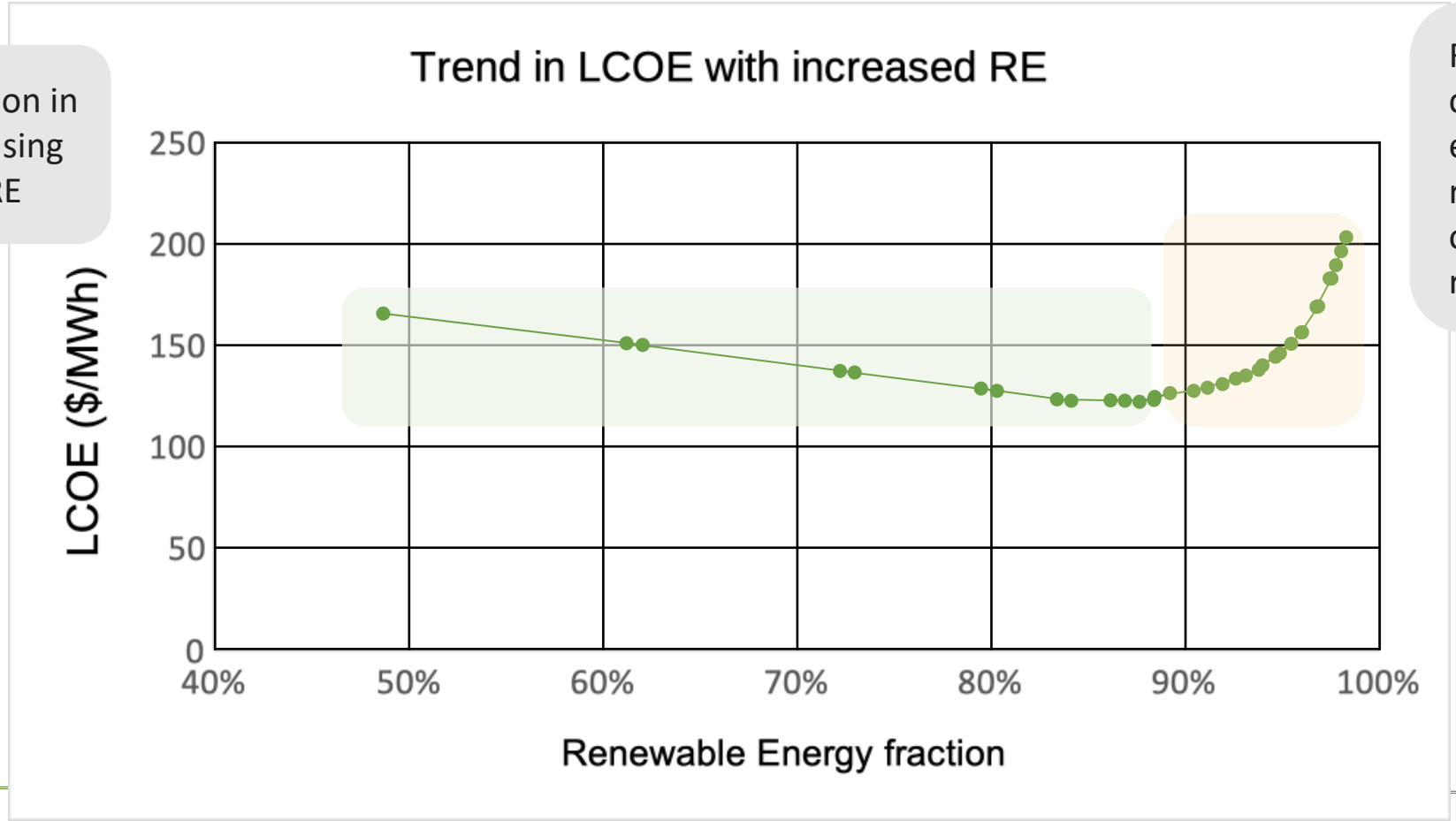
OCGT - Open Cycle Gas Turbine

Alternatives to fossil gas for firming and back-up discussed later

System LCOE 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

LCOE across a range of Wind and PV mix

Significant flexibility in the mix of wind and solar

PV (MW)

Wind (MW)

Wind (MW)	0	300	600	900	1200	1500	1800	2100	2400	270
0	202.33	197.12	191.95	186.96	182.15	177.82	174.22	171.52	169.61	168.3
300	195.56	190.36	185.28	180.32	175.67	171.61	168.35	166.00	164.40	163.1
600	188.68	183.57	178.50	173.65	169.22	165.49	162.60	160.55	159.17	157.8
900	181.78	176.67	171.68	167.00	162.90	159.51	156.95	155.19	153.83	152.4
1200	174.78	169.73	164.91	160.48	156.72	153.66	151.41	149.89	148.46	147.0
1500	167.75	162.85	158.25	154.15	150.71	147.96	146.00	144.56	143.07	141.6
1800	160.82	156.13	151.79	148.02	144.89	142.44	140.75	139.25	137.78	136.52
2100	154.14	149.66	145.64	142.16	139.33	137.14	135.66	134.27	132.98	131.96
2400	147.90	143.77	140.06	136.92	134.38	132.49	131.17	129.99	129.02	128.41
2700	142.41	138.60	135.25	132.48	130.20	128.59	127.56	126.69	126.05	125.62
3000	137.63	134.20	131.24	128.76	126.77	125.45	124.68	124.08	123.68	123.50
3300	133.64	130.55	127.93	125.73	124.03	122.95	122.40	122.06	121.89	121.95
3600	130.46	127.68	125.33	123.39	121.99	121.15	120.77	120.62	120.70	120.99
3900	127.92	125.43	123.36	121.70	120.52	**119.84**	**119.60**	**119.69**	**119.96**	**120.41**
4200	125.87	123.65	121.82	**120.39**	**119.40**	**118.91**	**118.81**	**119.08**	**119.50**	**120.09**
4500	124.29	122.32	120.70	**119.47**	**118.68**	**118.34**	**118.39**	**118.75**	**119.31**	**120.01**
4800	123.18	121.41	**119.97**	**118.90**	**118.31**	***118.08***	**118.24**	**118.69**	**119.35**	**120.15**
5100	122.41	120.80	**119.50**	**118.66**	**118.21**	**118.12**	**118.38**	**118.91**	**119.63**	120.50
5400	121.94	120.49	**119.41**	**118.75**	**118.43**	**118.47**	**118.82**	**119.43**	**120.20**	121.12
5700	121.76	120.50	**119.61**	**119.08**	**118.89**	**119.03**	**119.47**	**120.12**	120.96	121.92
6000	121.83	120.72	**120.01**	**119.61**	**119.53**	**119.77**	**120.29**	121.01	121.89	122.88
6300	122.13	121.21	120.66	**120.38**	**120.41**	120.76	121.35	122.12	123.05	124.07
6600	122.70	121.96	121.54	121.36	121.50	121.93	122.57	123.40	124.37	125.42
6900	123.52	122.92	122.58	122.51	122.74	123.24	123.95	124.82	125.83	126.91
7200	124.51	124.01	123.76	123.80	124.11	124.69	125.48	126.39	127.43	128.52
7500	125.67	125.24	125.09	125.23	125.65	126.32	127.15	128.09	129.15	130.25

