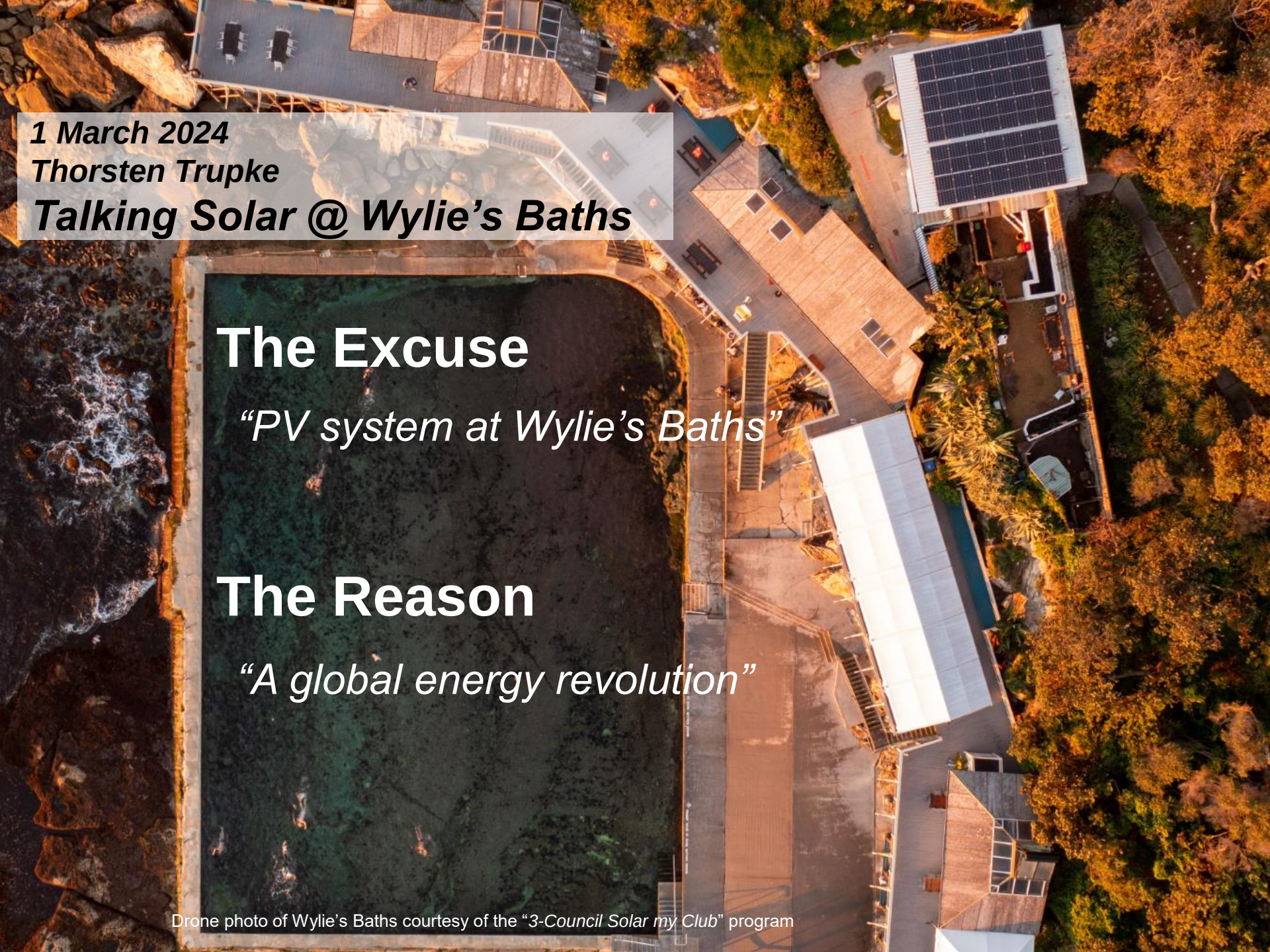


1 March 2024
Thorsten Trupke
Talking Solar @ Wylie's Baths

The Excuse

"PV system at Wylie's Baths"

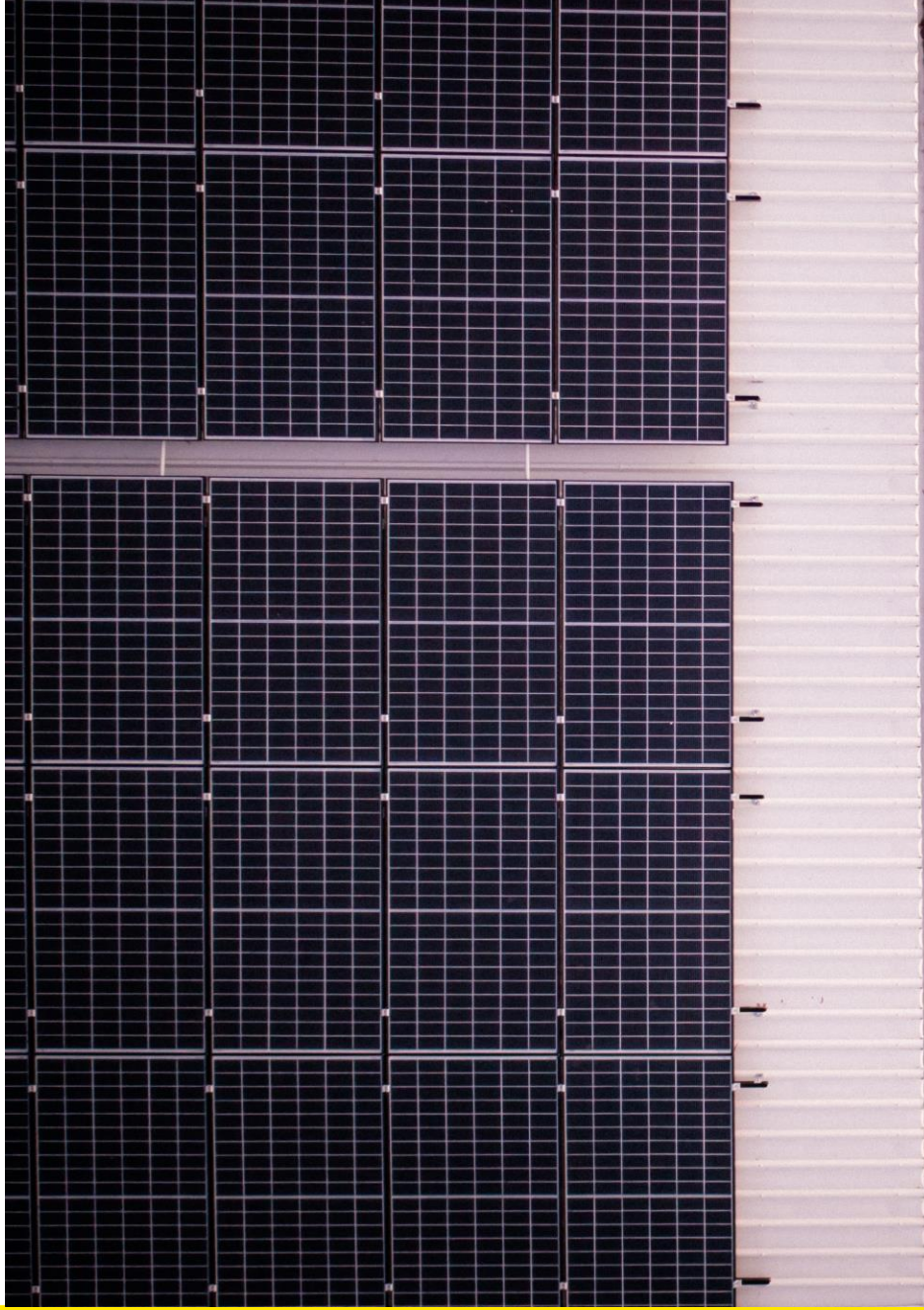
The Reason

"A global energy revolution"

Drone photo of Wylie's Baths courtesy of the "*3-Council Solar my Club*" program

Agenda

- **The Basics**
- **Solar Energy - The Big Picture**
  - The Past
  - The Present
  - The Future
- **Solar Energy - The Small Picture**
  - PV system at Wylie's Baths



The Basics

Photovoltaics vs Solar Thermal

The Basics

Photovoltaics vs Solar Thermal

Photovoltaics

- **Electricity** from absorbing sunlight
- No moving parts
- Installed on Marco's roof

A thing of beauty…

Solar thermal

- **Hot water** from absorbing sunlight
- Tank provides storage
- Installed at Wylie's Baths on the roofs of the boys' and girls' change rooms

PV Systems
- “not one size fits all”

