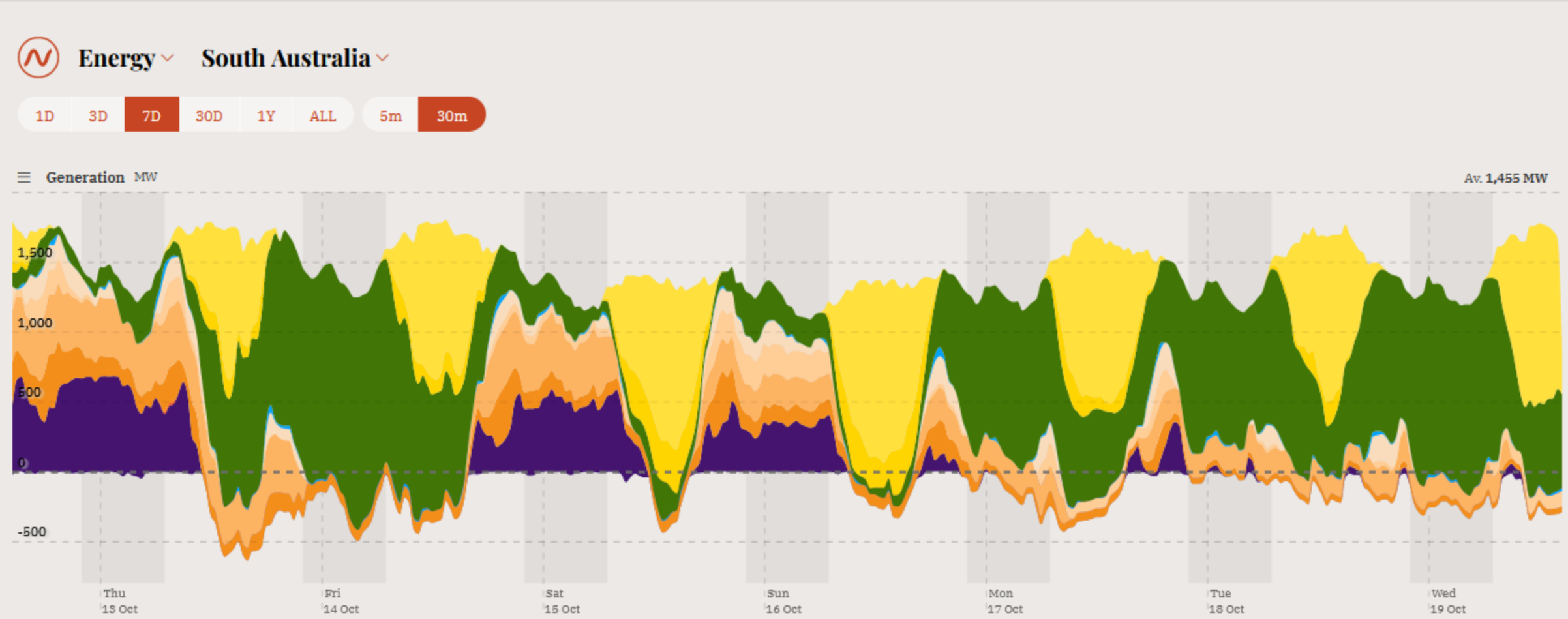
Electrification – managing energy data

Dr Richard Bean, FAIE
University of Queensland
Hatch Newcastle
Monday 24 October 2022