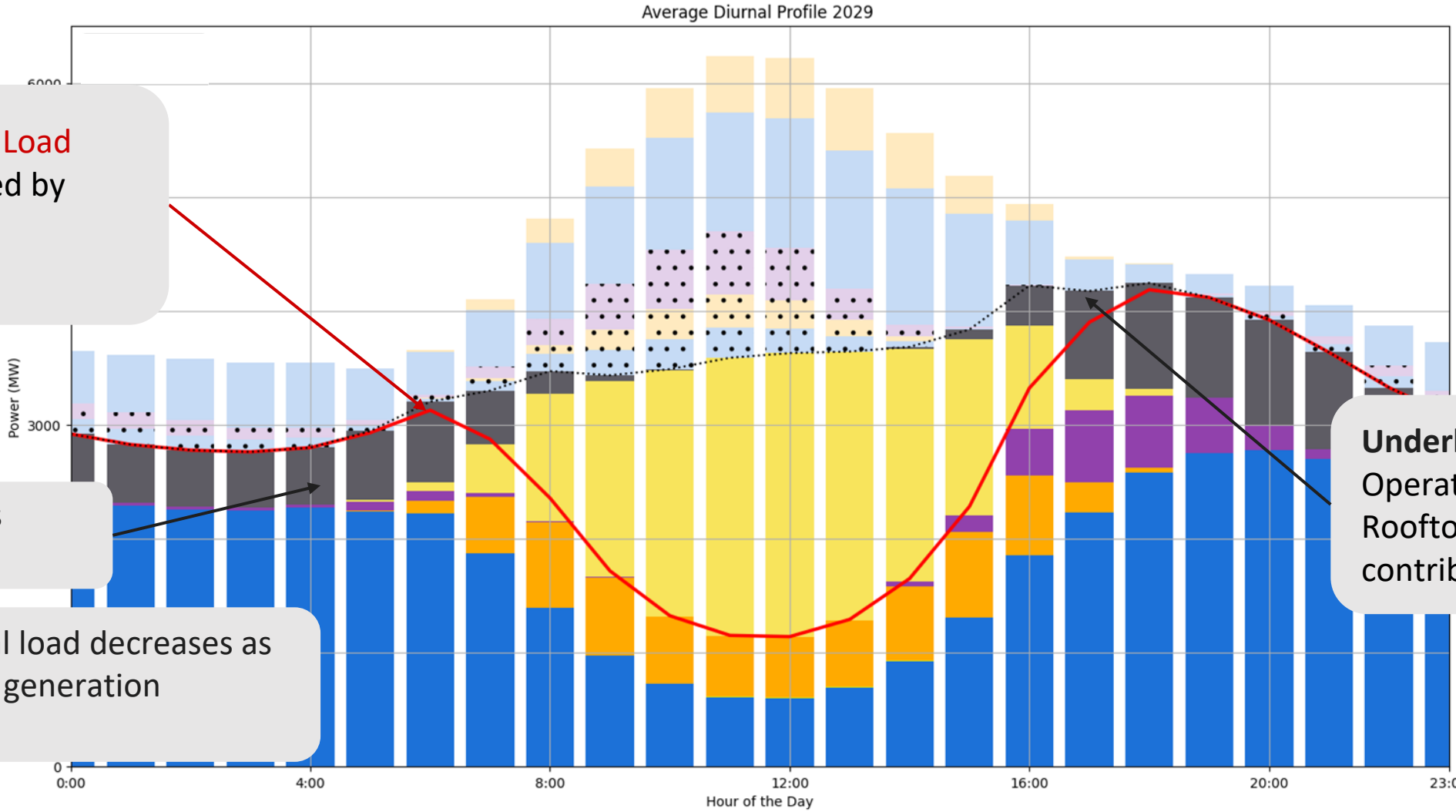
131.18	130.67	130.37	130.23	130.25
127.98	127.71	127.61	127.69	127.90
125.39	125.35	125.51	125.85	126.35
123.50	123.74	124.14	124.70	125.36
122.24	122.68	123.28	123.99	124.80
121.43	122.03	122.74	123.56	124.46
121.00	121.69	122.48	123.38	124.35
120.78	121.56	122.45	123.44	124.49
120.79	121.67	122.66	123.72	124.81
121.03	122.00	123.05	124.16	125.30
121.48	122.51	123.63	124.78	125.98
122.13	123.22	124.38	125.57	126.79
122.95	124.07	125.25	126.47	127.72
123.95	125.09	126.29	127.52	128.79
125.17	126.34	127.55	128.80	130.08
126.54	127.72	128.95	130.21	131.51
128.04	129.25	130.49	131.77	133.07
129.68	130.90	132.16	133.45	134.77
131.43	132.66	133.93	135.23	136.56

Minimum LCOE can be achieved with 4800 MW of new wind and 1500 MW of new PV.