Residential

~10 KW

~25 panels

Commercial

Up to several 100KW

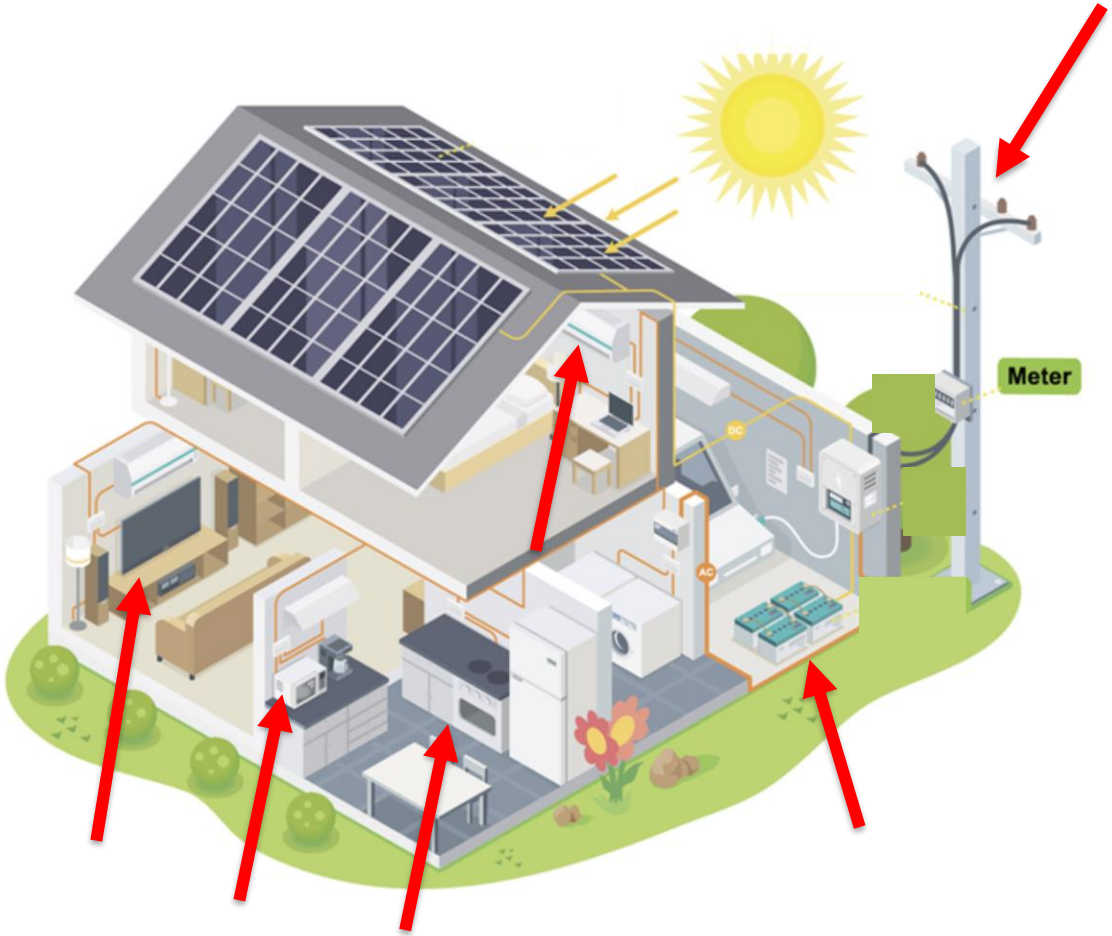
Hundreds / Thousands of panels

Utility scale

100 MW to GW

Several 100,000 to millions of panels

"Using PV generated electricity"



1. Use on site

2. Store and use at another time

3. Distribute and use / store elsewhere

"Storing Electricity" Batteries

Residential

5 – 10 KWh

Utility Scale

1.2 GW/2.4 GWh battery to be built in Victoria

~ 200,000 X

“Storing Electricity”
Batteries

60 – 100 KWh battery capacity

Enough energy to power a household for **several days!**

The Big Picture
- Why Photovoltaics matters

- We live in the age of anthropogenic climate change
- Energy supply is a major contributor to climate change
- The way humans **generate, distribute, store** and **use** electricity must – will – **has started to** change radically!
- The global transition away from fossil fuels to renewables is well under way!

"Electricity generated using solar cells is one of several key pieces in a complex puzzle"

The Big Picture
- Why Photovoltaics matters

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"Electricity generated using solar cells is one of several key pieces in a complex puzzle"

Big Picture – The Past

First efficient cells (1953/4)

Credit: Bell Labs

"The new device … may spark the beginning of a new era, leading eventually to the realisation of one of mankind's most cherished dreams – the harnessing of the almost limitless energy of the sun for the uses of civilisation."

Slide courtesy of Martin Green

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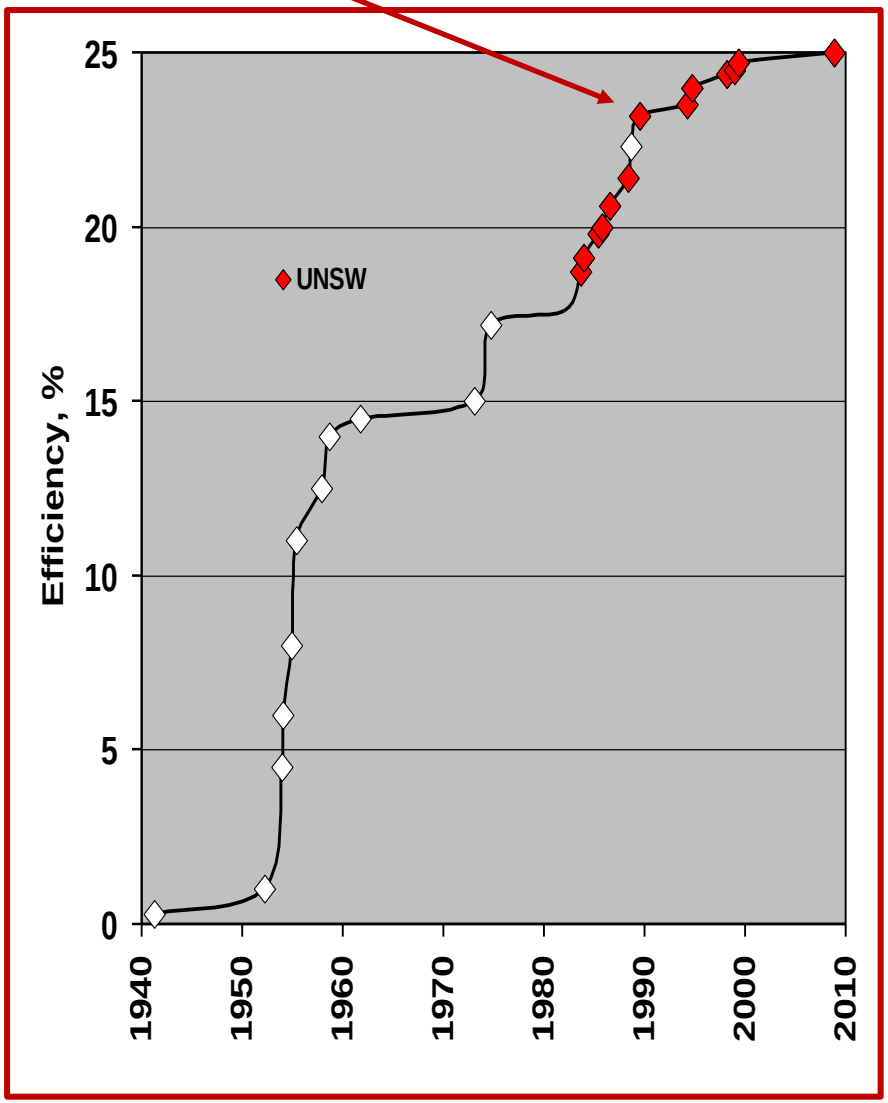
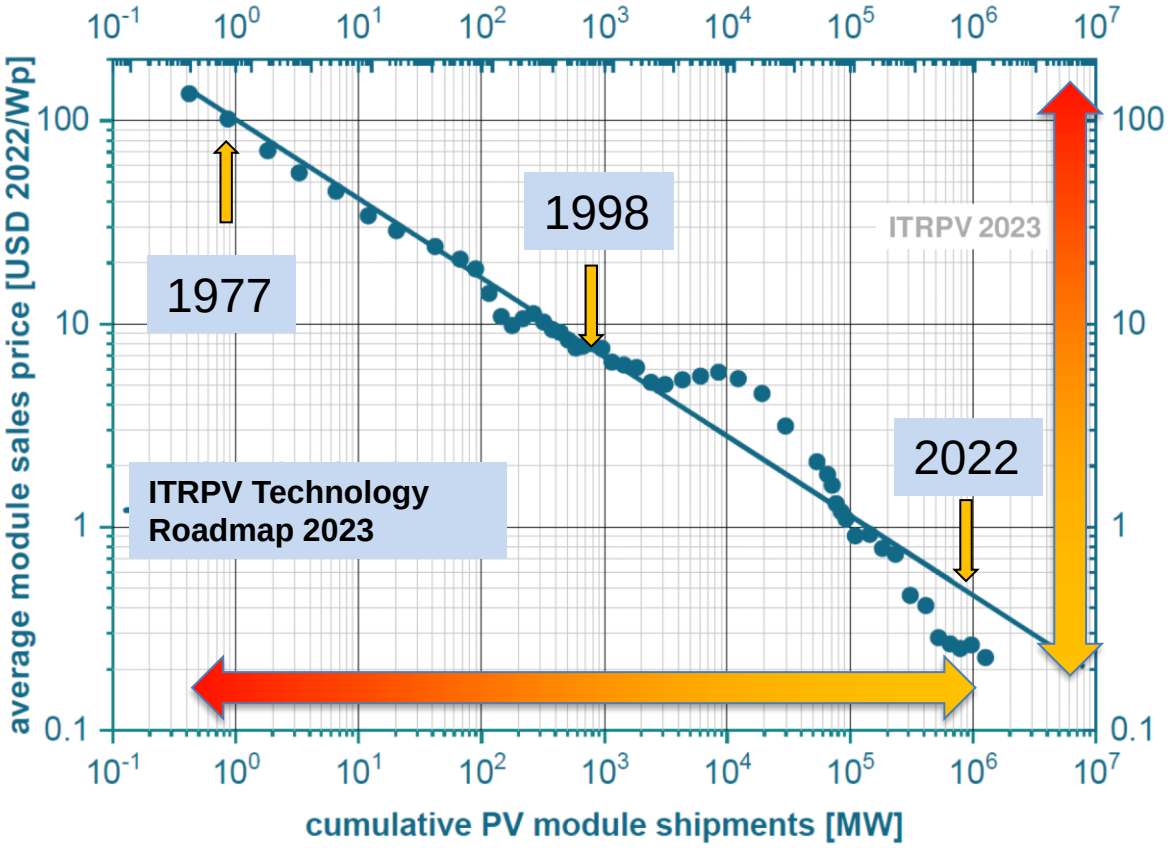
Big Picture – The Past



Pictures courtesy of Martin Green

Big Picture – The Past



Photovoltaic Learning Curve:

- Prices dropped **1,000 x over 45 years**
- Installed capacity increased **1,000,000 times**
- **1TW$_p$** installed capacity achieved in 2022