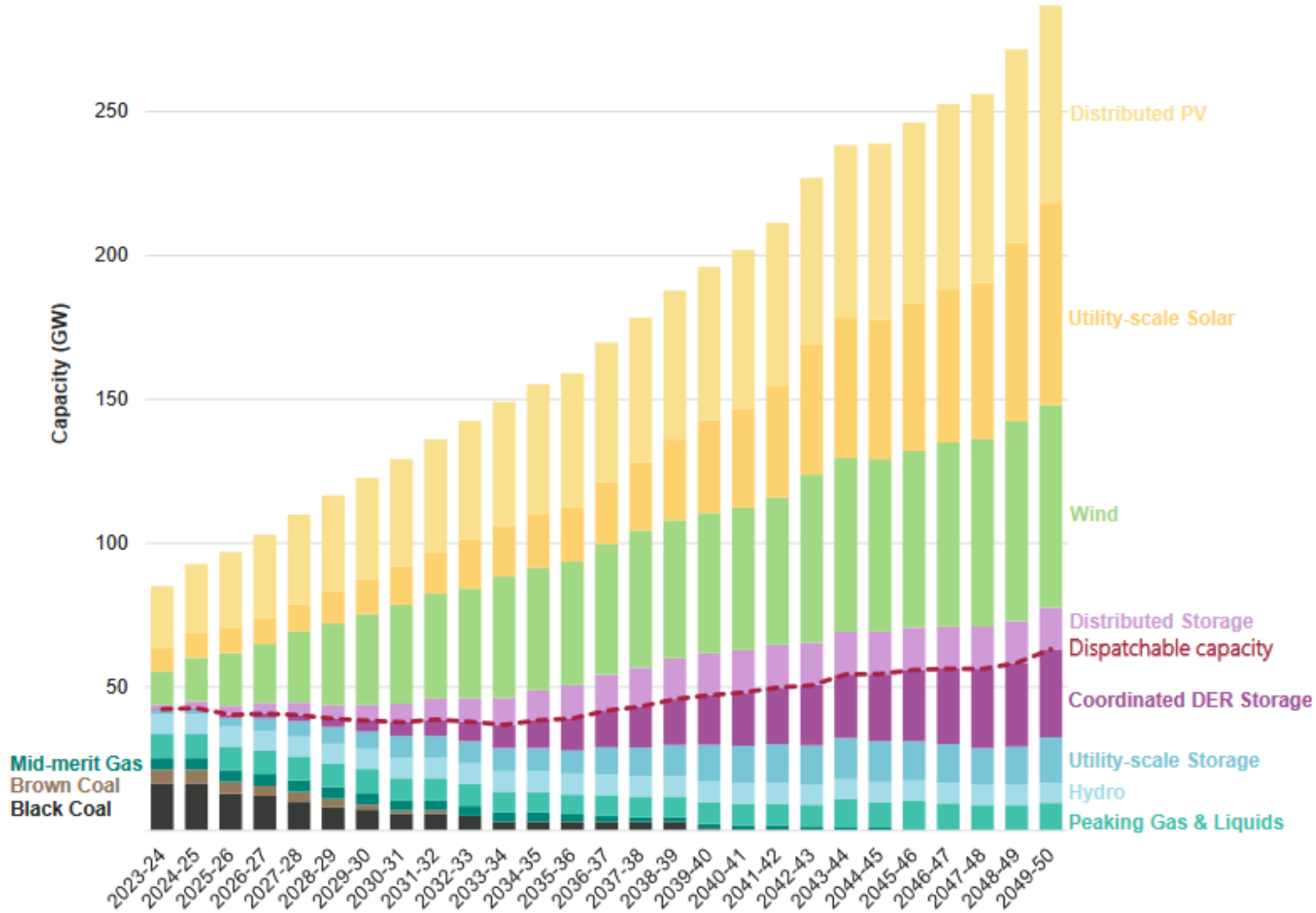
A WEEK IN SOUTH AUSTRALIA



Source: OpenNEM.org.au 19 October 2022 (yellow = Rooftop and Utility Solar, green = wind)

AEMO Integrated System Plan forecast

Figure 1 Forecast NEM capacity to 2050, *Step Change* scenario

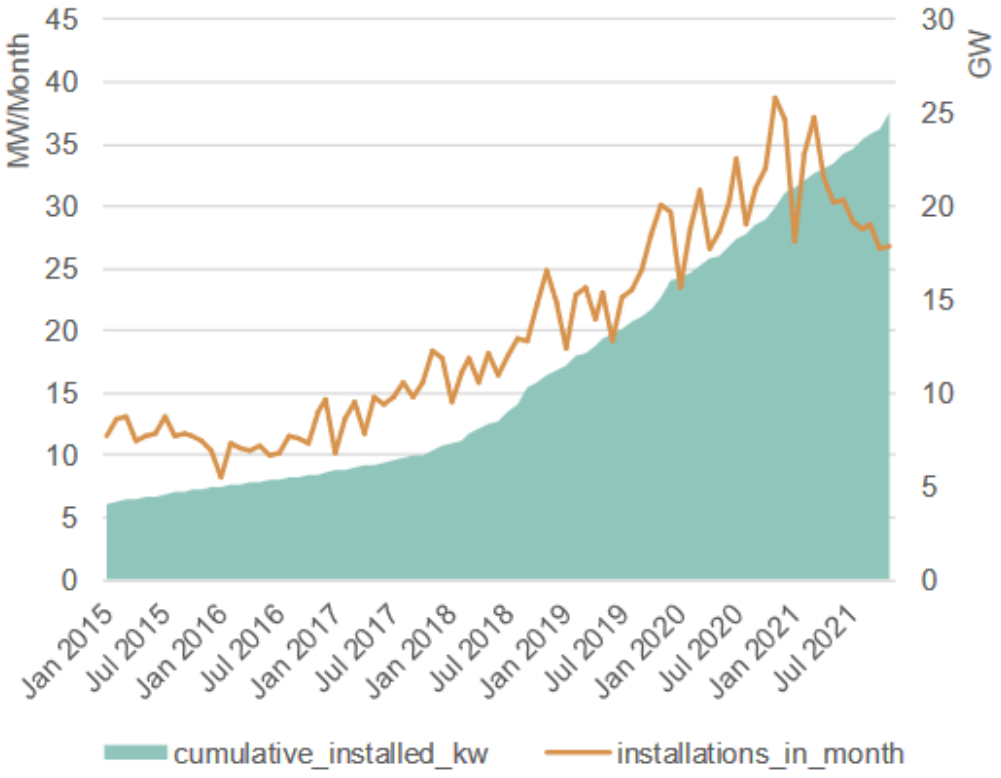


Source: AEMO 2022 ISP based on May 2022 information

ARENA FORECAST

DER Penetration Continues Apace

PV has seen an average annual growth rate of 32%[1]

