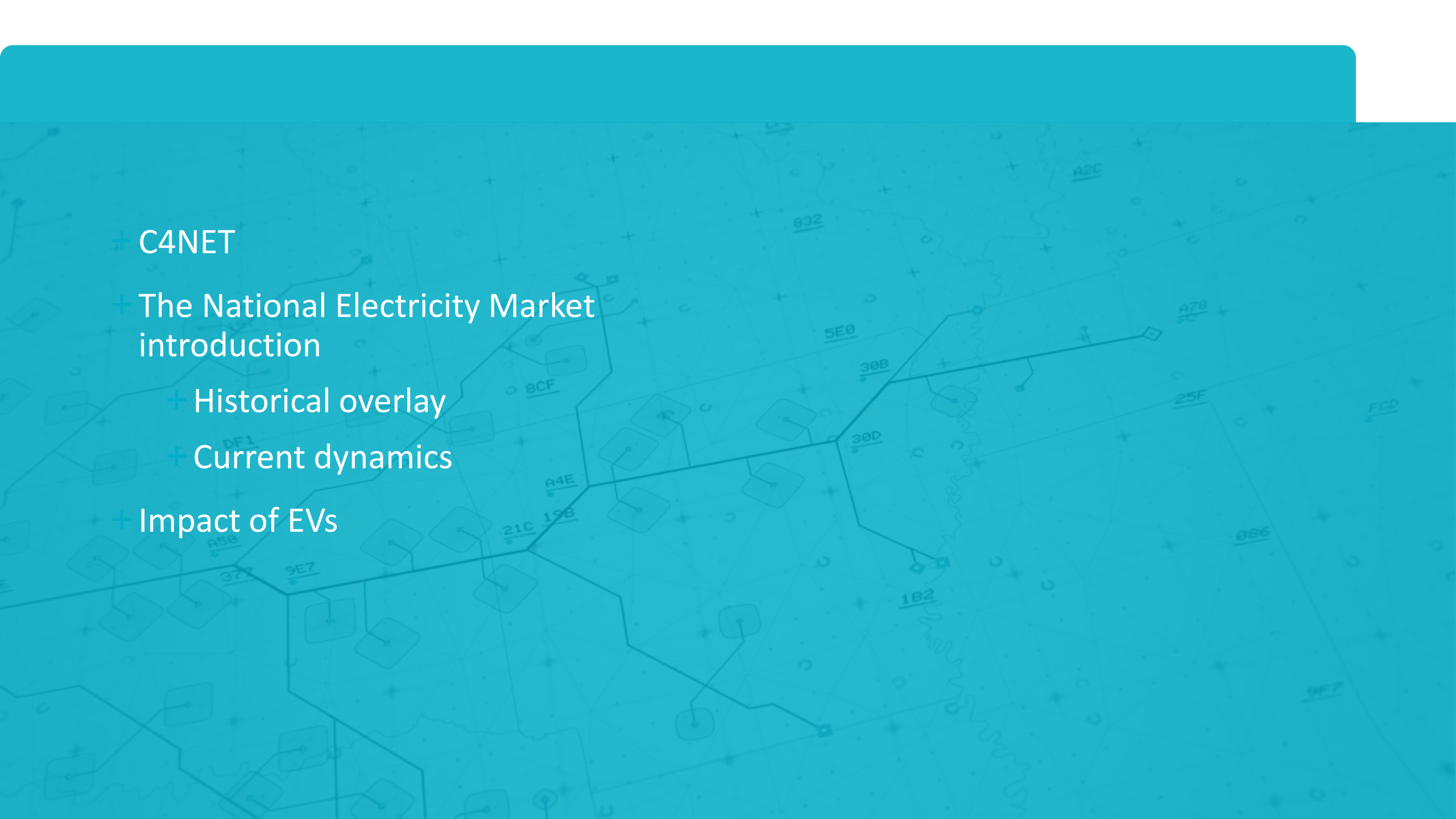




C + N E T

Powering the transportation sector into the next generation of zero emission vehicles