Battery storage of 5000 MWh of 4-hour battery and 200 MWh of 2-hour battery.

Average Diurnal Profile for 2029

Variability of RE occasionally requires gas to meet load



Operational Load
Load supplied by large-scale generation

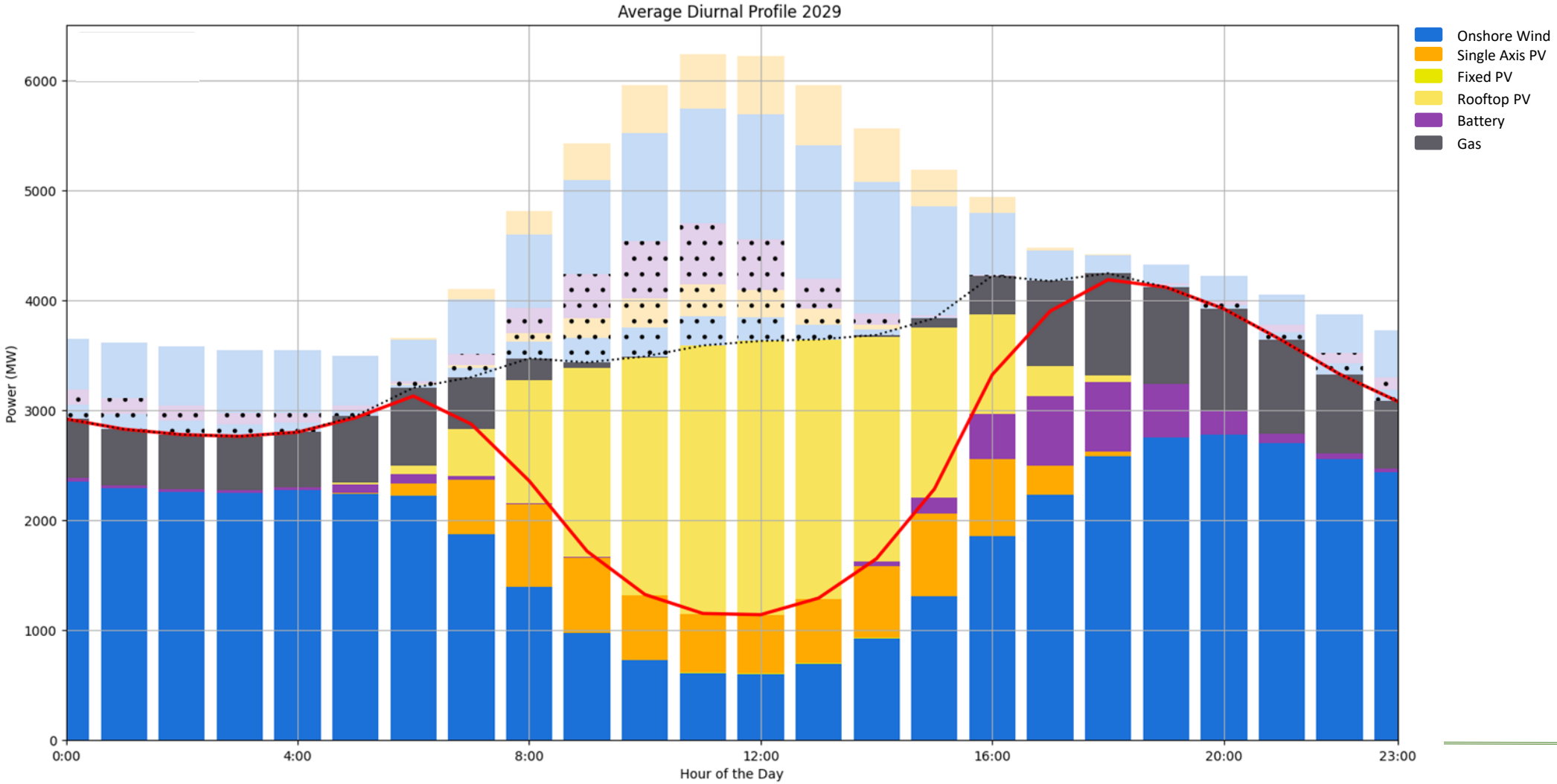
Flexible gas generation