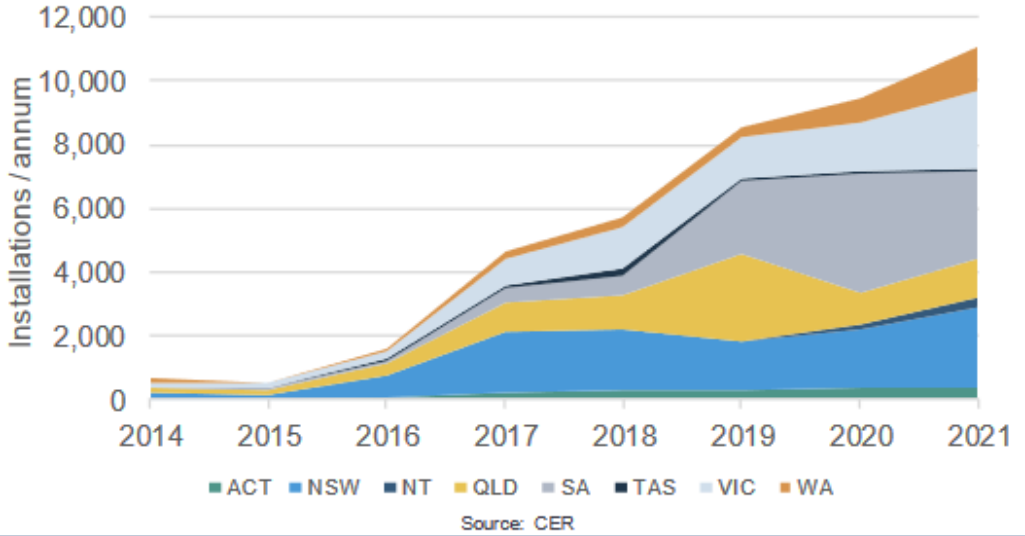


Source: APVI

DEIP

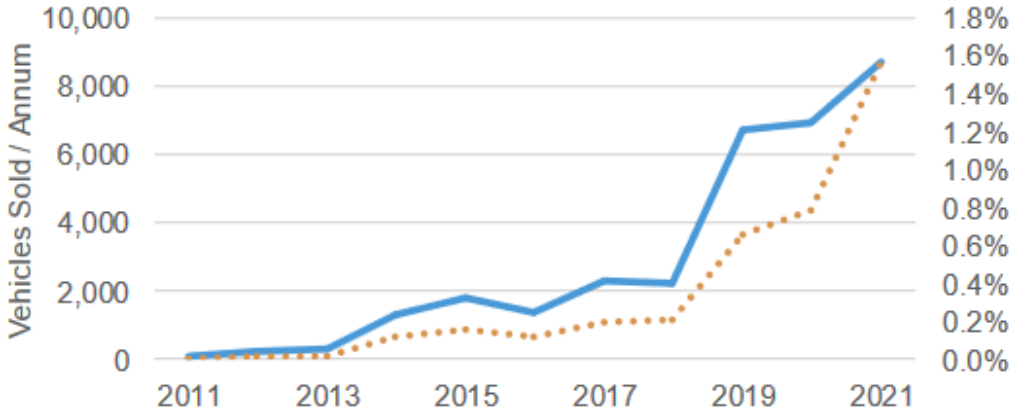
[1] Figures quoted are from 2017 to present

Small batteries have an average annual growth rate of 28%[1]



Source: CER

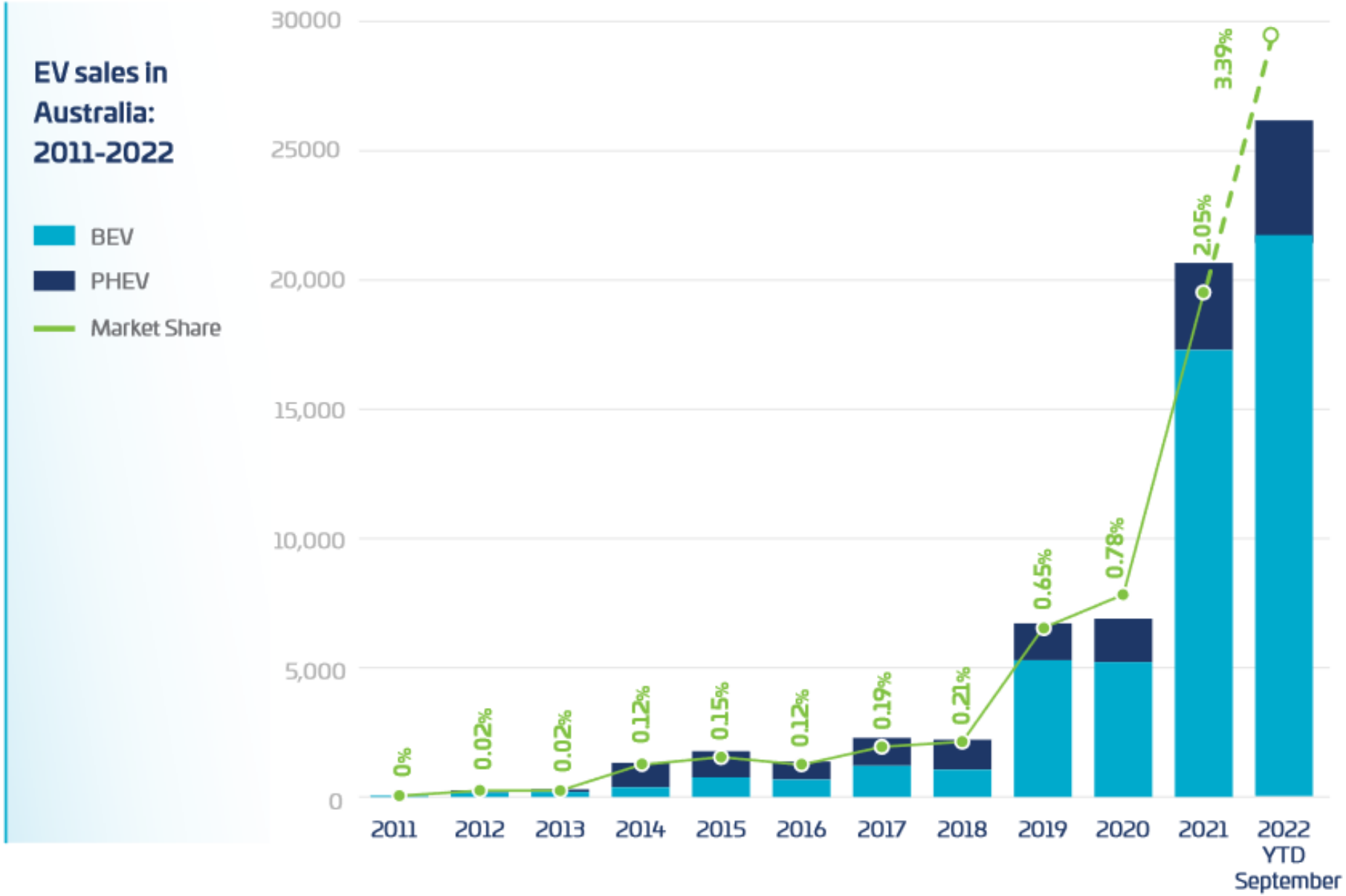
EVs have an average annual growth rate of 59%[1]