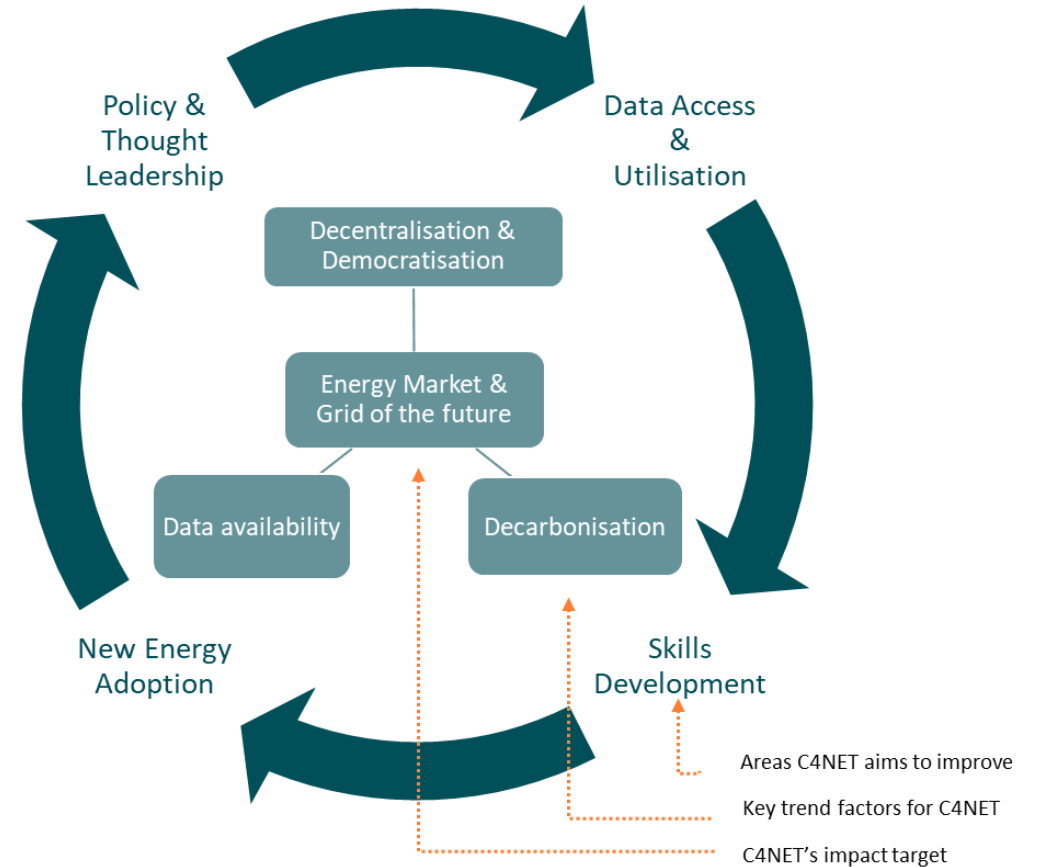
iMove Conference  
November 2022

- 
- + C4NET
  - + The National Electricity Market introduction
    - + Historical overlay
    - + Current dynamics
  - + Impact of EVs

# About C4NET: Enabling the energy grids and markets of the future



- + Delivers data-driven research, in collaboration with government, industry and academia - to assist the rapid transition of the energy sector.
- + The Centre's novel energy solutions address:
  - Data access and utilisation
  - New energy adoption
  - Evidence-based policy & program support
  - Emerging skills gaps
- + The Centre is an independent, member-based, not-for-profit company with an area of focus on the local energy systems, spanning distribution networks to consumers.