Operational load decreases as rooftop PV generation increases

Underlying Load
Operational Load + Rooftop Solar contribution

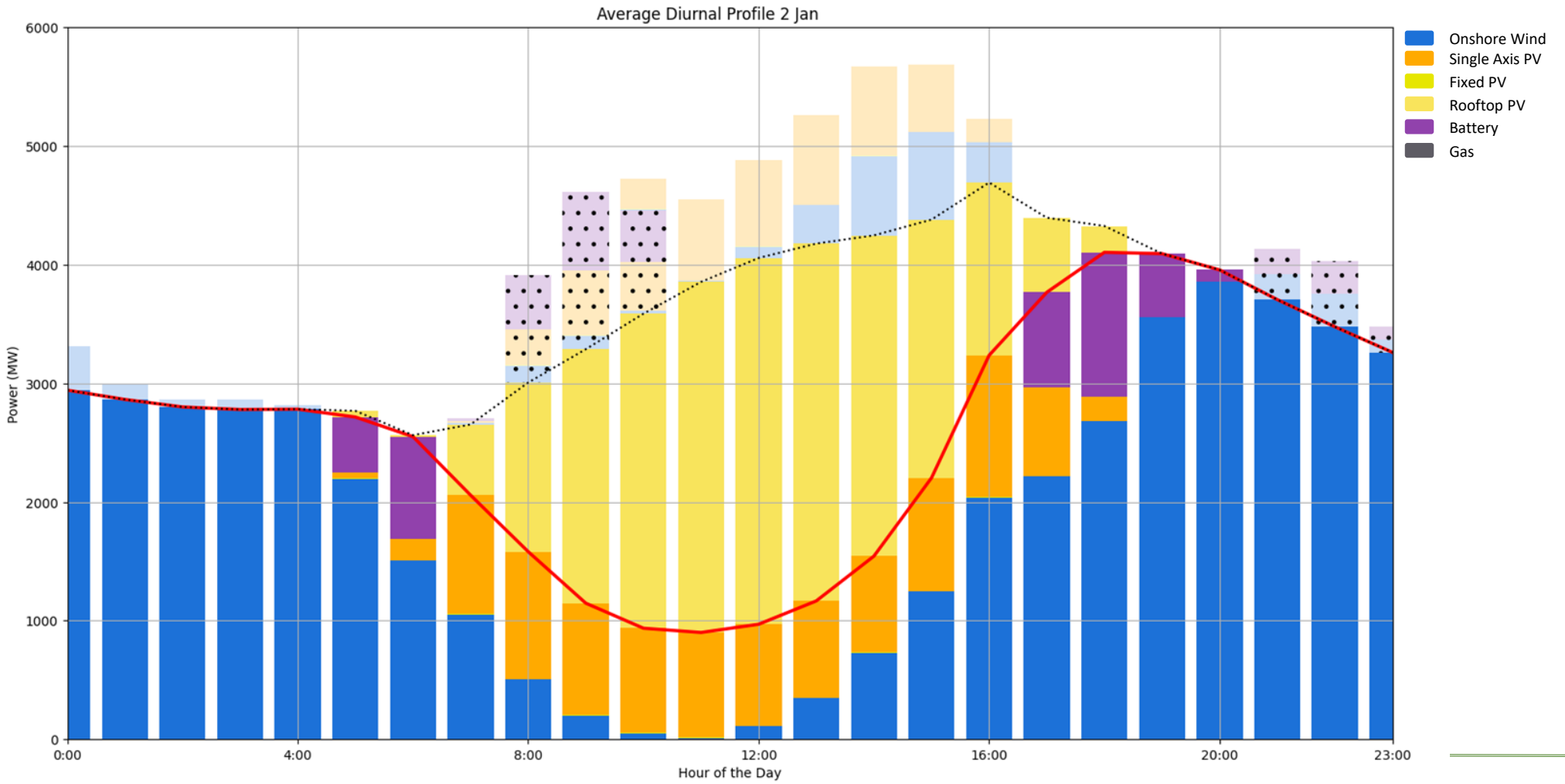
Average Diurnal Profile for 2029

Variability of RE occasionally requires gas to meet load



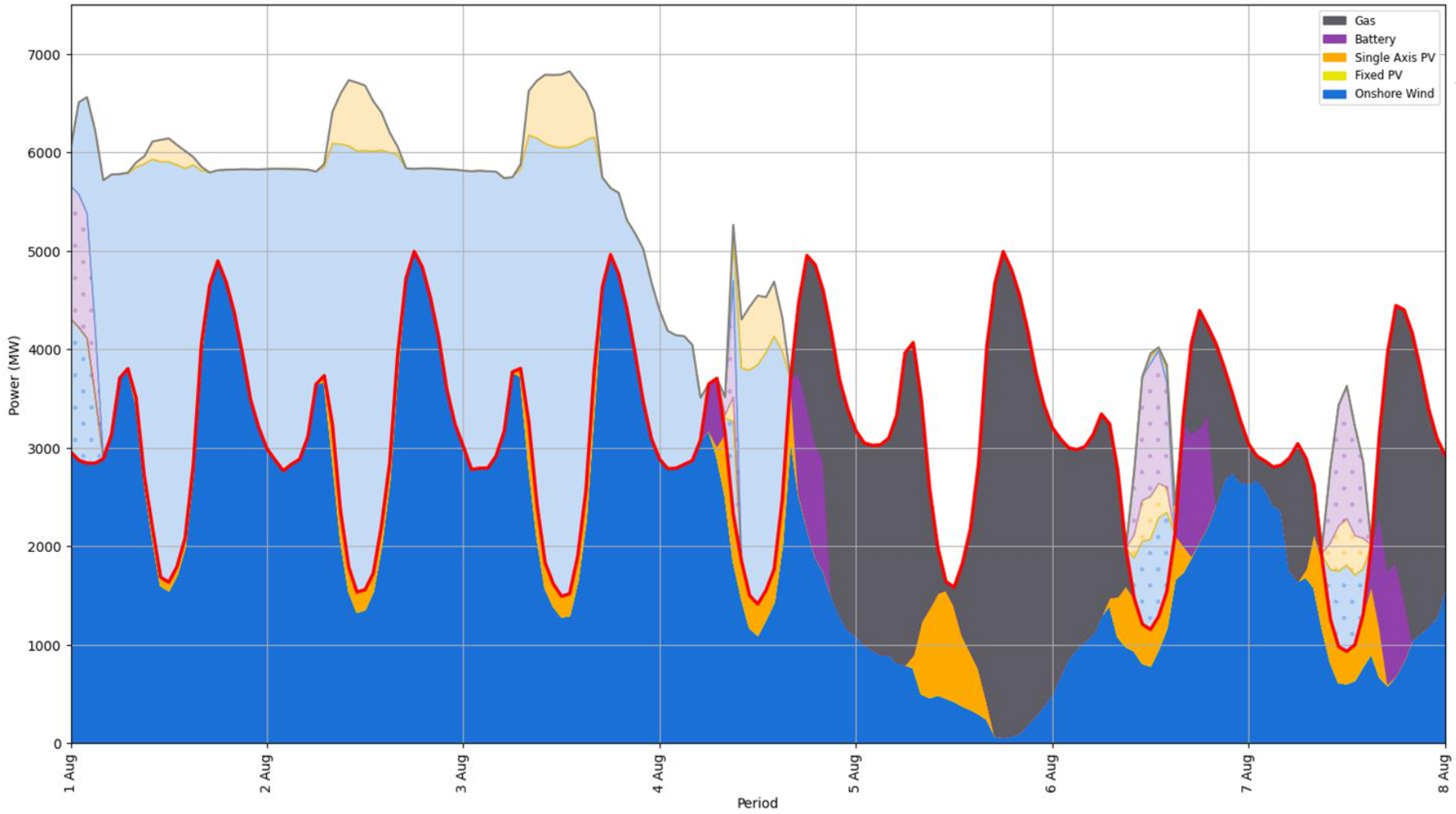