Source: EVC State of EVs 2021

Source: ARENA DEIP presentation March 2022

EV COUNCIL SALES FIGURES



Source: EV Council October 2022

CSIRO PROJECTION FOR SMALL-SCALE EMBEDDED TECHNOLOGIES

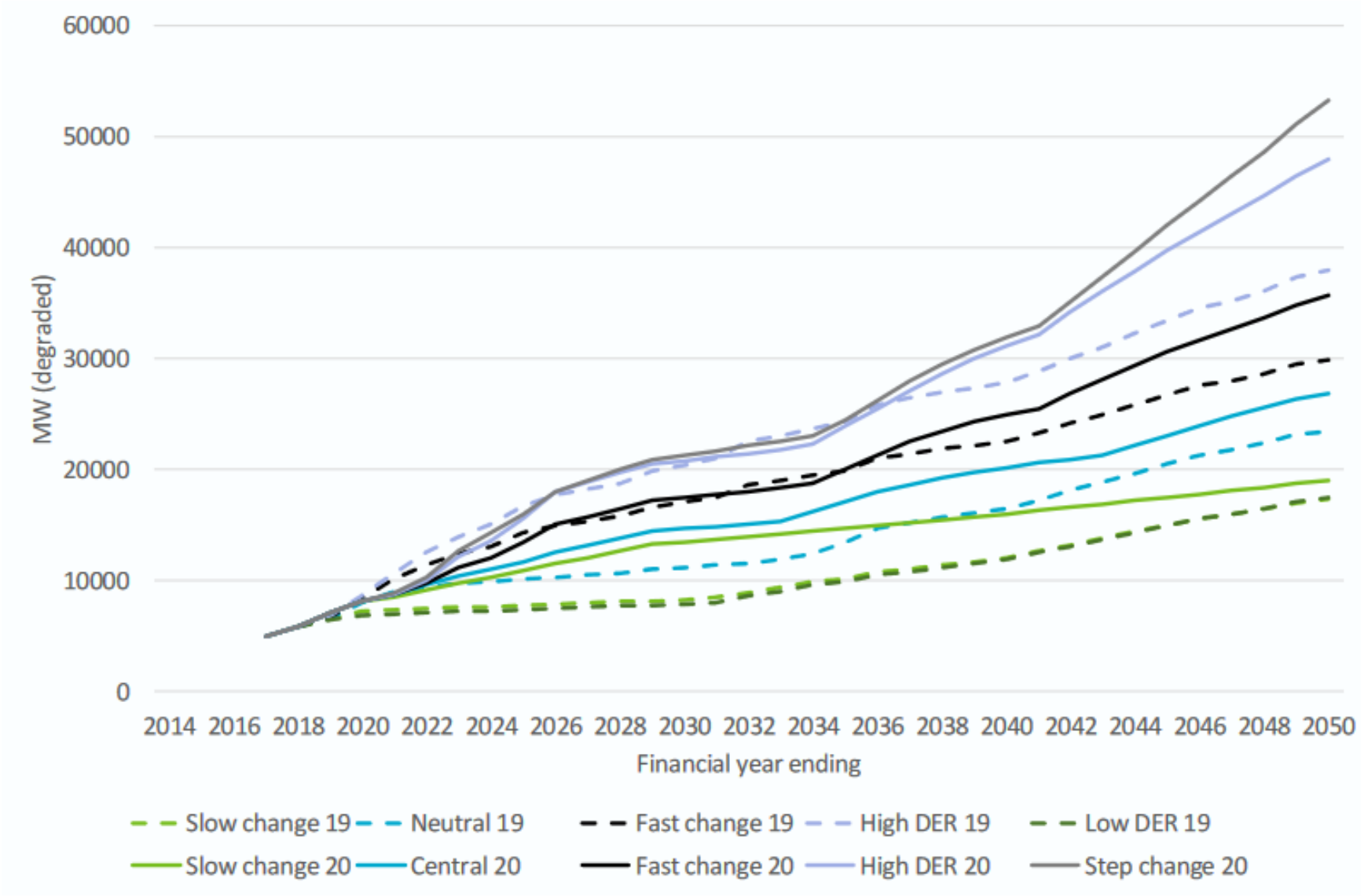


Figure 5-1 Projected national capacity of residential rooftop solar by scenario compared with 2019 projections