- + C4NET

- + The National Electricity Market introduction

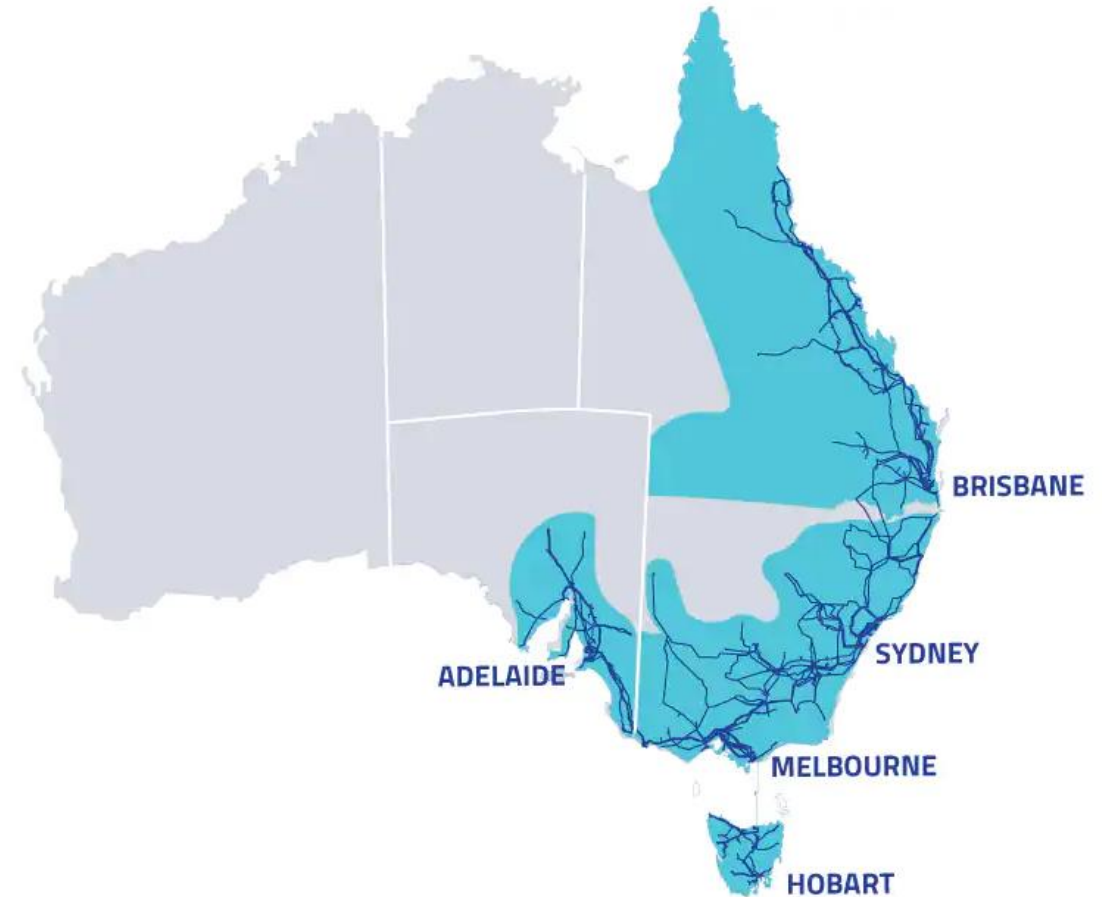
  - + Historical overlay