One day in summer: 2nd January

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



Dunkelflaute winter week: 1st to 8th Aug

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

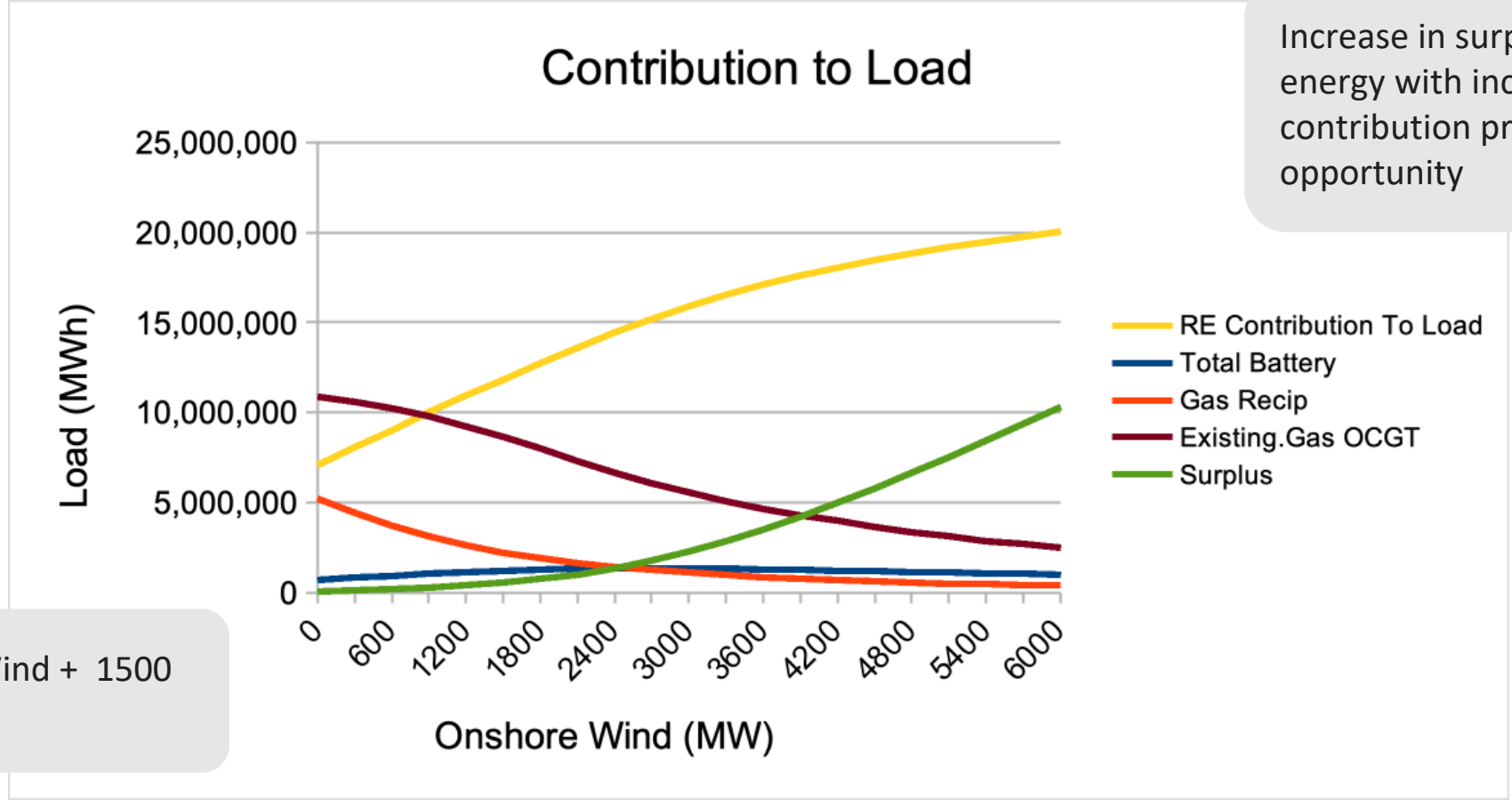


Onshore Wind
Single Axis PV
Fixed PV
Rooftop PV