1977:
1 MW$_p$:
A few 100 rooftop systems

1998:
1 GW$_p$:
Still far less than one coal fired station

2022:
1 TW$_p$
PV replaces hundreds of 1GW coal fired stations

Big Picture – The Present

Loy Yang A power station in the Latrobe Valley: **2.2 GW_p**

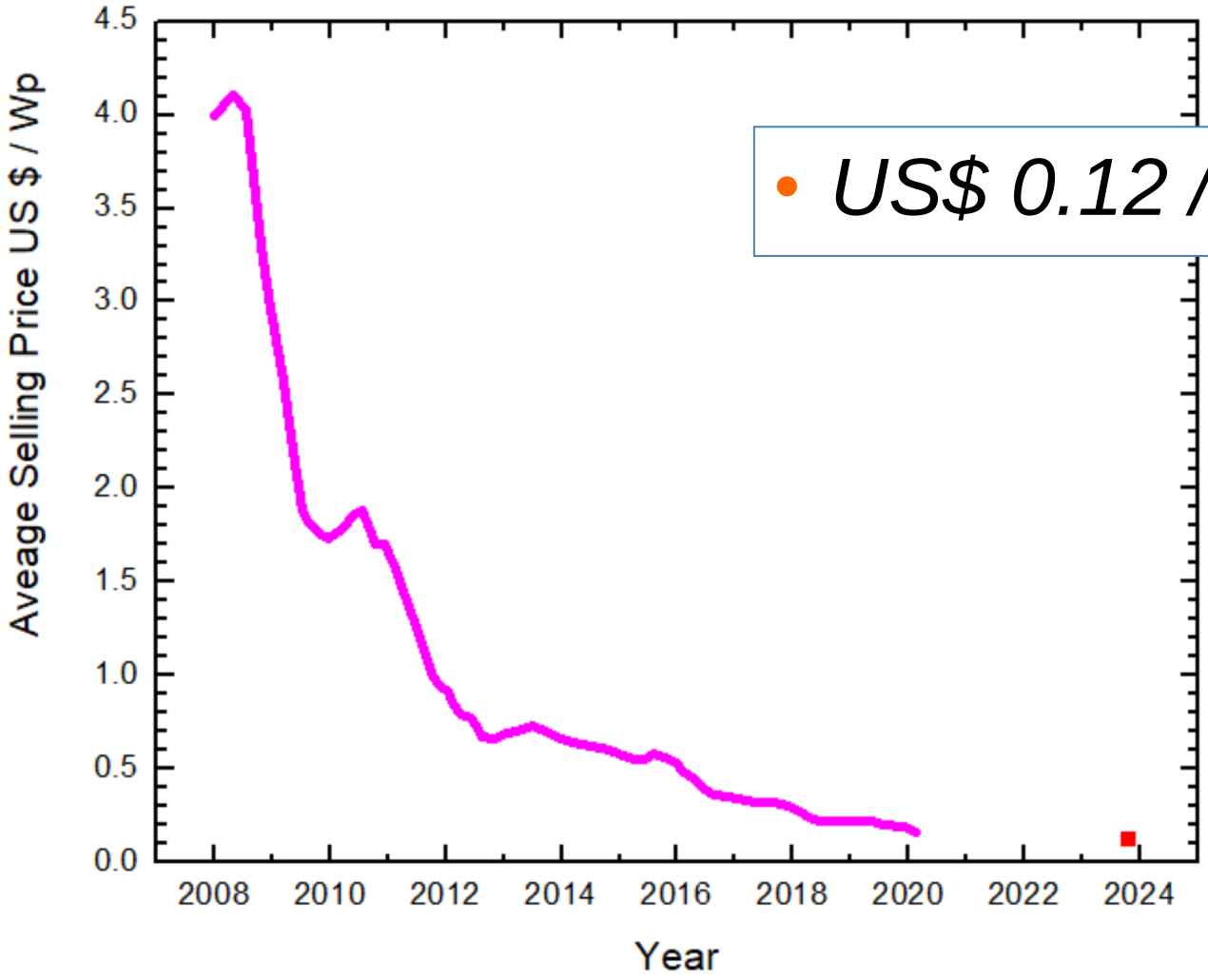
2023 PV capacity: **~1.3 TW_p**

Allowing for capacity factors:

Global PV capacity replaces ~200 Loy Yang A stations today!

- PV globally generates ~10 times the electricity used across Australia

Big Picture
– The Present



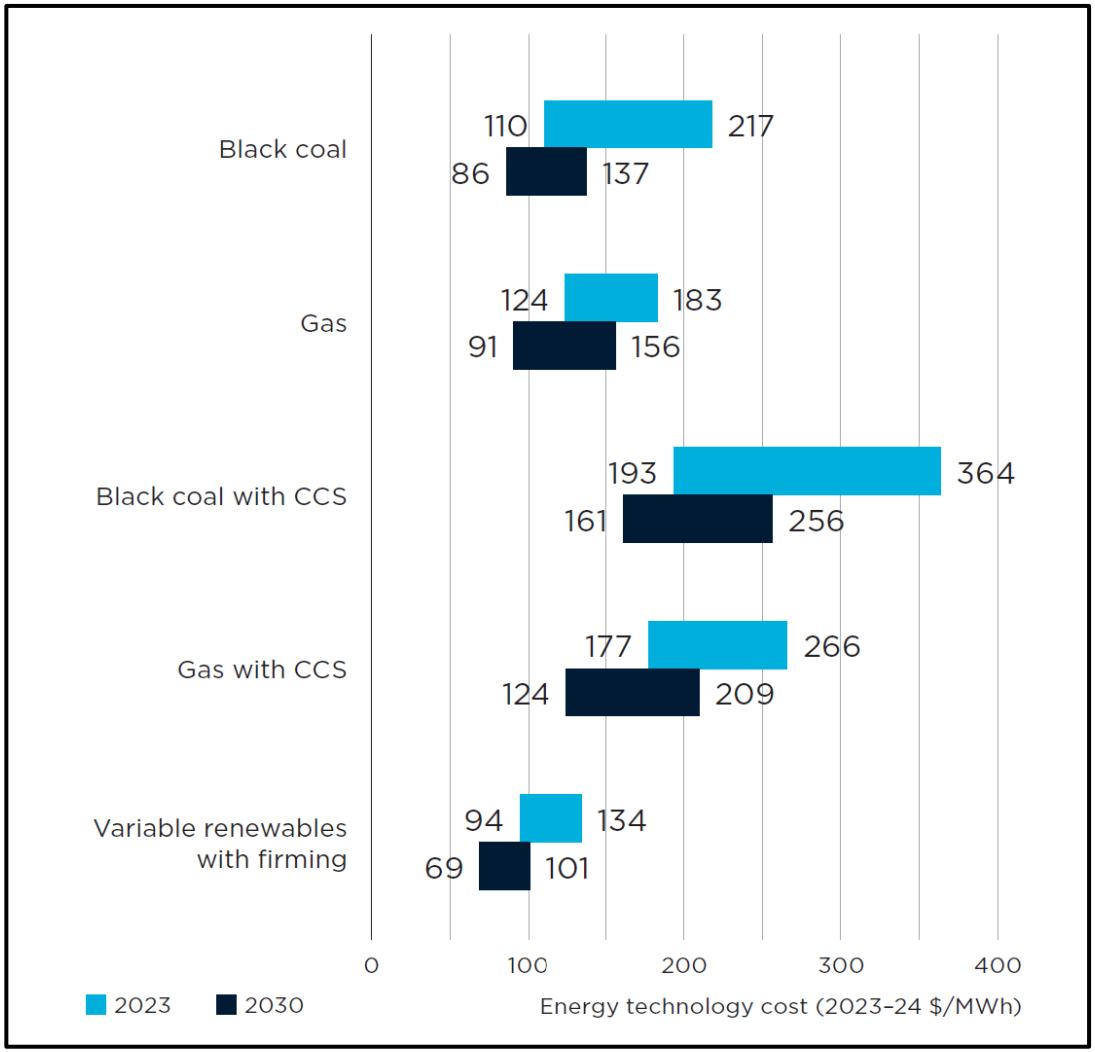
- *US$ 0.12 / W_p in 2024*

Big Picture – The Present

- Q-cells Q.Maxx panels used at Wylies Baths: **350 W_p**
- US$ 0.12 / Wp in 2024
- 350 W_p x 0.12 $ / Wp = US$ 42

US$ 42…!

Big Picture – The Present



Levelised Cost of Electricity (LCOE)

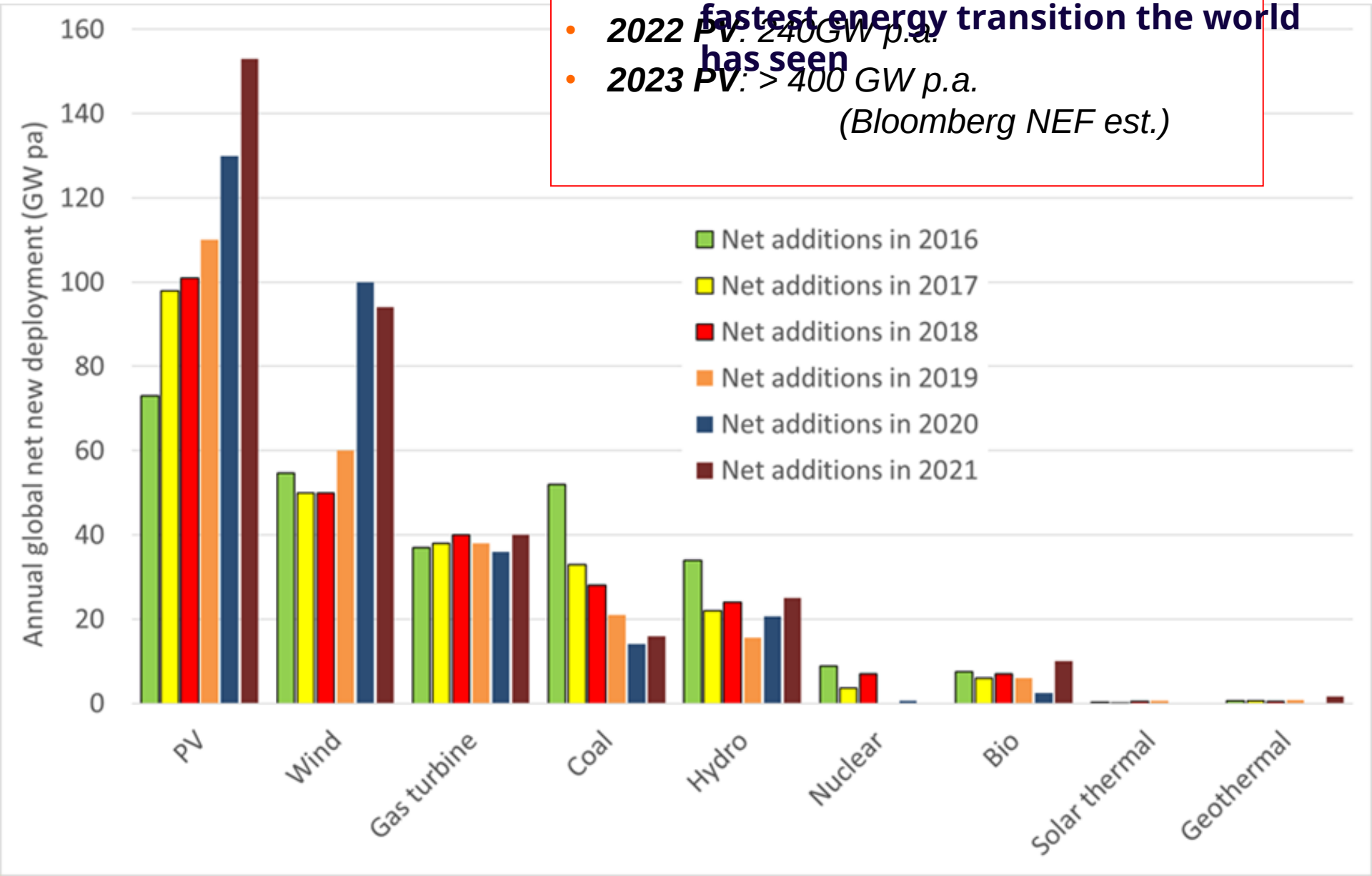
*Variable renewables **with firming** the cheapest option for new electricity capacity in Australia*