  - + Current dynamics

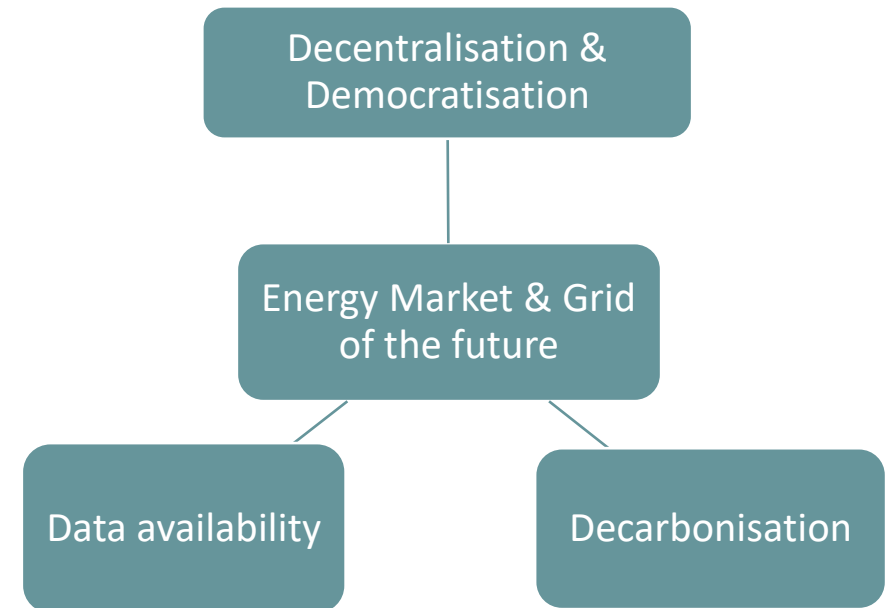
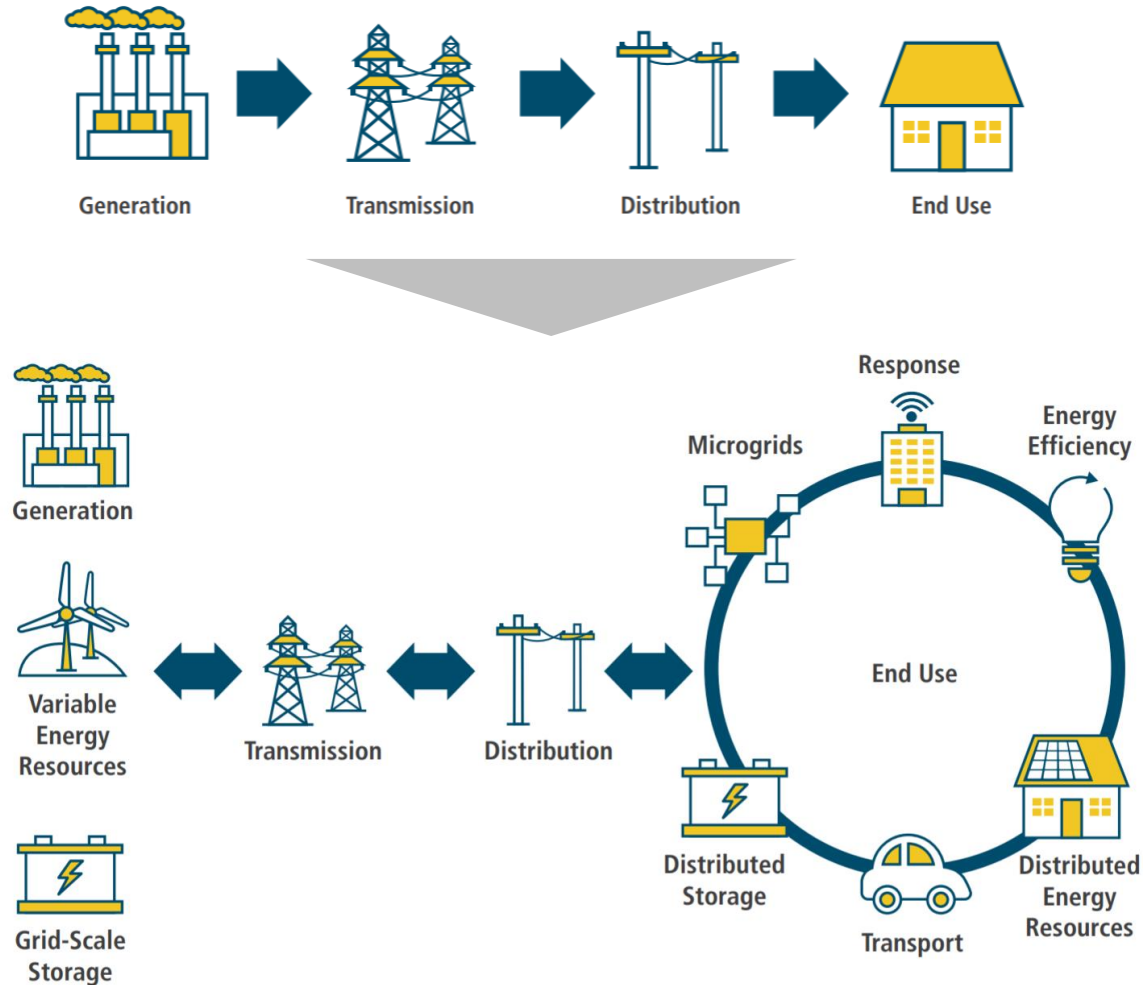
- + Impact of EVs