Battery
Gas

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

Energy Mix - Contribution to Load

Falling gas demand with increased RE contribution

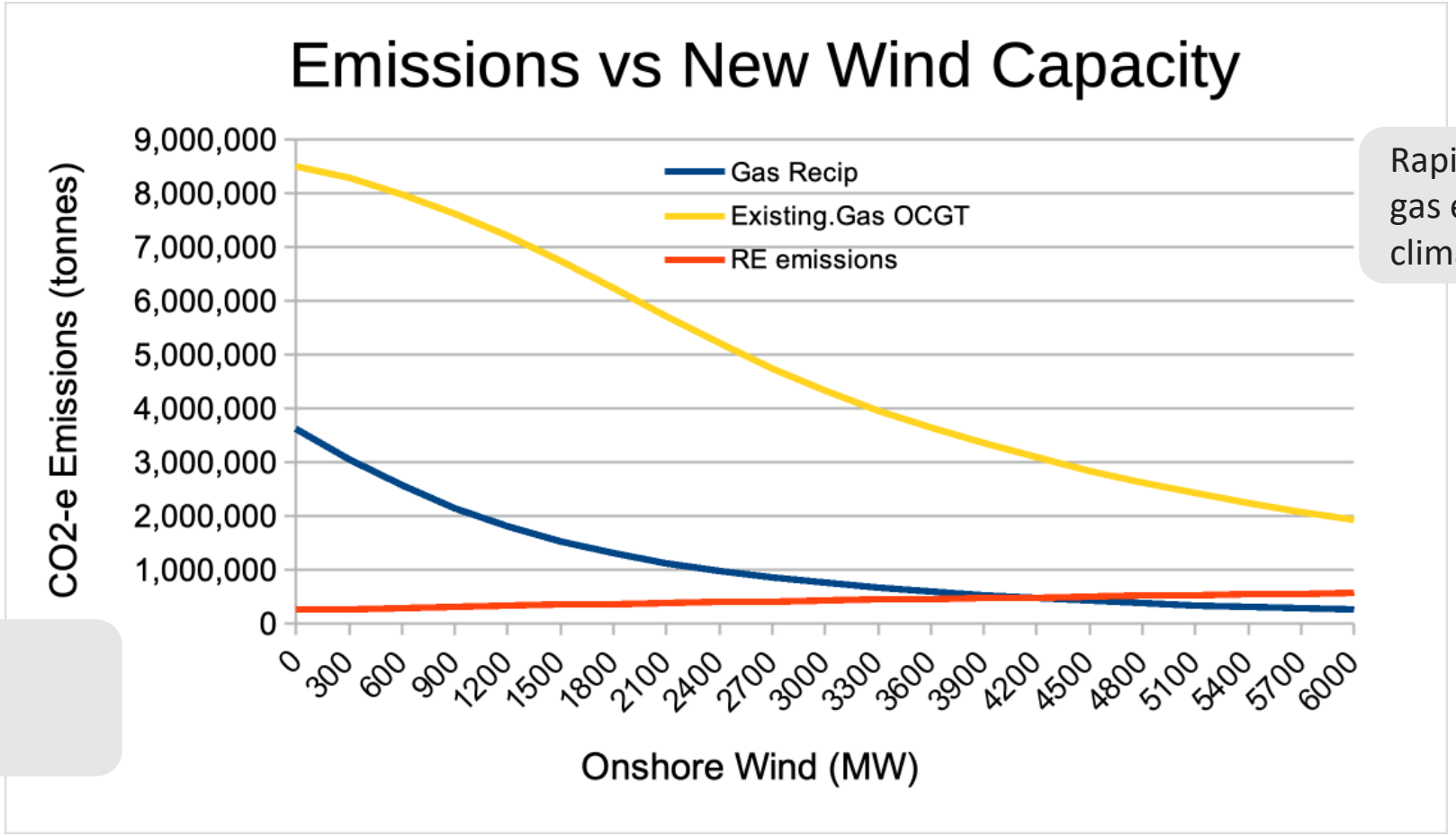


Increase in surplus spilled energy with increasing RE contribution presents an opportunity