Big Picture – The Present

RENEW ECONOMY
CLEAN ENERGY NEWS AND ANALYSIS

A. Blakers, Solar and wind are leading fastest energy transition the world has seen

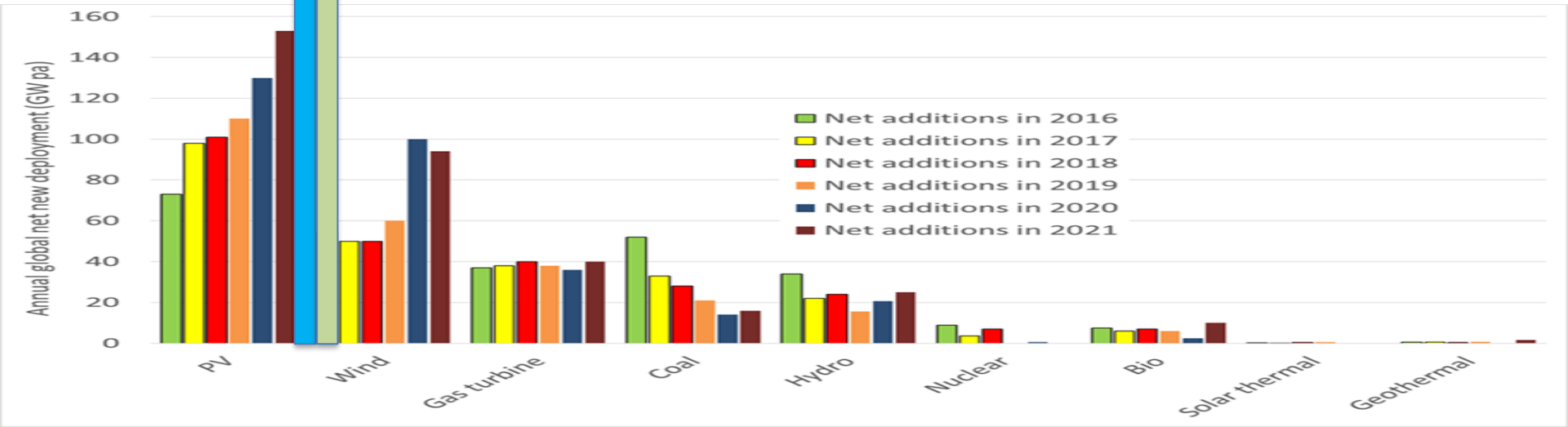
- ***2022 PV**: 240GW p.a.*
- ***2023 PV**: > 400 GW p.a.*
  (Bloomberg NEF est.)



2023

2022

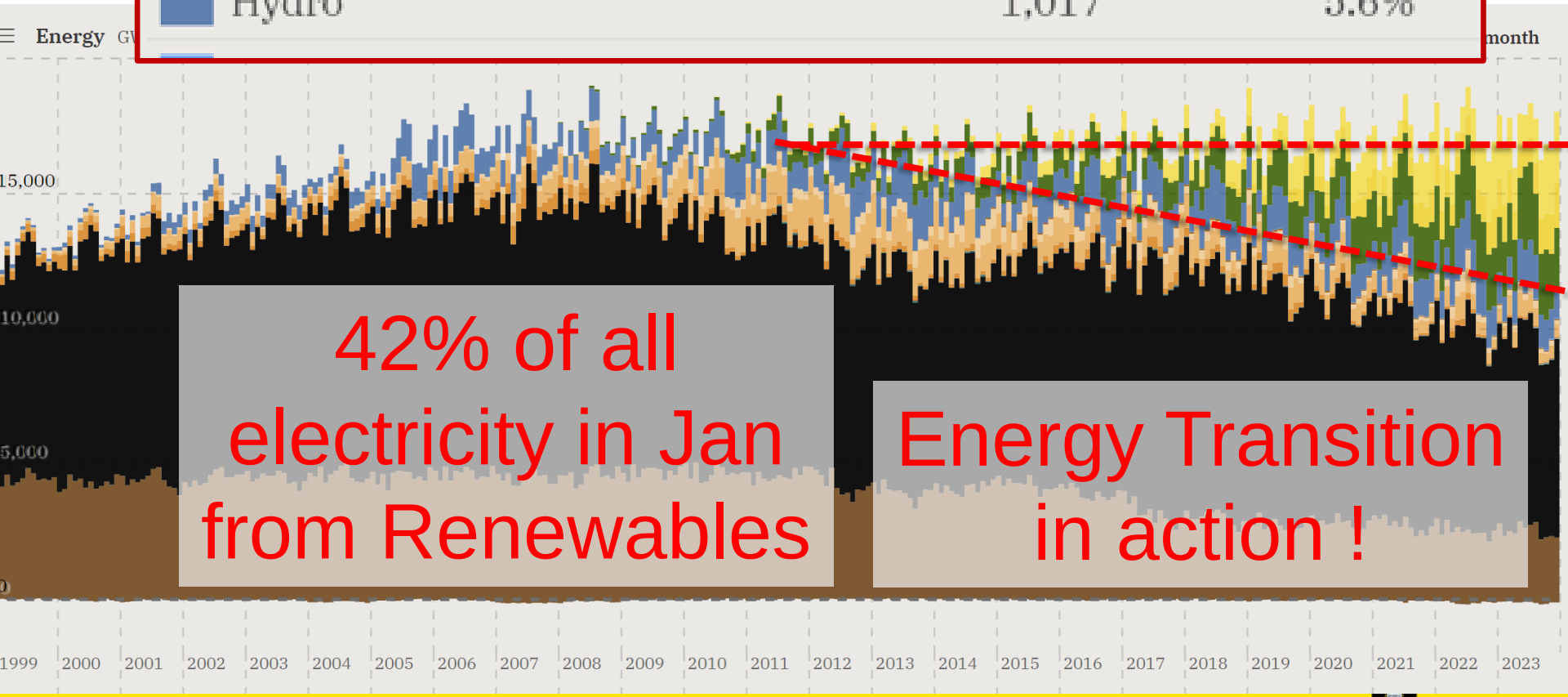
What is the renewable percentage of electricity generation in Australia?



Bi

Aus

Sources JAN 2024		
Solar (Rooftop)	2,640	14.5%
Solar (Utility)	1,654	9.1%
Wind	2,307	12.7%
Hydro	1,017	5.6%



42% of all electricity in Jan from Renewables

Energy Transition in action !

https://opennem.org.au/

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Big Picture
– The Present

Big Picture
– The Present

Big Picture – The Present

- Al Dharfa Solar Farm (Abu Dhabi)
  - 2 GW_{DC}
  - ~ 4,000,000 c-Si solar panels

Big Picture
– The Present

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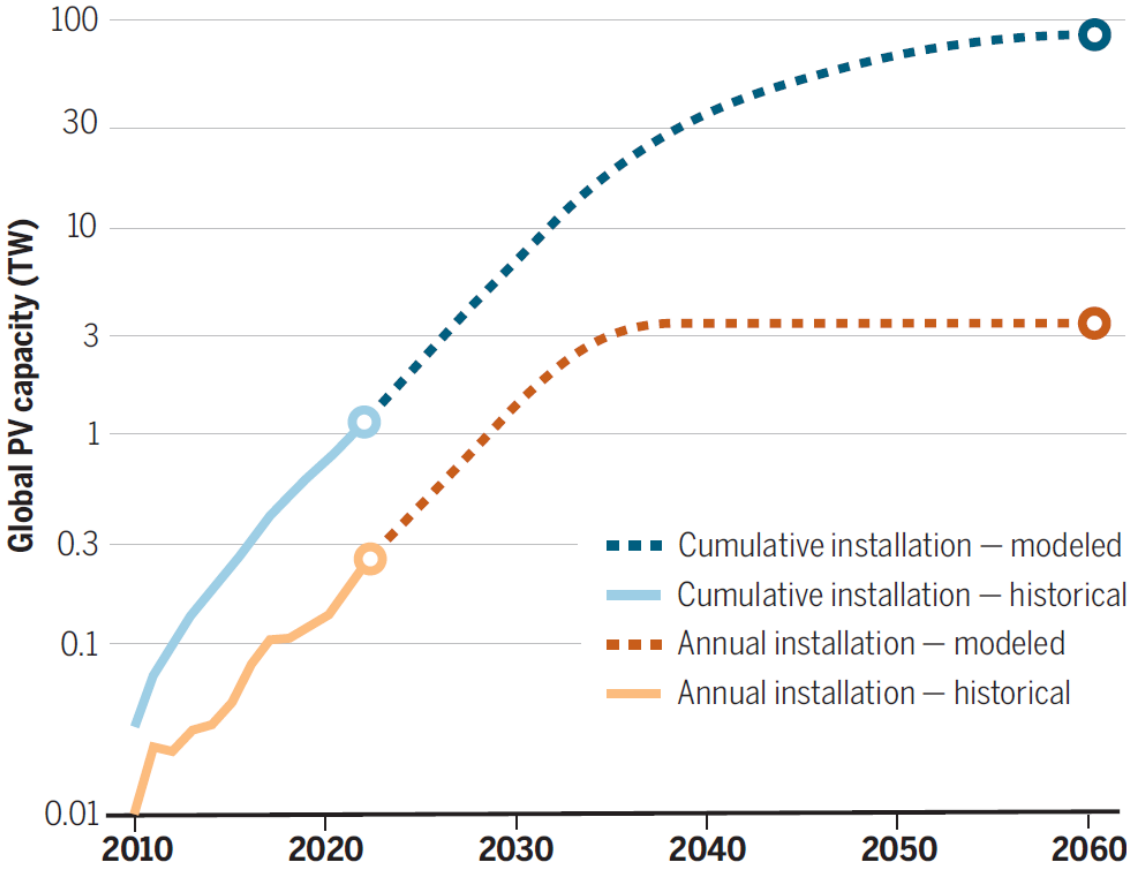
  - PV system at Wylie's Baths