# The National Electricity Market (“NEM”)

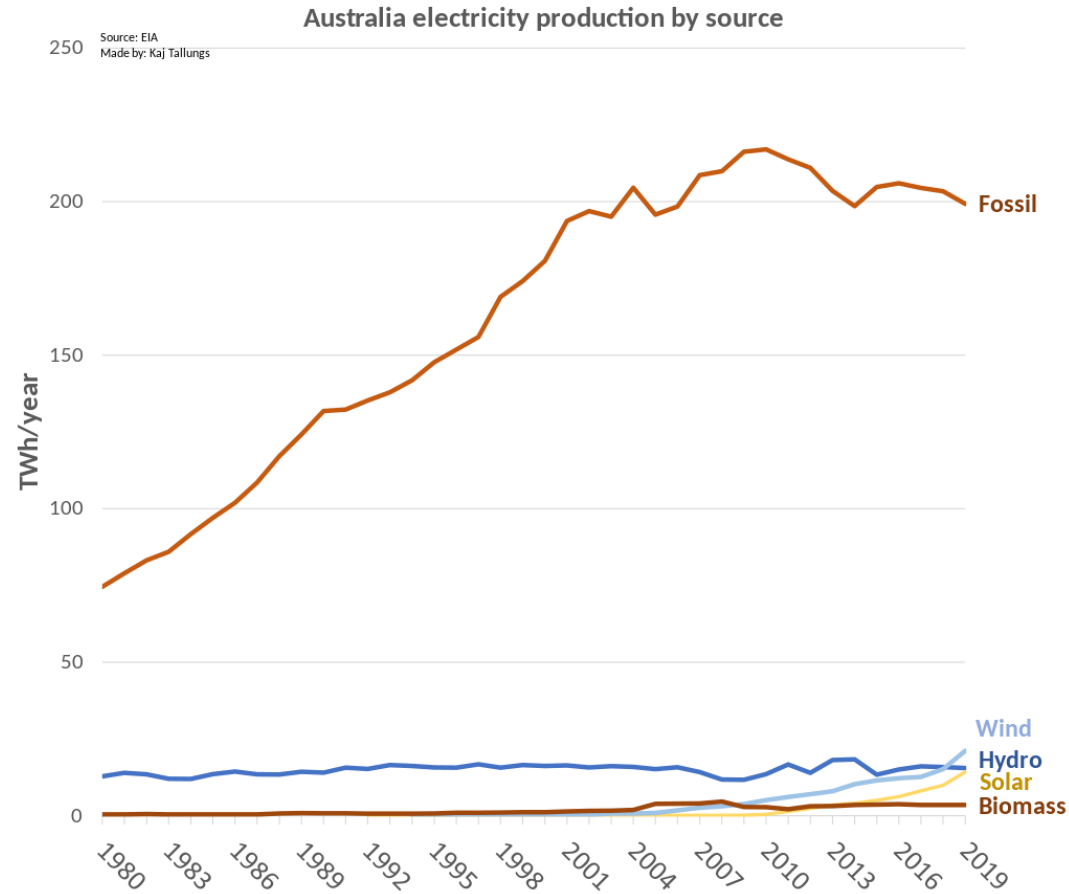
- + Commenced trade as a wholesale spot market in 1998.
- + Interconnects 5 regional market jurisdictions:
  - Queensland
  - New South Wales (including ACT)
  - Victoria
  - South Australia
  - Tasmania
- + ~200 TWh electricity
- + 9 million customers
- + 54 GW generation capacity
- + ~\$17B trades/a
- + ~40,000 km transmission and distribution cables