Source: CSIRO projections document 2020

CSIRO PROJECTION FOR SMALL-SCALE EMBEDDED TECHNOLOGIES

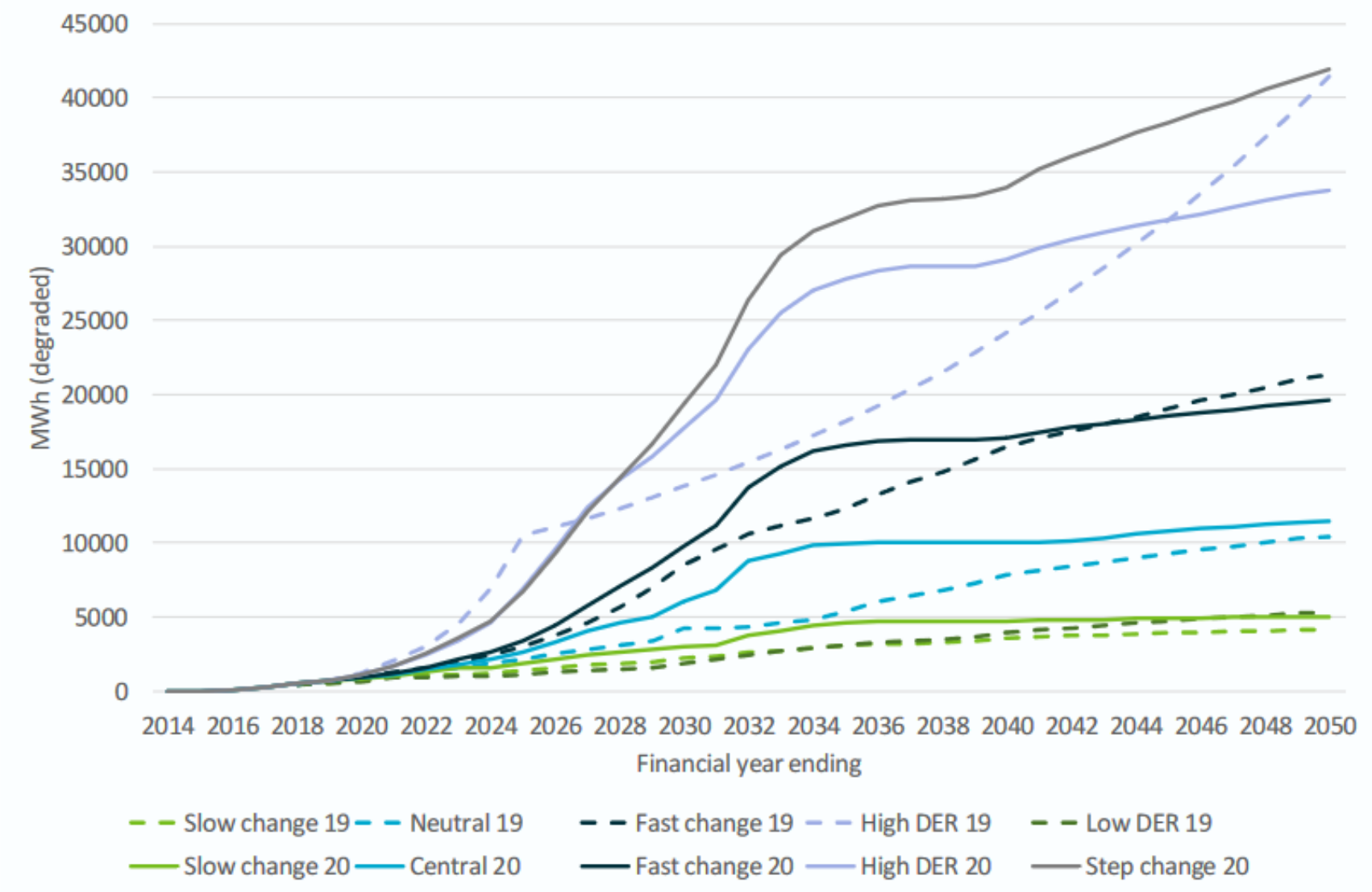
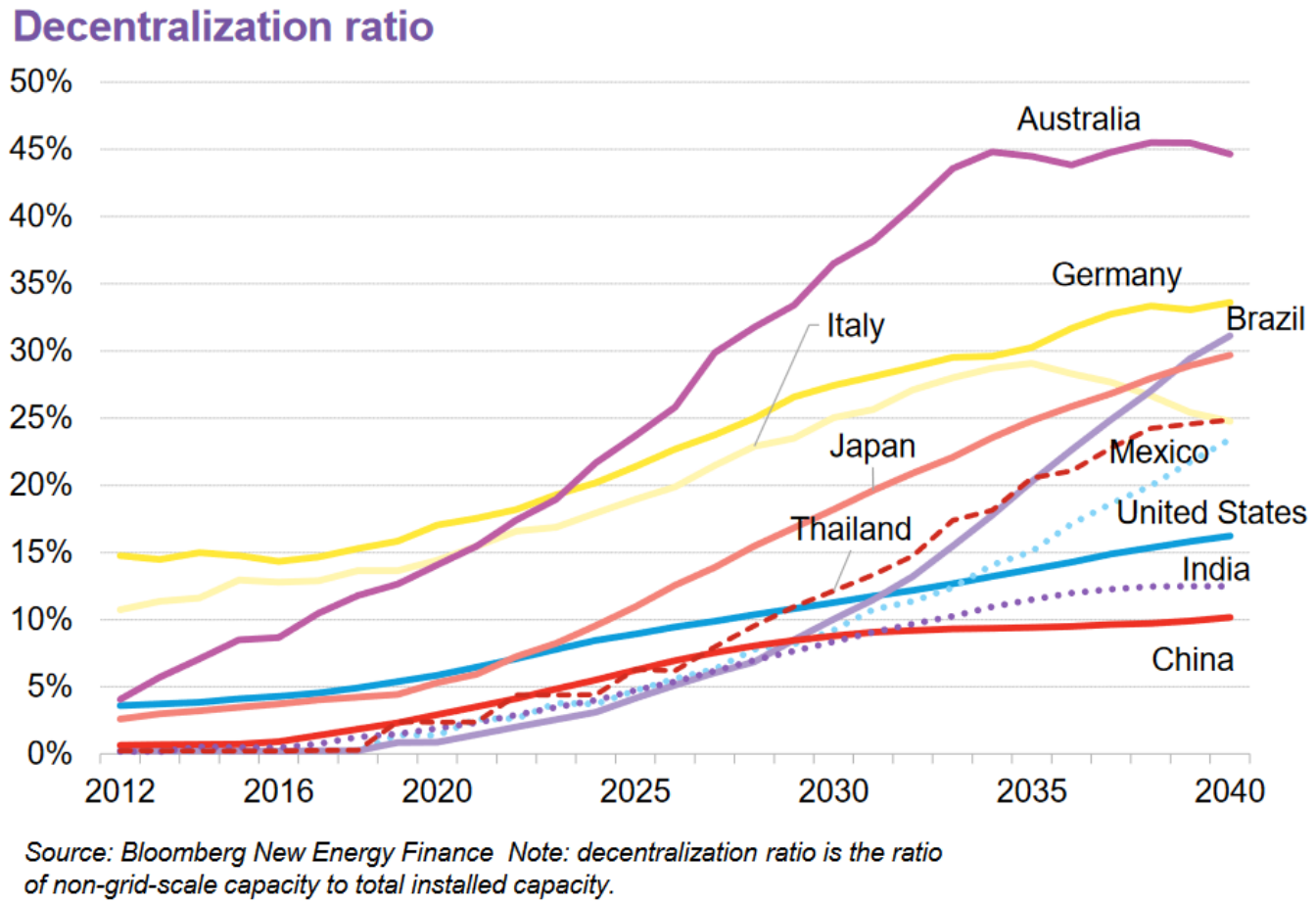


Figure 5-6 Projected capacity of residential batteries compared to 2019 projections