Big Picture – The Future



- **Outrageous growth** to continue for 30 years
- **70 - 80 TWp** of installed PV by 2050
- **3-4 TWp installed each year**
- PV to generate 3-4 times the total global 2020 electricity consumption

N. Haegel et al. Science, ***380*** *6640, p.39 April 2023*

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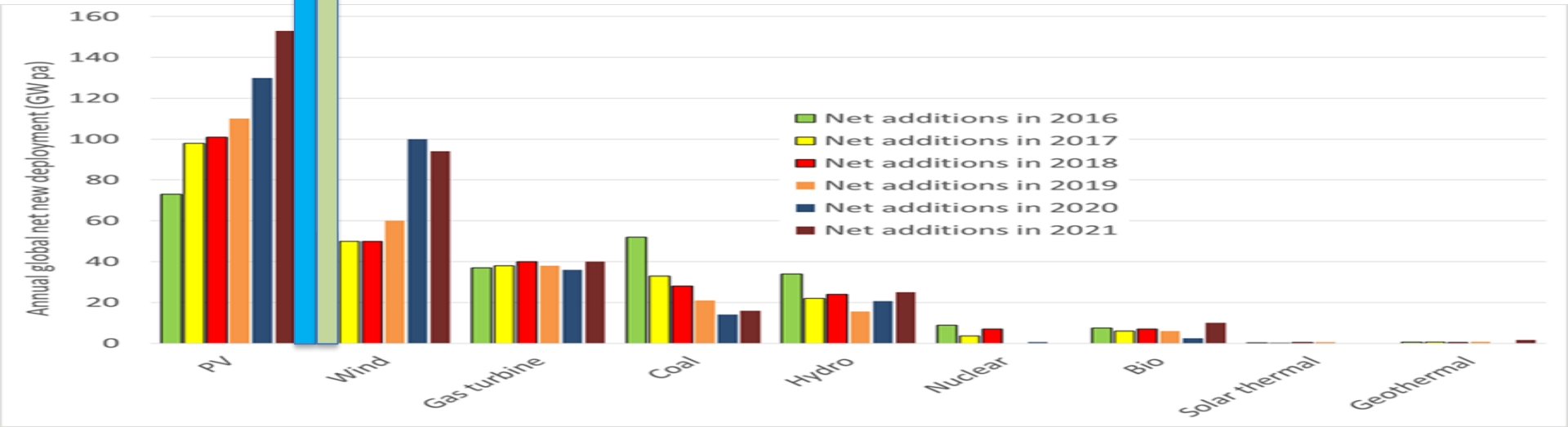
2023

2022

3 TWp p.a.

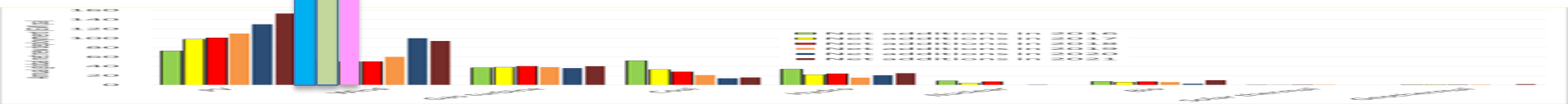


2040

2023

2022

3 TWp p.a.



Big Picture – The Future

Land area requirements:

The Sydney Morning Herald

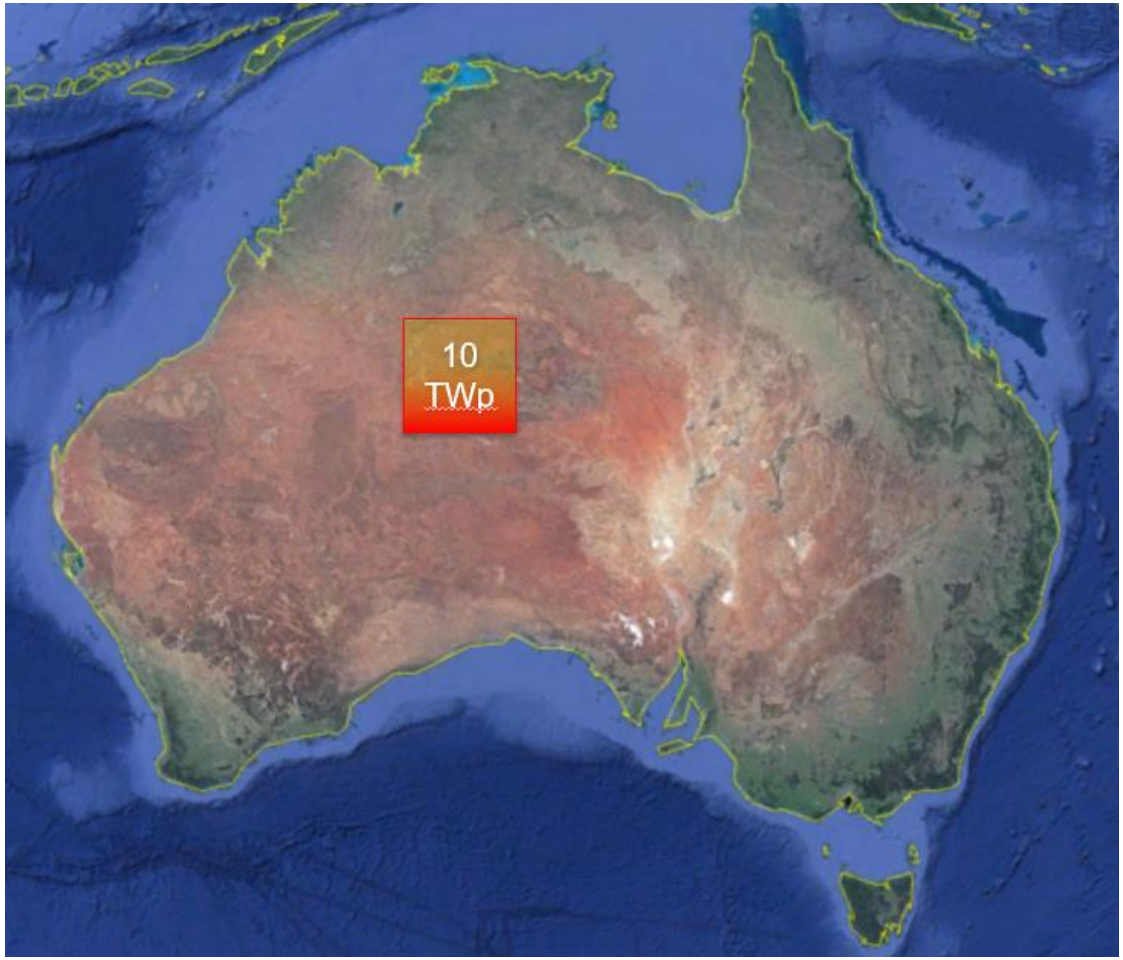
Exclusive Politics Federal Climate policy

Call to cancel renewable rollout, Nationals declare bush is full

Mike Foley and Nick O'Malley
February 6, 2024 — 7.30pm

Save Share A A A 692 View all comments

Big Picture – The Future



Land area requirements:

- 10 TWp installed in Australia
- Requires 450km x 450 km
- 2.5% of Australian land mass
- Sufficient to cover most of 2020 **global** electricity demand
- Vision for a future Australia as net exporter of energy

Big Picture
– The Future

Big Picture – The Future

Integration of renewables incl. high penetration of Solar PV is not trivial:

- Technical and market challenges create opportunities (**innovation**)
- Economics will drive this transition, but
- Achieving optimal outcomes require **systematic long term planning**
  - (political leadership, NOW)
- PV is only one of several key elements of the energy revolution:
  - Storage (batteries, **EVs**, pumped hydro)
  - Distribution (High voltage DC)
  - Demand side management
  - Energy efficiency

The “lucky country” is in pole position !