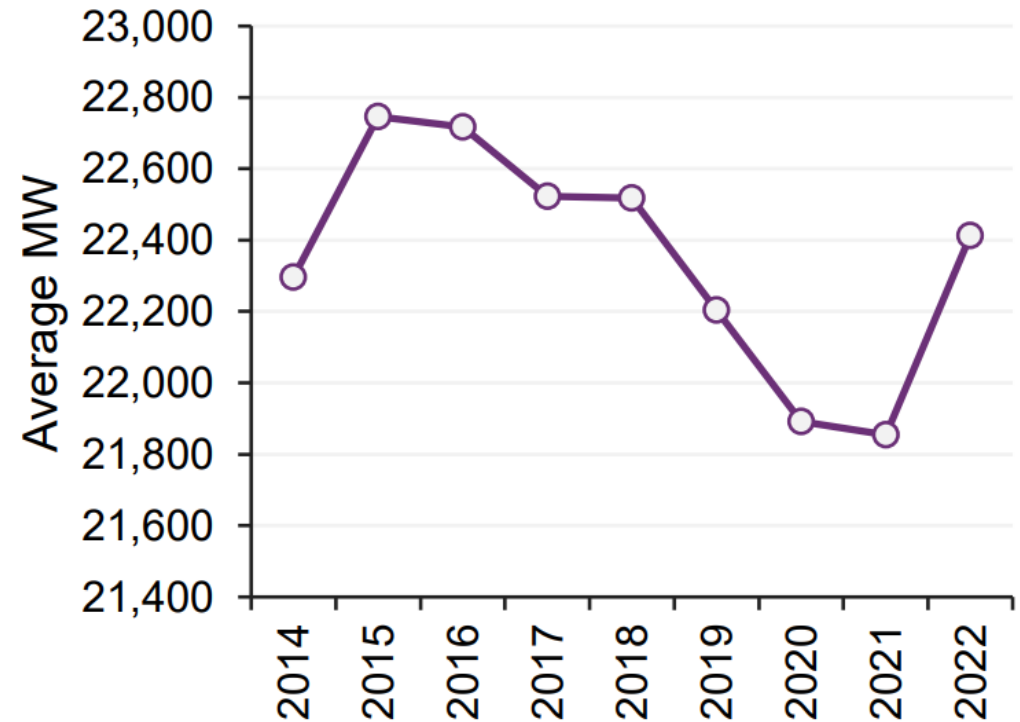
# The NEM is in transition



# With long-life assets to be planned for

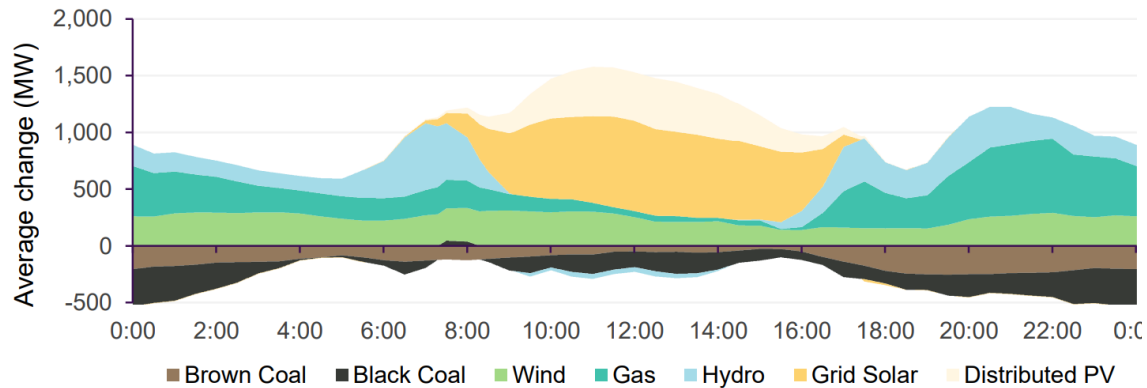


NEM average operational demand (Q3s)