Source: CSIRO projections document 2020

DECENTRALISED FUTURE

Australia, Germany, Japan, Brazil – most decentralized

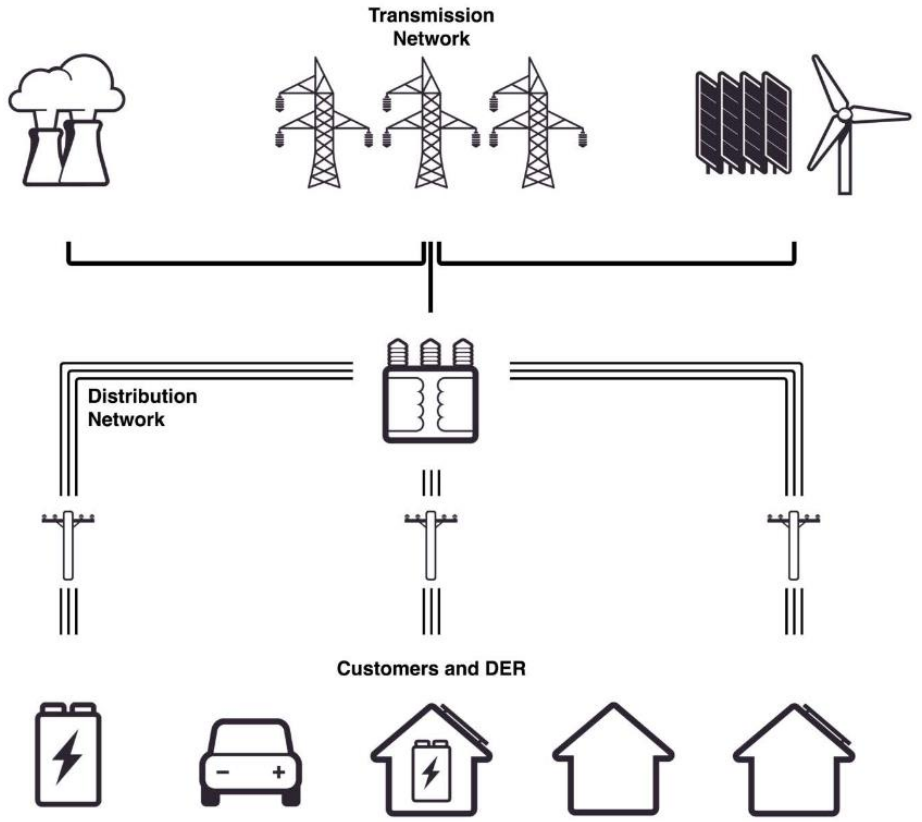


Source: Bloomberg New Energy Finance Note: decentralization ratio is the ratio of non-grid-scale capacity to total installed capacity.

Source: BNEF New Energy Outlook 2017

Dynamic Operating Envelopes

Distribution network operators have poor visibility of low voltage networks.
Don't want to exceed physical and operational limits.
Bi-directional flows of energy in the distribution network.
"DOEs are dynamic connection limits that represent the guard rails of the distribution network"



Source: "On the calculation and use of dynamic operating envelopes" (ARENA 2020)

Dynamic Operating Envelopes

ACT NextGen Battery storage program (230 V +10% -6%)