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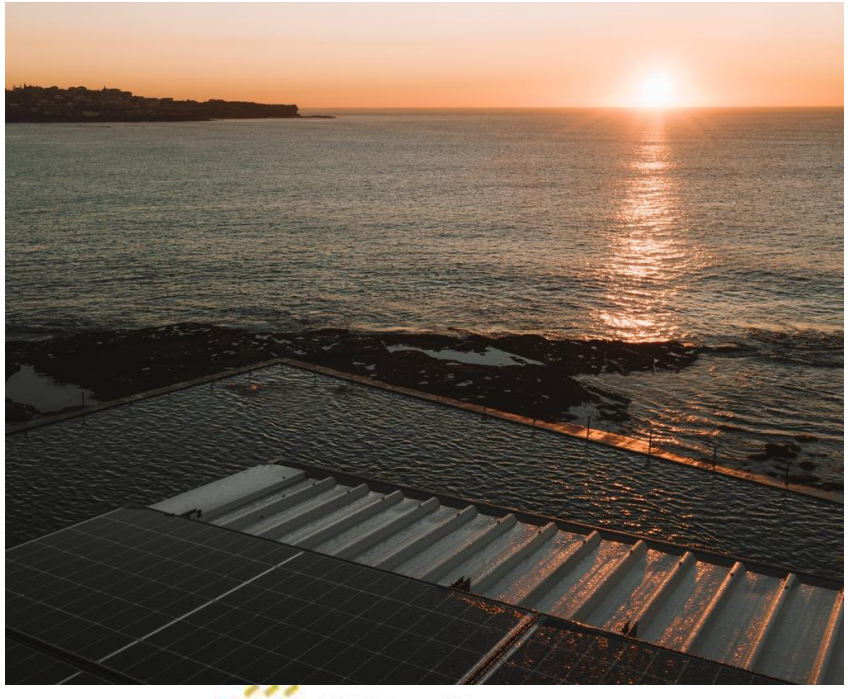
  - **PV system at Wylie's Baths**

Drone photos of Wylie's Baths courtesy of the "*3-Council Solar my Club*" program

The smaller picture

- the PV system at Wylie's Baths

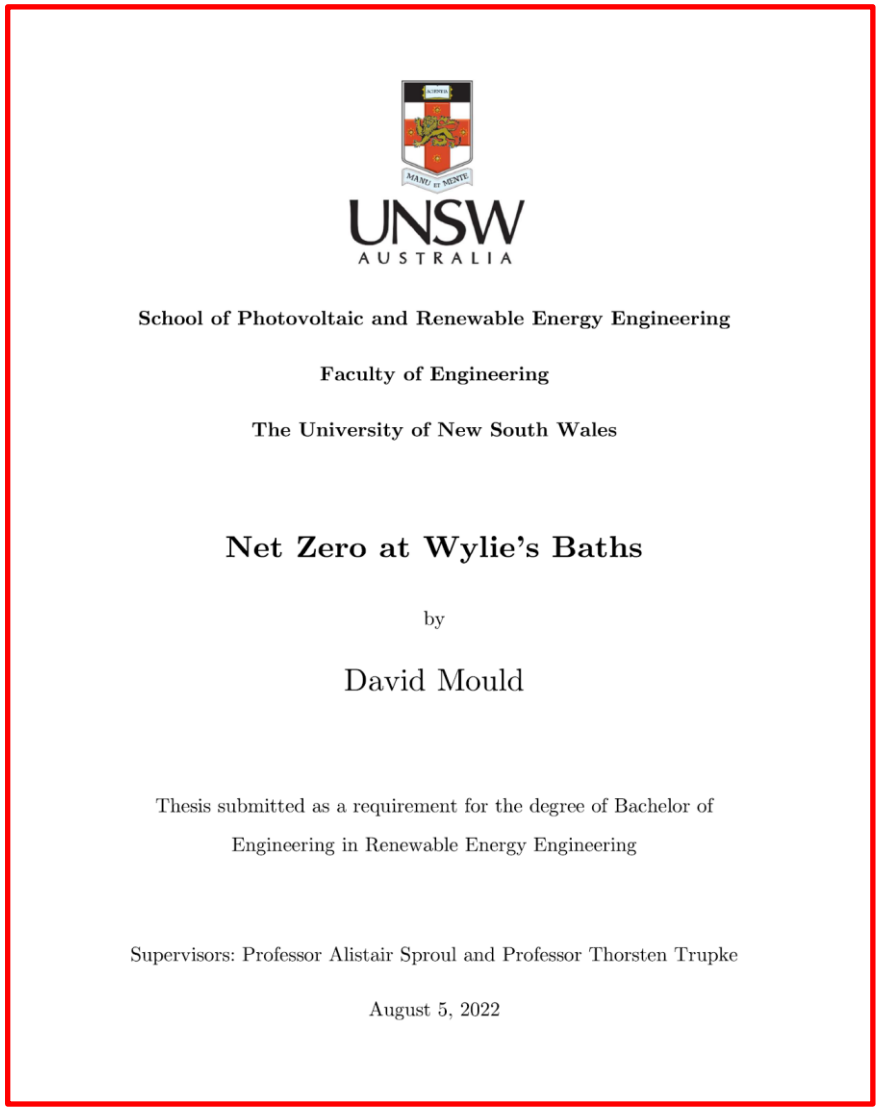


- Operational since **7 March 2021**
- 35 x Q-cells Maxx 350W panels
- 12.25 KWp DC
- 10 KWp AC
- Flat to roof mounting

Drone photos of Wylie's Baths courtesy of the "*3-Council Solar my Club*" program

The smaller picture

- the PV system at Wylie's Baths



UNSW AUSTRALIA

School of Photovoltaic and Renewable Energy Engineering

Faculty of Engineering

The University of New South Wales

Net Zero at Wylie's Baths

by

David Mould

Thesis submitted as a requirement for the degree of Bachelor of Engineering in Renewable Energy Engineering

Supervisors: Professor Alistair Sproul and Professor Thorsten Trupke

August 5, 2022

David Mould 4th year thesis:

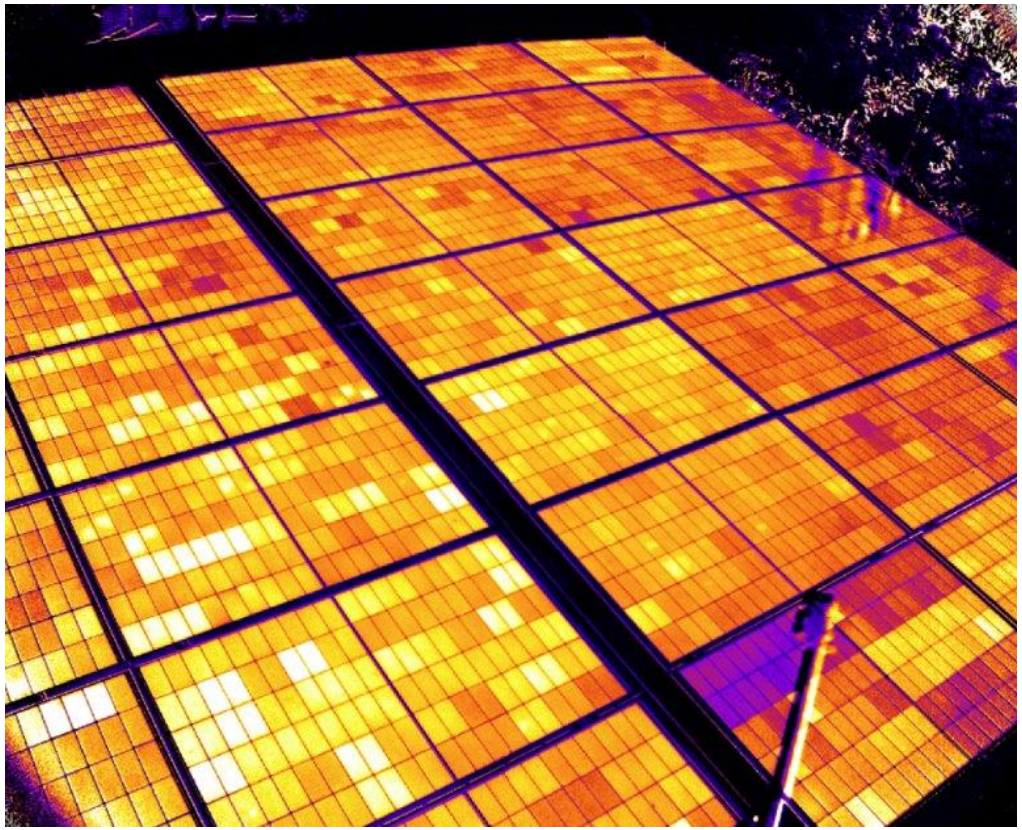
- Performance data analysis
- Energy saving measures
- Analysis of additional efficiency upgrades

The smaller picture

- the PV system at Wylie's Baths

Australian Government
Australian Renewable Energy Agency

ARENA



Testing world-first "luminescence imaging" solutions at Wylie's Baths

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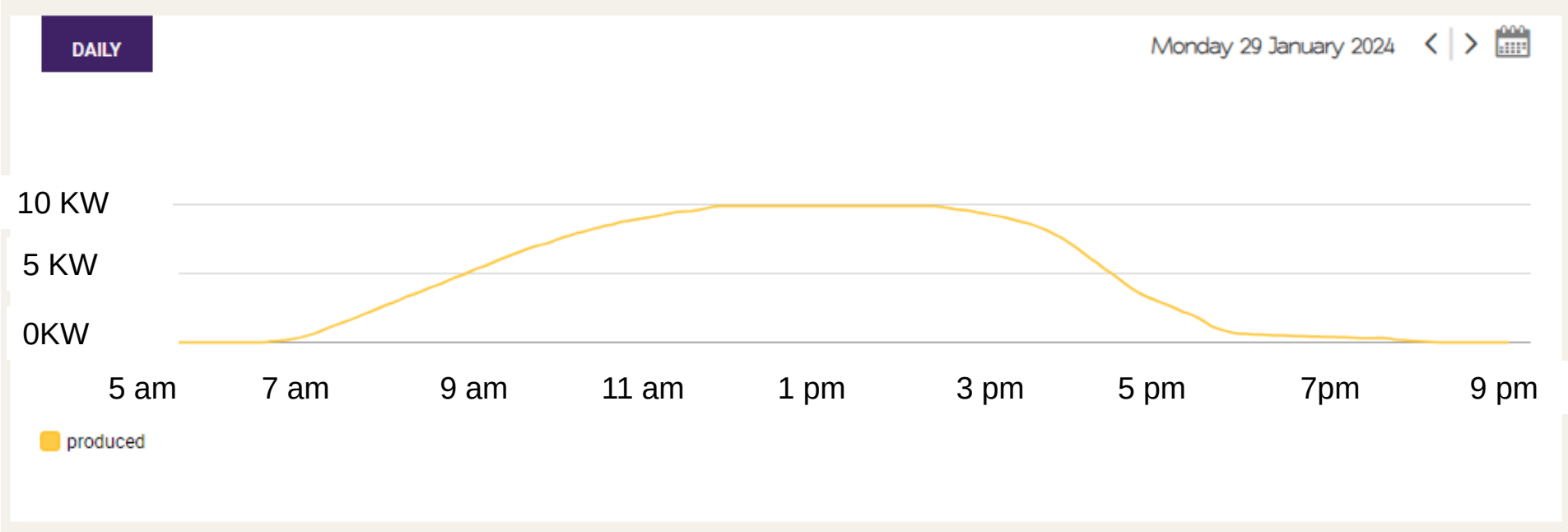
The smaller picture