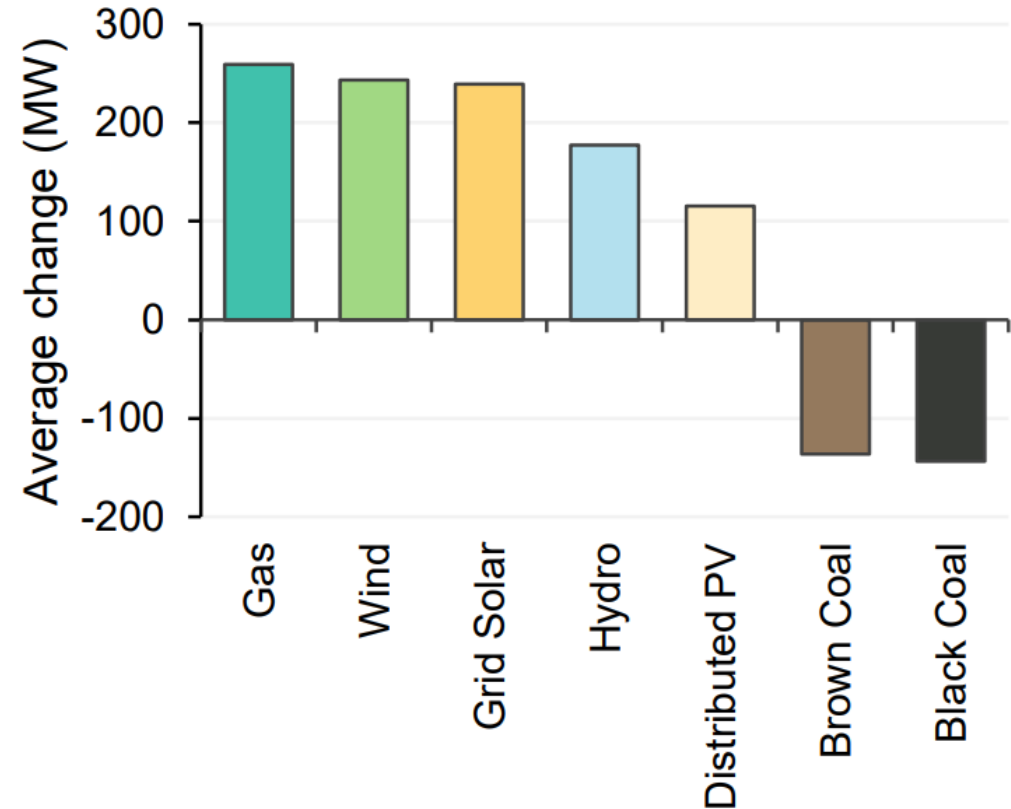


# The generation mix is heading to variable renewable energy

Change in supply – Q3 2022 versus Q3 2021 by time of day



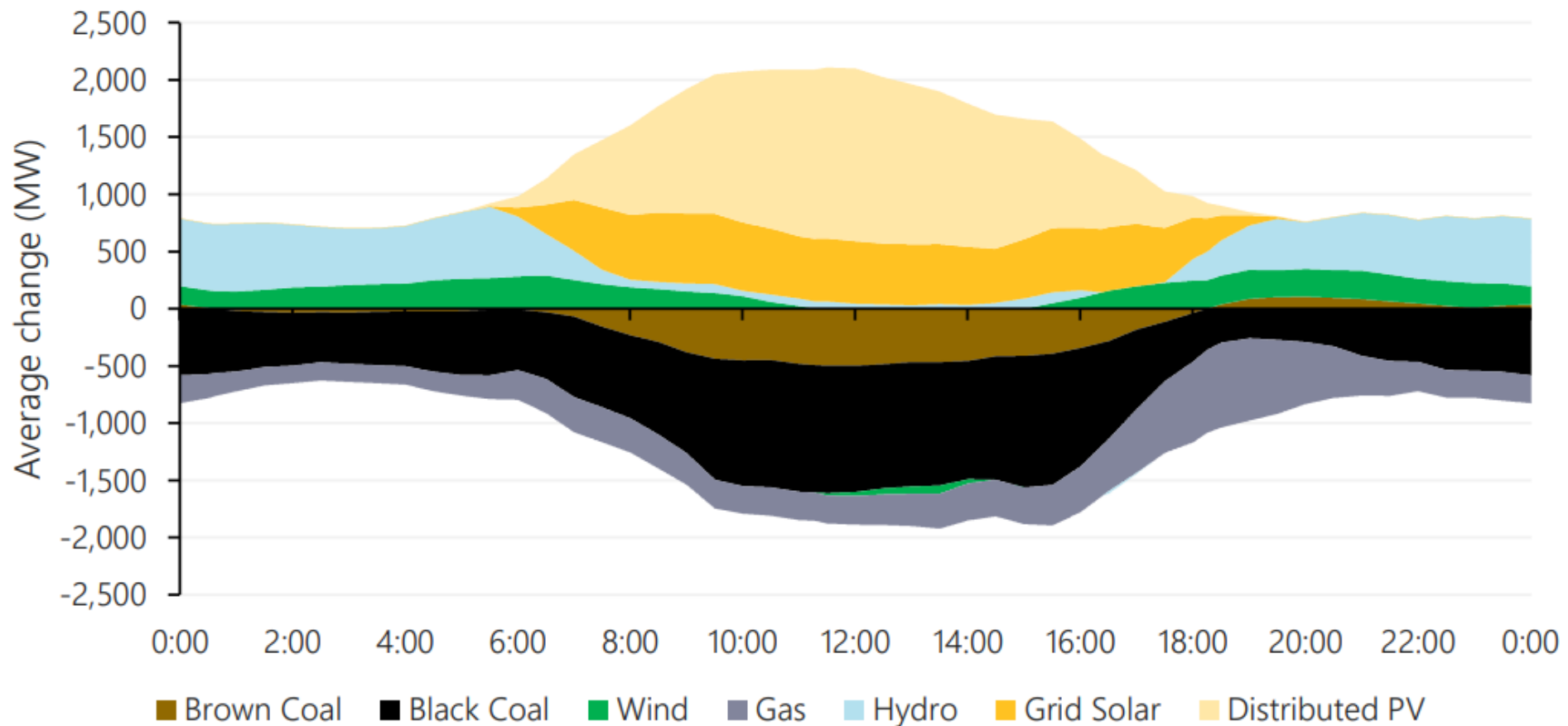
Change in supply – Q3 2022 versus Q3 2021