4800 MW of New Wind + 1500 MW New PV

Carbon emissions with increasing new wind

Falling emissions with increased RE contribution and reduced gas use

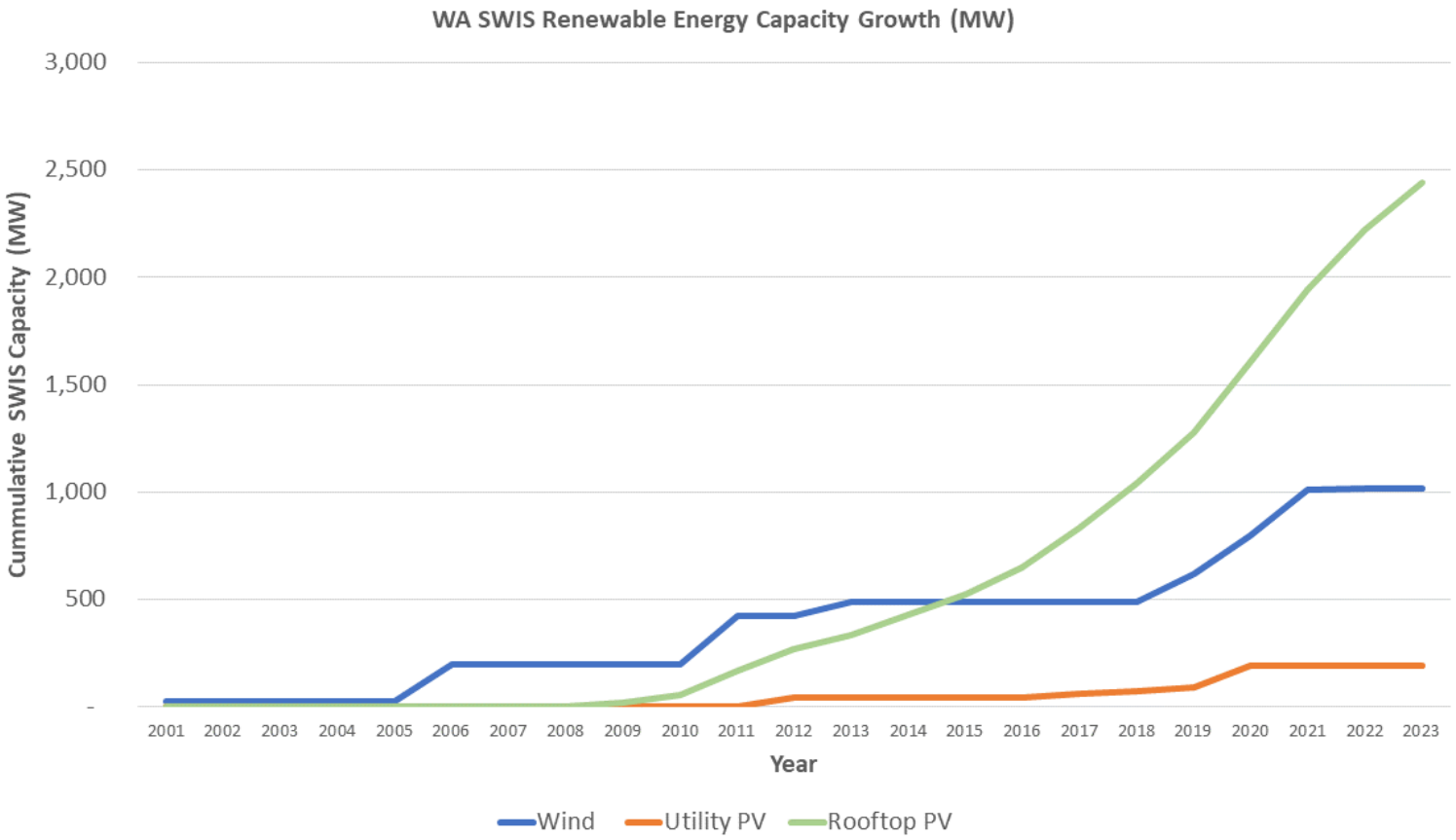


Rapid phase-down of fossil gas essential to meet climate goals

New PV 1500 MW & Increasing new wind

What RE asset class works best currently?

Rooftop solar is a run away success story



[SWIS DA Projections]

What does this all mean?

1 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 cheap resource for industry innovation.
2 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.
3 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 is used in decreasing amounts, we must manage supply during the transition.
4 How effective is increasing VRE contribution in reducing carbon emissions?	Gas used in decreasing amounts during in the transition thus reducing emissions.

What may change?

- Everything and rapidly
- WA government policy on transmission investment unlocking more utility scale renewables
- More Customer owned Energy Resources (CER) 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.

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)

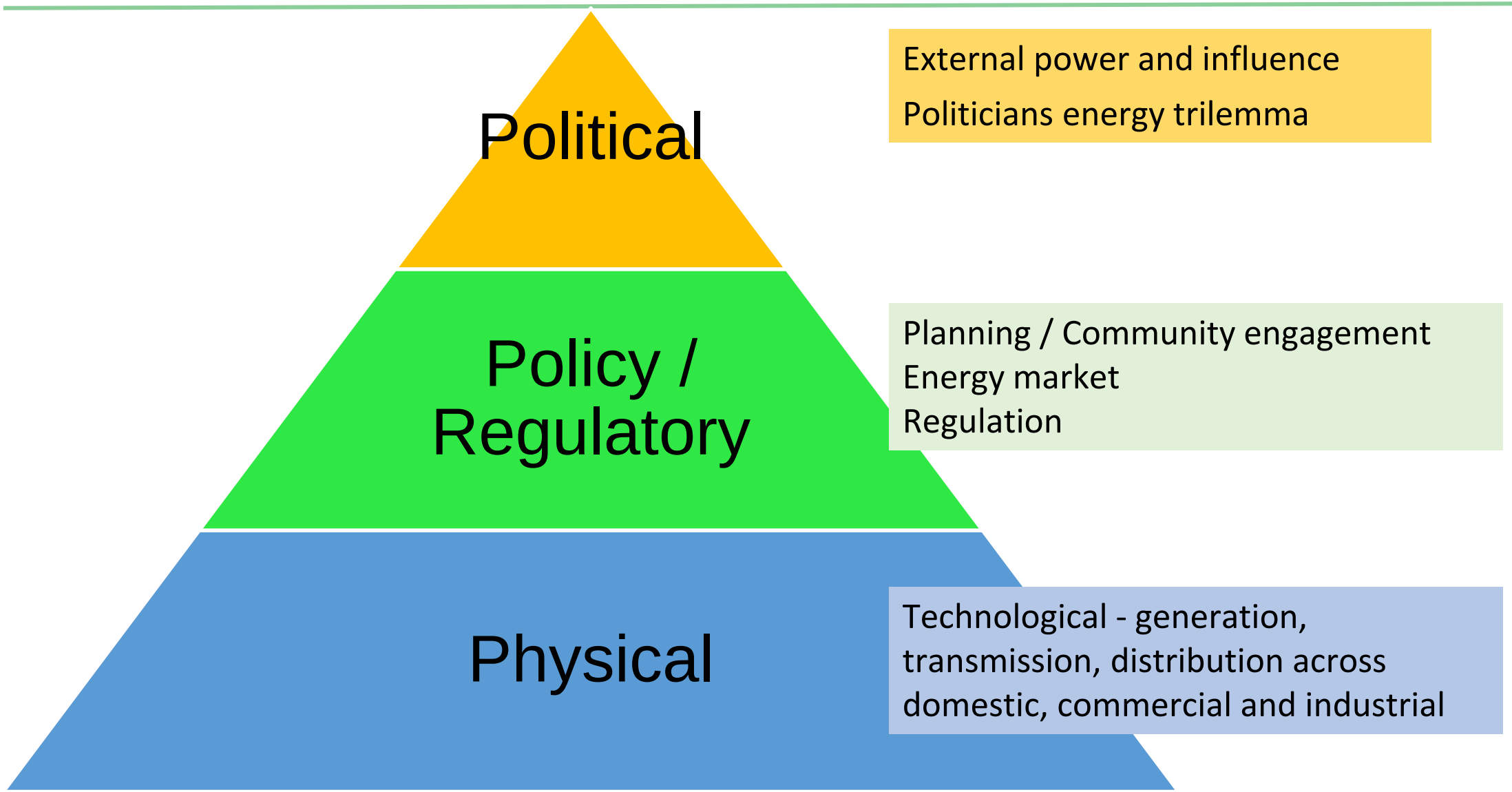
5

How does SEN advocate for change?