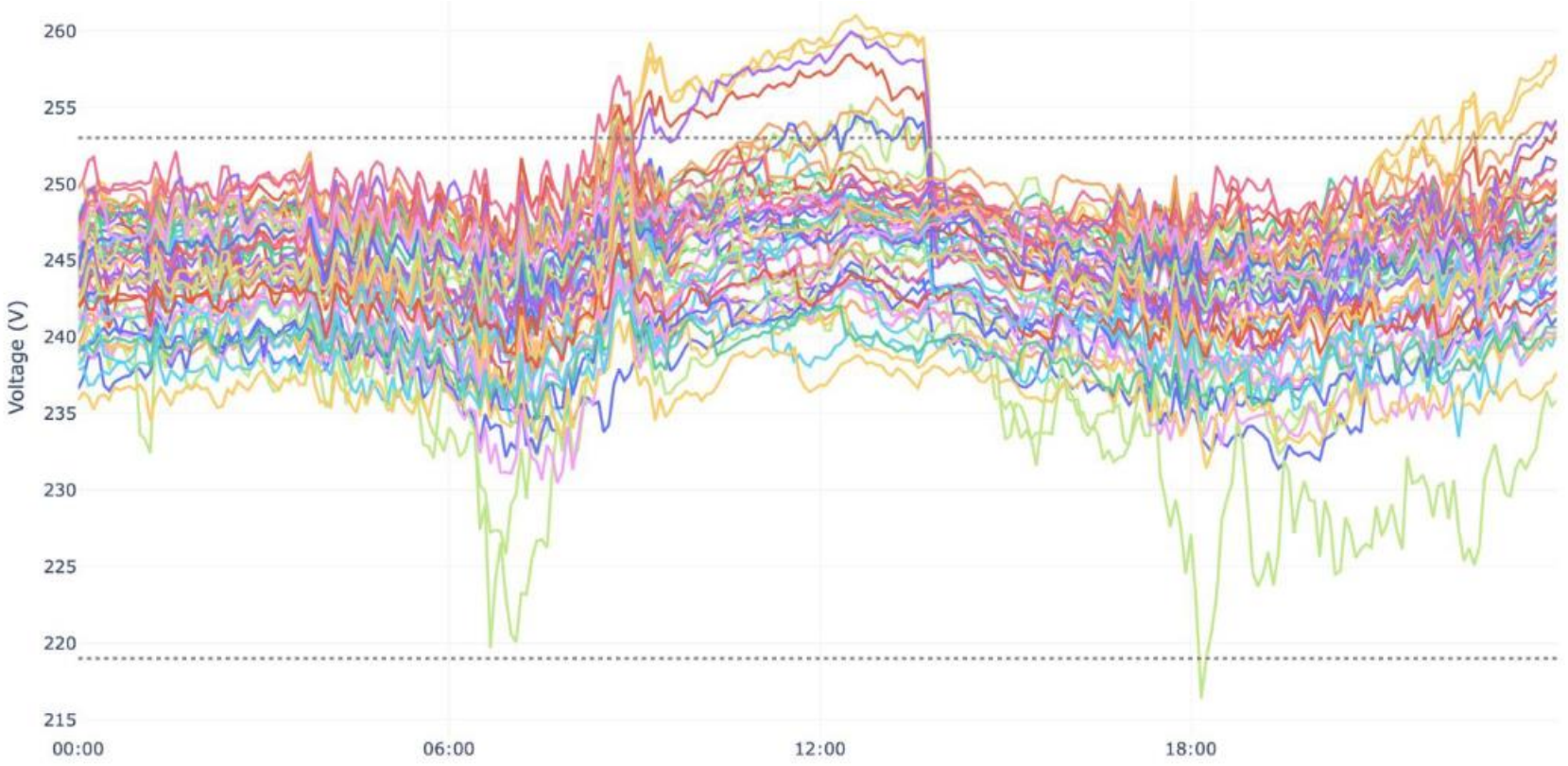


Figure 7. Voltage measurements from customers participating in the ACT NextGen Battery Storage Program for the 30th August 2018. These measurements demonstrate over-voltage conditions during the day due to residential solar PV, with some under-voltage conditions occurring in the morning and evening peak periods due to high-demand. This image is a clear example of the increasing dynamic range of voltage conditions experienced on the electricity distribution network.

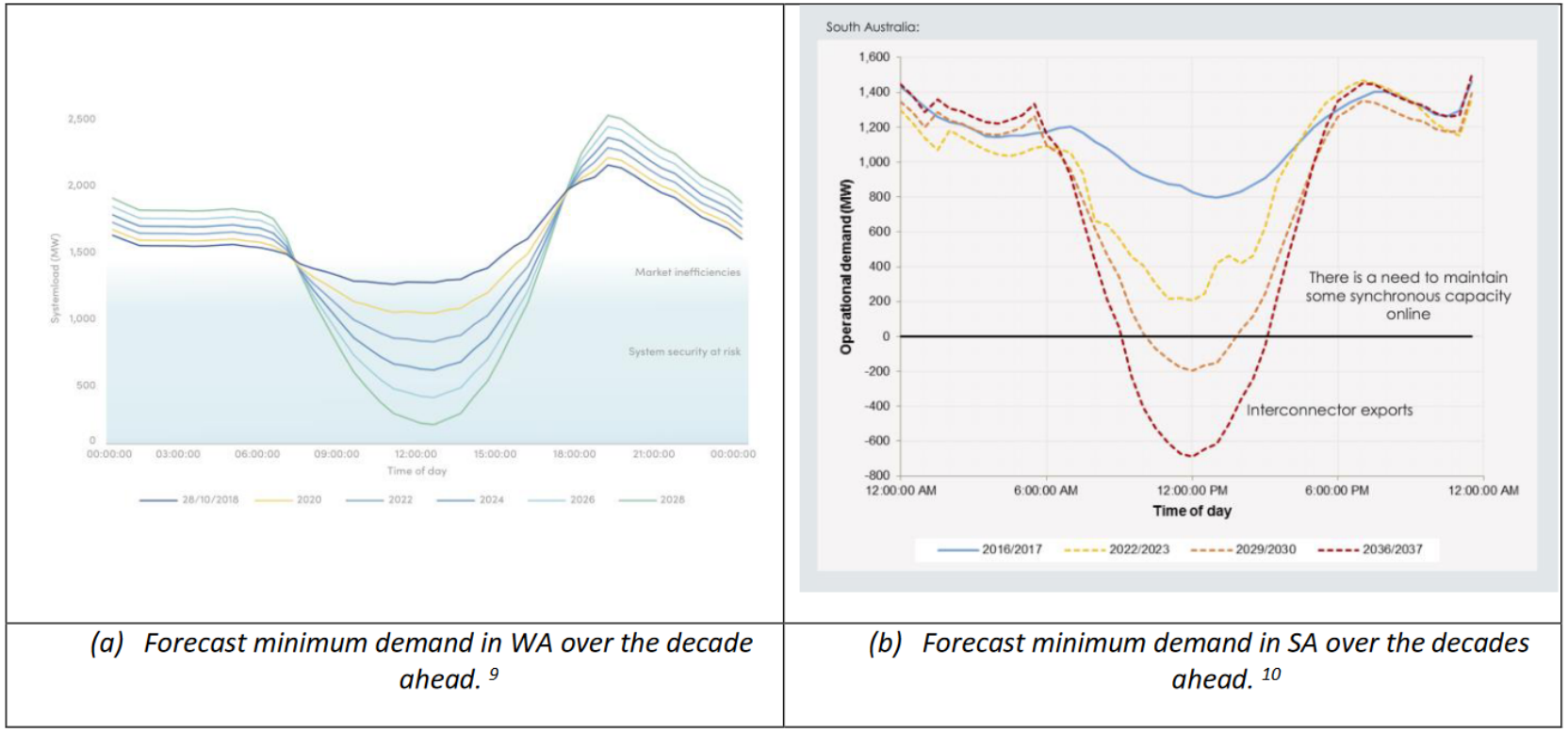
Source: "On the calculation and use of dynamic operating envelopes" (ARENA 2020)

AUSTRALIAN RENEWABLE ENERGY AGENCY (ARENA) PROGRAMS

Distributed Energy Integration Program (DEIP)

Dynamic Operating Envelopes Workstream

Instead of offering customers a static export limit, we can vary import and export limits based on time and location, enabling greater hosting capacity on the local network and better integrating renewables into the network.



(a) Forecast minimum demand in WA over the decade ahead. [9]

(b) Forecast minimum demand in SA over the decades ahead. [10]

Figure 18. Understanding how to maintain energy security is an increasingly urgent challenge as several locations in Australia, in this case Western Australia and South Australia, are headed towards negative minimum demand over the coming decades.