- the PV system at Wylie's Baths

A perfect sunny day: **29 January 2024**



PV generation
Total: **75.6 kWh**

Total Consumption
Total: **172 kWh**

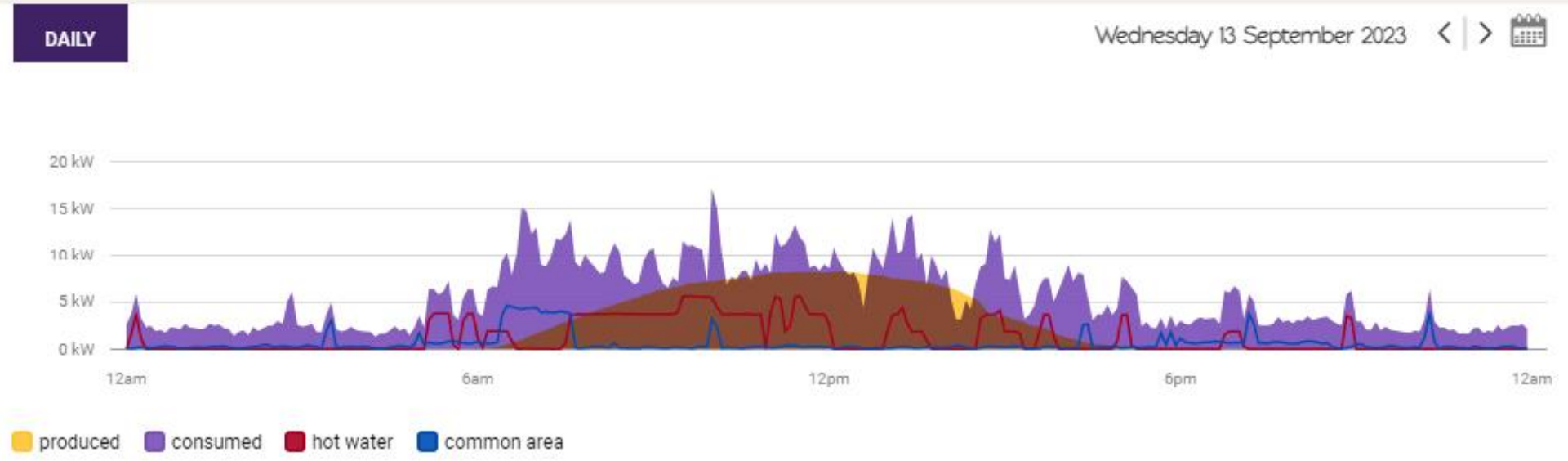
44 % of all used electricity was generated by PV onsite!

The smaller picture

- the PV system at Wylie's Baths

A perfect sunny day: **13 September 2023**

solar analytics



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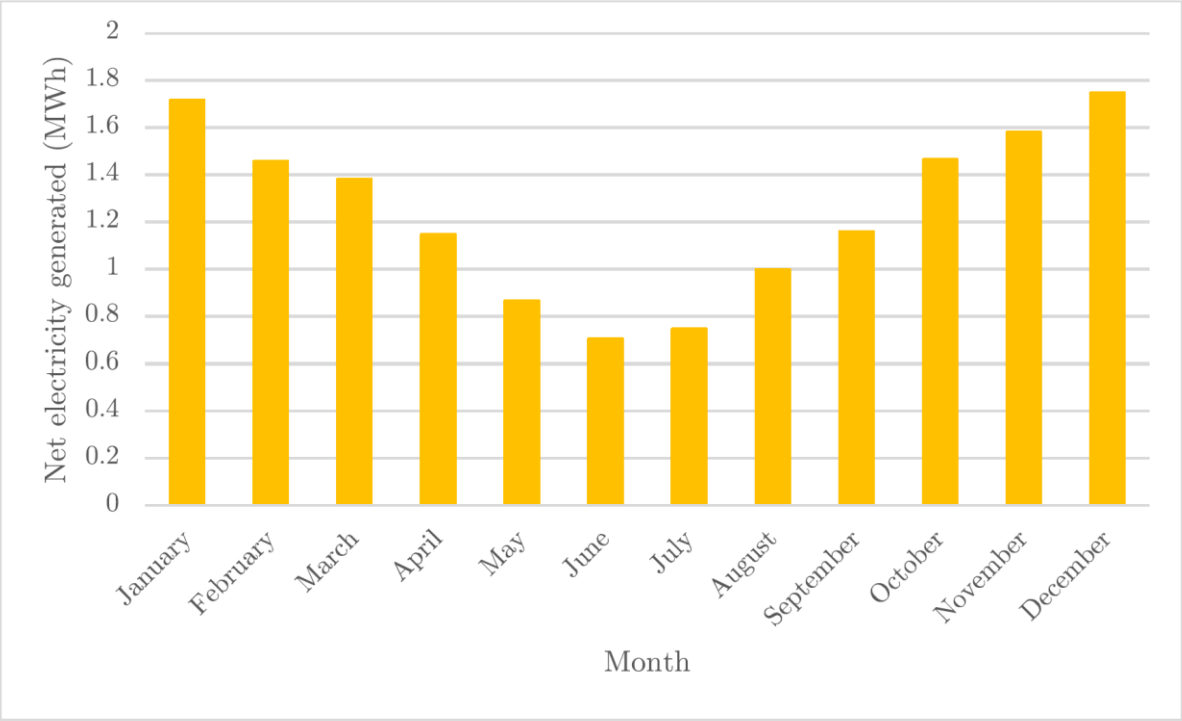
The smaller picture

- the PV system at Wylie's Baths

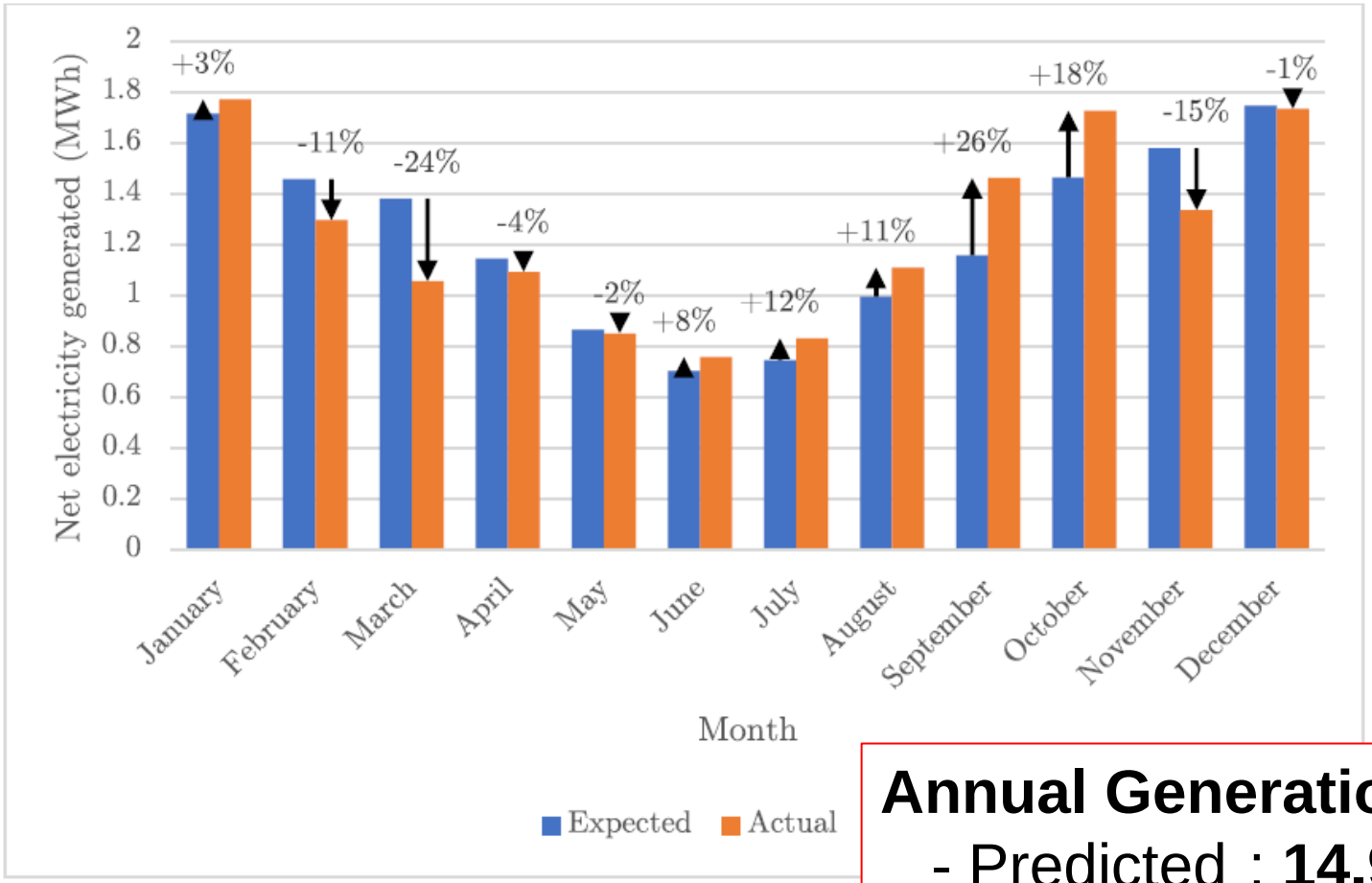


Annual Generation :

- Predicted : **14.97 MWh**

The smaller picture

- the PV system at Wylie's Baths



Annual Generation :

- Predicted : **14.97 MWh**
- Actual : **15.04 MWh**

The smaller picture

- the PV system at Wylie's Baths

IQ Solar
PERFORMANCE GUARANTEED

Financials:

- **Annual PV generation:** 15 MWh = 15,000 KWh

  "Virtually 100% of PV generated power is consumed onsite"

  "Every KWh generated does not need to be imported from the grid"

- **Electricity price at Wylies's Baths:** $0.418 / KWh
- **Annual saving:** 15,000 x $0.418 = **$ 6,270 per year**
- **System Cost:** $15,821

Break even after 2.5 years!

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The smaller picture

- the PV system at Wylie's Baths

Additional PV

Kiosk: 7.5MWh p.a.

Showers: 6.7MWh p.a.