Energy Transition – a Political Process

- Over focus on socio-technical aspects of the transition without considering power and politics
- Energy tightly bound to economics, jobs and growth, rise and fall of empires, core to our modern lifestyle, controlled by governments(?)
- Government objectives: energy security; energy costs; emissions reduction / environmental impacts
- Energy policy controlled by incumbents - interests are not aligned to a viable future
- WA state net zero 2050 policy (Nov'21), Sectoral Emission Reduction Strategies – low hanging fruit is electricity sector
- Investment needed for once in a lifetime transition – especially transmission network
- Technology is here right now! – solar, wind, batteries, long duration energy storage, Lowest Cost of Energy
- Investment, policy, system planning and market regulation and technology integration are key - not new technology (CCS, hydrogen etc are planned distractions)

Simplified 3Ps Energy Advocacy Model



Advocating for Change

Organisational Capability

Policy Engagement

Communications

Public and Industry Education

Allies

Technical Modelling and Research

Civil Society Advocacy

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

Civil Society Advocacy

2022-24 SWIS Decarbonisation Campaign Meeting List as at July 2024

Energy Policy WA 8th March 2022

Western Power 1st April 2022

AEMO 26th May 2022

Economic Regulation Authority 18th July 2022

Energy Policy WA 29th August 2022

Synergy 5th August 2022

Alinta 25th October 2022

AEMO 8th Feb 2023

Hon Steve Thomas 1st March 2023

State Energy Advisor and EPWA 28th March 2023

Energy Policy WA 25th July 2023

AEMO 17th August 2023

Energy Policy WA 10th October 2023

Hon Bill Johnston 17th October 2023

Hon Brad Pettitt 31st October 2023

Hon Steve Thomas 7th November 2023

WA Chief Scientist 4th December 2023

Hon Stephen Dawson 17th January 2024

Hon Jessica Shaw 4th April 2024

Synergy 17th April 2024

WA Chief Scientist 17th April 2024

Hon Darren West 18th April 2024

JTSI 23rd April 2024

Energy Policy WA 16th May 2024

Western Power 17th May 2024

JTSI Green Energy Group 22nd May 2024

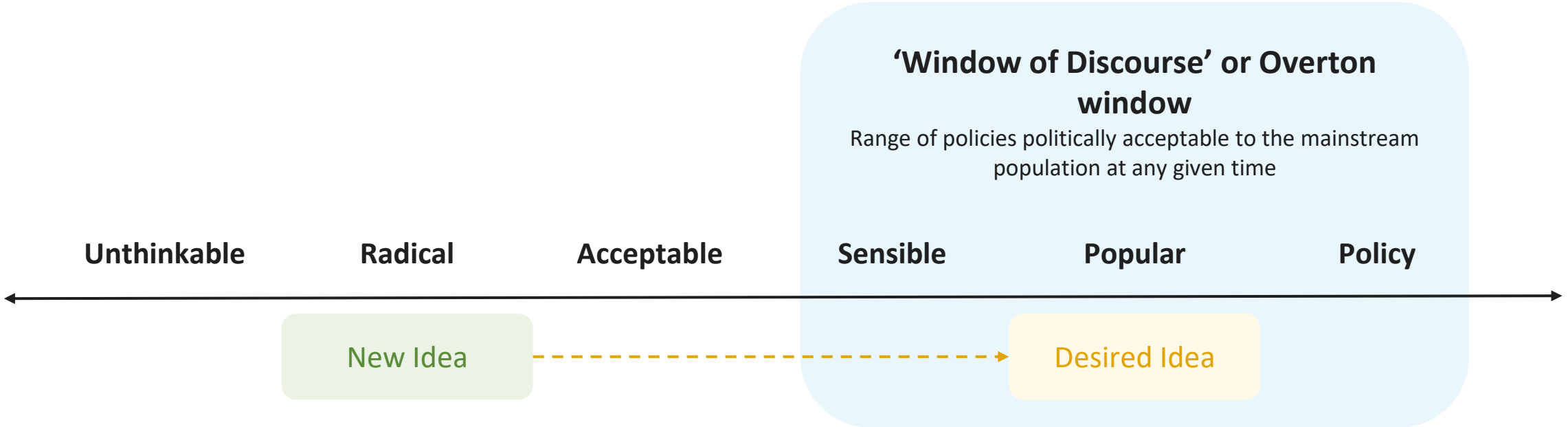
Hon Reece Whitby 16th July 2024

Excludes meetings with eNGOs and allies

Civil society advocacy works

Change comes slowly from steadily applied pressure, then suddenly

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



Summary

- 90%+ renewable energy future for WA – rapid phase down of gas
- Gas is only “vital” in the short term
- Industry decarbonisation largely via electrification
- Work to be done to overcome transition roadblocks
- Civil society advocacy works
- Energy sector moving rapidly, emerging technology and government policy on technology pathways – keep informed of the news and implications
- We need your help!

Thank You

Q & A

QR Code - volunteers don't need have to have technical background... economic, financial, social media, etc