Source: ARENA "On the Calculation and use of DOEs" (2020)

PROJECT SHIELD

Synchronising **H**eterogeneous **I**nformation to **E**valuate **L**imits for **D**NSPs

Partners:

- University of Queensland
- GridQube Pty Ltd
- Essential Energy
- Ergon Energy
- Energex
- Luceo Energy

Project SHIELD aims to develop software that aggregates data from a range of sources to help distribution network service providers (DNSPs) manage distributed energy resources (DER) in low voltage networks.

See
https://ProjectShield.com.au
https://arena.gov.au/projects/project-shield/

PROJECT SHIELD

Previous Redback / Luceo / Energy Queensland project

- Installed 20,000 devices on households in Queensland to collect **one-minute resolution energy data** (e.g. voltage, current, power factor)

- Can be used for **real-time visualization** of what is happening in a distribution network

- The data is also useful for studying how much data we need on a particular distribution transformer to confidently provide a dynamic export limit (**GridQube simulation**)

- Idea to provide access to **collected data** to researchers

Forecasting Energy on micro/macro Level

Some organisations already provide solar “nowcasting” e.g. **SolCast, OpenClimateFix.**

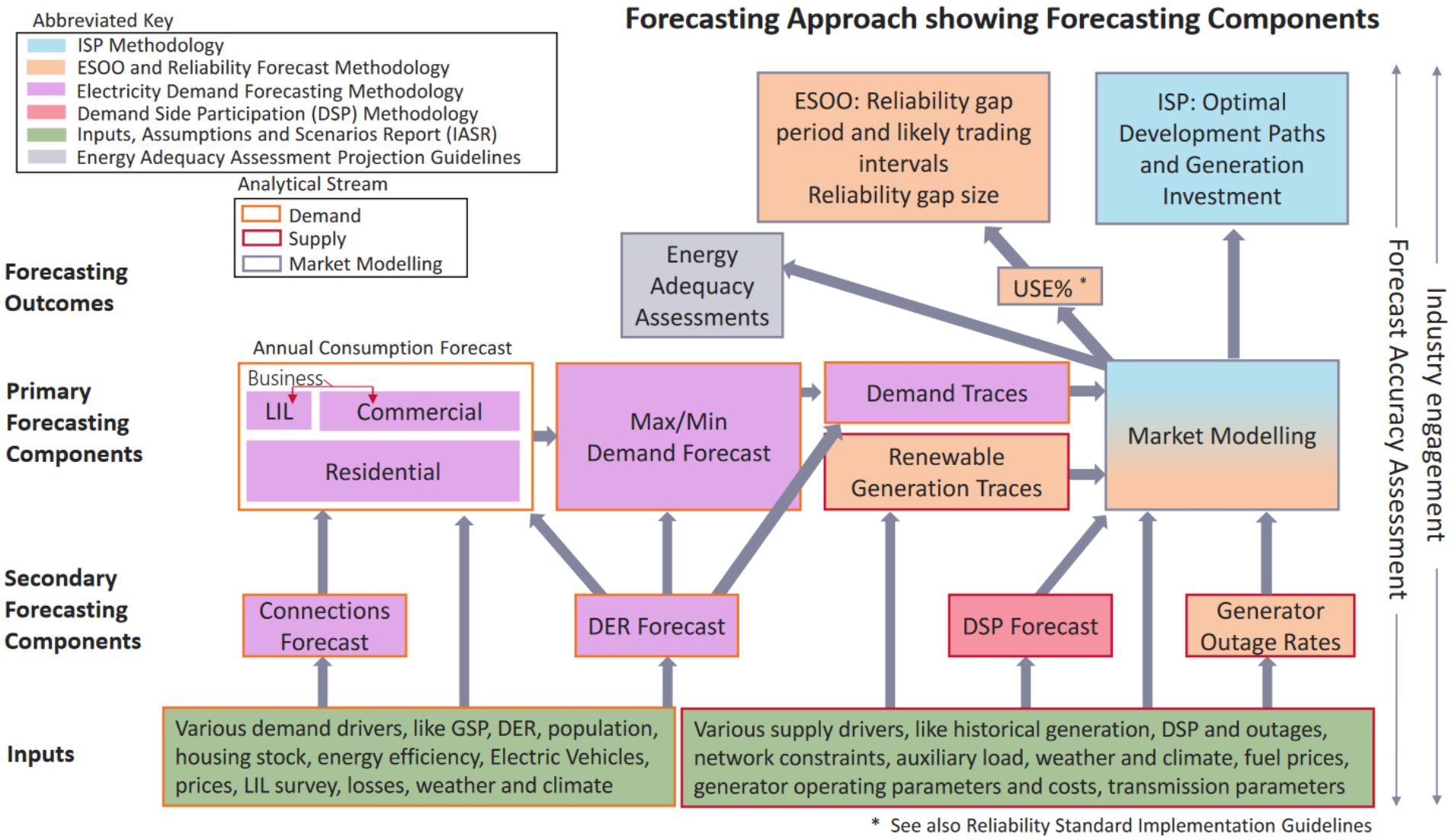
The principles of forecasting at the residential / distribution transformer / regional level are similar e.g. **regression** with weather variables, numerical weather prediction (NWP)

We are interested in **real-time** and **day-ahead** forecasting of solar generation and household load (how batteries will behave could a problem if they act in correlated ways).

Forecasting **individual households** is very difficult

Also, ideally want to use **probabilistic** forecast not just a **point** forecast.
Challenges with control room integration, IT etc.

AEMO Forecasting Chart



Source: AEMO Forecasting Approach

Future Research

- **Dynamic Operating Envelopes** – import and export limits
  - Simulations
  - How to integrate probabilistic forecasts?

- **EV Grid integration**
  - Bidirectional flows

- **Forecasting** – integrating smart meter and weather data from different sources
  - Hierarchical forecasting – how to aggregate forecasts?

- **Battery management**
  - What happens if residential batteries operate in correlated ways “behind-the-meter”?

Thank You

Contact information

R.Bean1@uq.edu.au