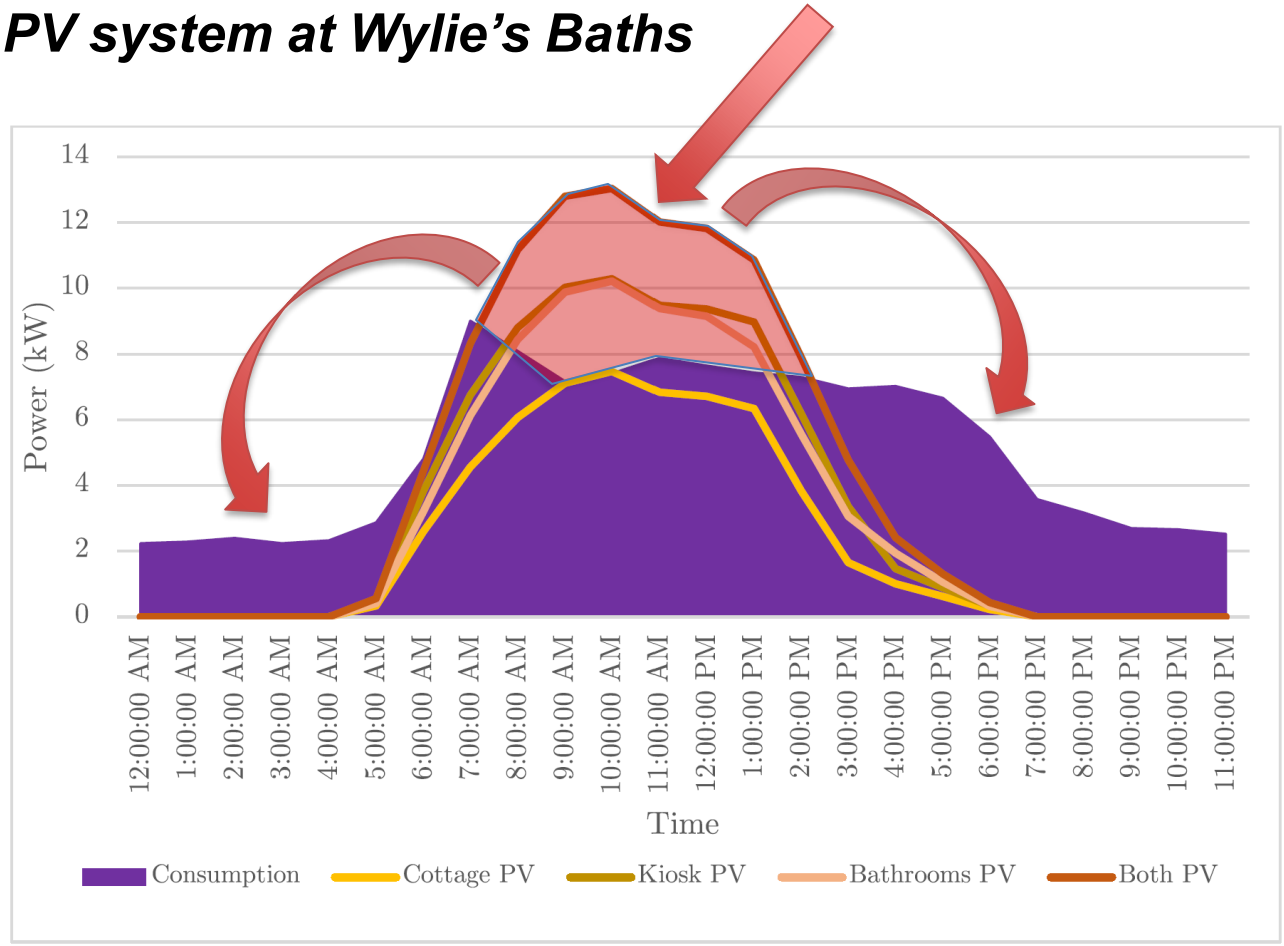
"Potential to double annual PV generation"

Also looking into heat pumps to replace electric water heaters

The smaller picture

- the PV system at Wylie's Baths

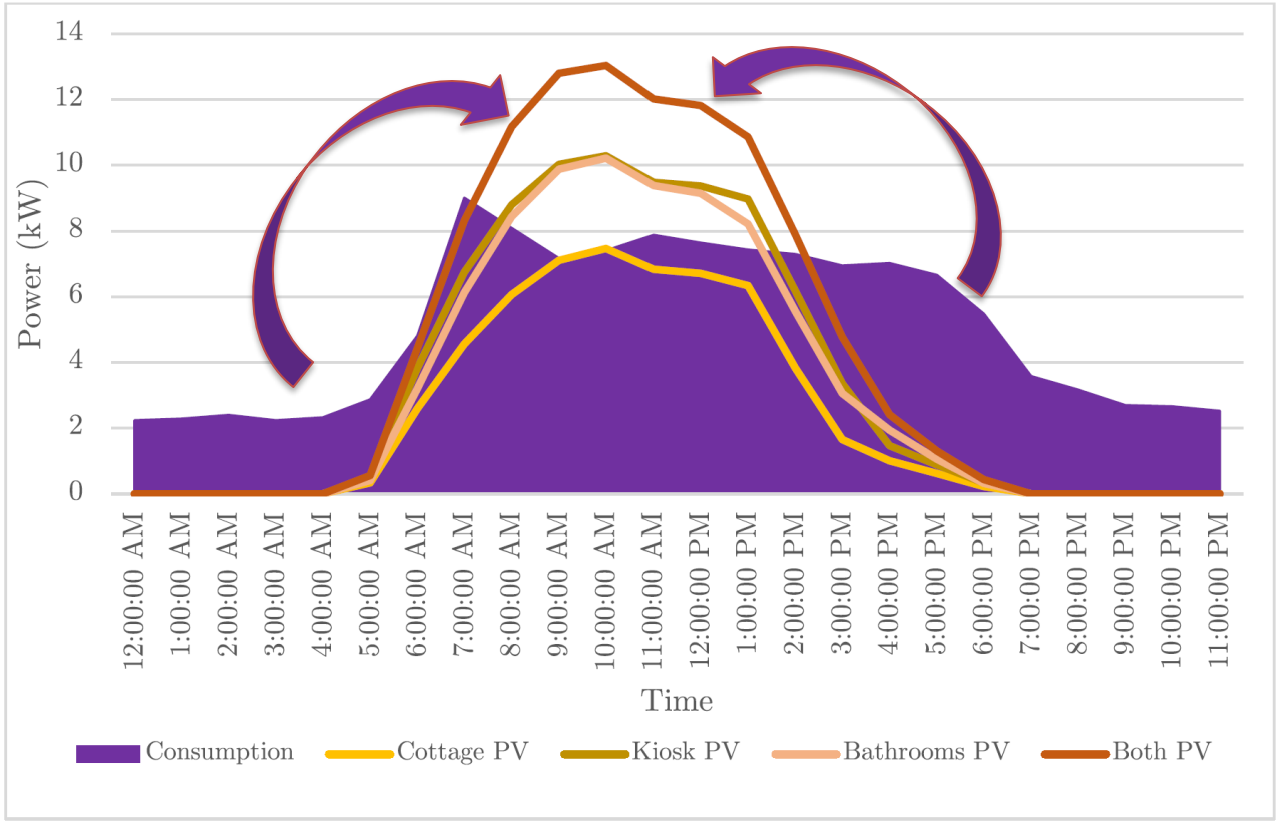
- **Excess energy, that is not needed during the day**



- Additional PV cannot be 100% self-consumed
- **Storage:** Battery stores excess energy for consumption at other times

The smaller picture

- the PV system at Wylie's Baths



Demand side management:

- Move consumption into daytime
- Turn appliances off at night or when not in use
- Replace energy inefficient appliances

Summary

- A future in which 70 TWp of PV is installed globally is feasible – a future to look forward to!
- The road to that future is not trivial. Technical and market challenges exist - represent opportunities for Australian innovation
- Australia has an outstanding renewable energy R&D ecosystem, established over 50 years
- Australia set to be the lucky country – once again

- Energy efficiency measures at Wylie's Baths can be seen as a microcosmos of the transitions that must take place on a large scale
- This transition requires **systematic planning** and **political leadership** to avoid inefficiencies and social imbalances

Q&A


Solar Talk @ Wylie’s Baths
Friday 1 March

Questions welcome!

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The Nuclear Option

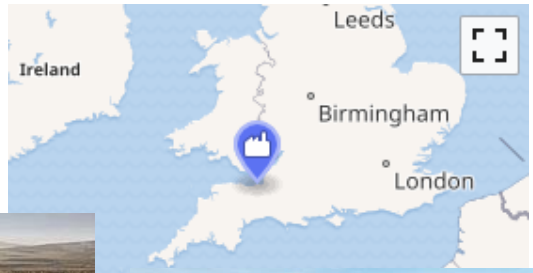
Hinkley Point C – *a cautionary tale*

- A 3,260 MW nuclear power plant under construction in England
- First new nuclear power facility built in the UK since 1995 and first built in Europe since the 2011 Fukushima disaster
- Additional reactor at an **existing nuclear power site**
- Expected construction cost estimates:
  - 2012: £16bn
  - 2015: £18bn
  - 2023: £33bn (now expected to be exceeded)
- Built by a consortium of **French EDF** and **state-owned China General Power (CGP)**
- After paying contracted 1/3 of the original budget, **CGP recently refused to pay their share of the substantial cost overruns**

- **Electricity cost:** Guaranteed wholesale price of £ 92.50 / MWh (**inflation adjusted to 2012 pounds** for the construction period and 35 years of operation)
  - i.e. ~ £ 128 / MWh (**~ 25c / kWh in AUD). This is the wholesale price!**
    - **~ 3 times firmed renewables!**

The Nuclear Option

Hinkley Point C – *a cautionary tale*



Timeline

2007: First submission of the reactor design to UK's Office of Nuclear Regulation (ONR)
2011: EDF submits application to UK's Infrastructure Planning Commission
2013: Development Consent Order form the UK government
2015: EDF and CGP sign strategic joint investment agreement
2016: Final investment decision on the project, final go-ahead from UK government
2017: Breaking ground, **anticipated completion 2023**
2019: Steel containment liner placed, using the world's biggest land-based crane
2023: Scheduled commissioning date now expected in **2028** (multiple delays)

> 20 years from first submission to commissioning, in a country with existing nuclear infrastructure and associated regulatory frameworks and supply chains