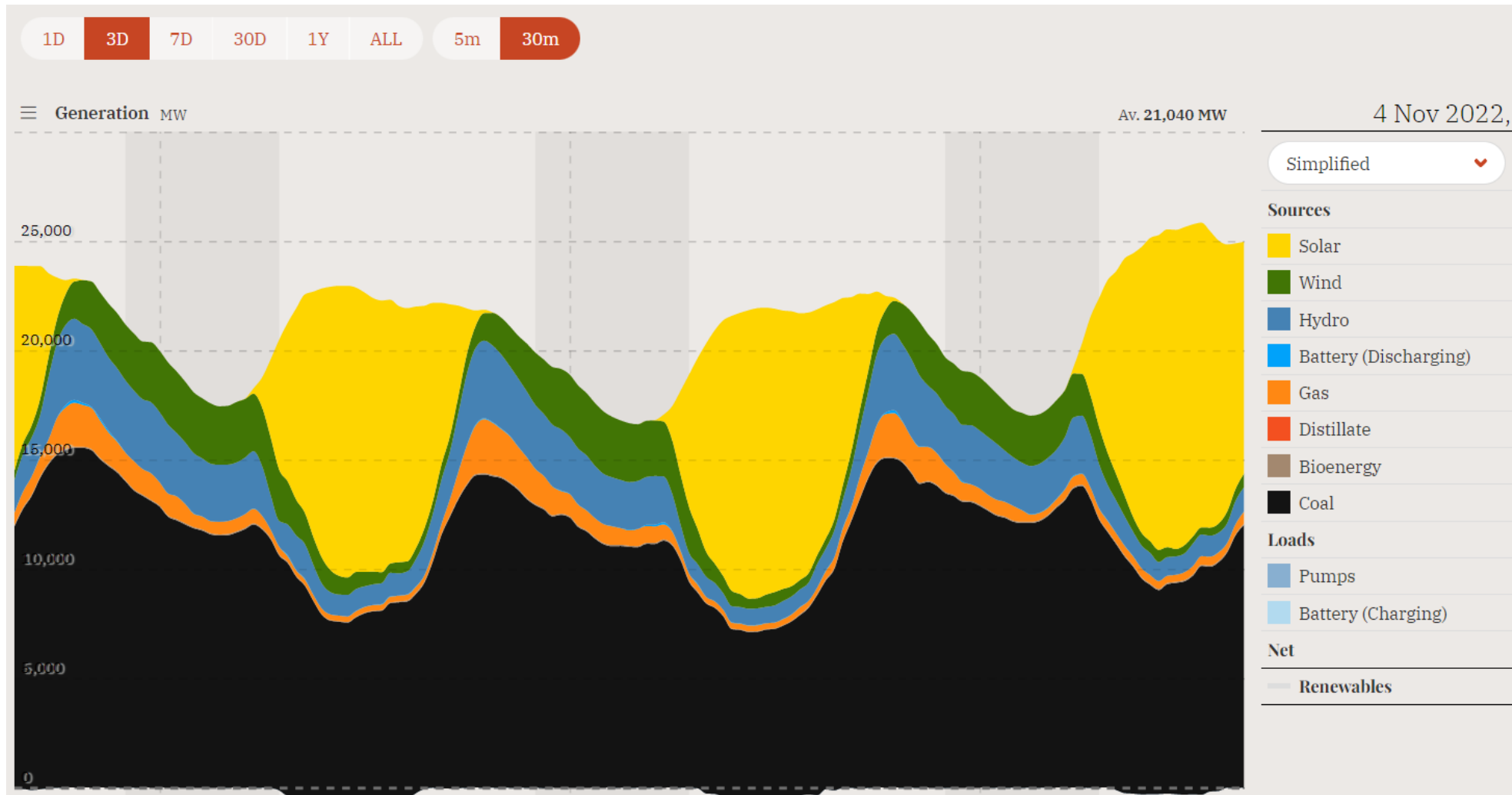


# ...and the current gas increase is only recent

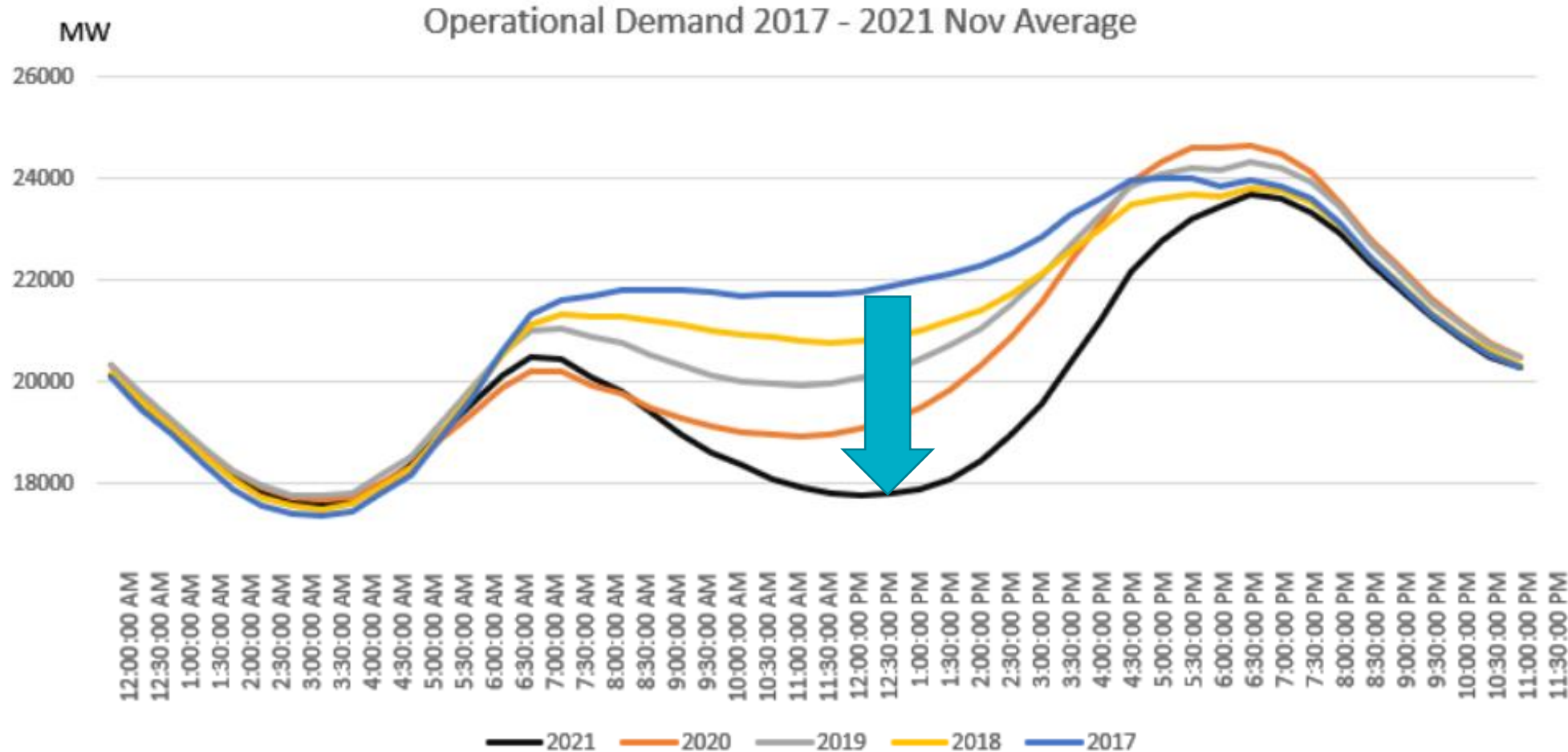
Change in supply – Q4 2021 versus Q4 2020 by time of day



# What does a day look like from a generation perspective

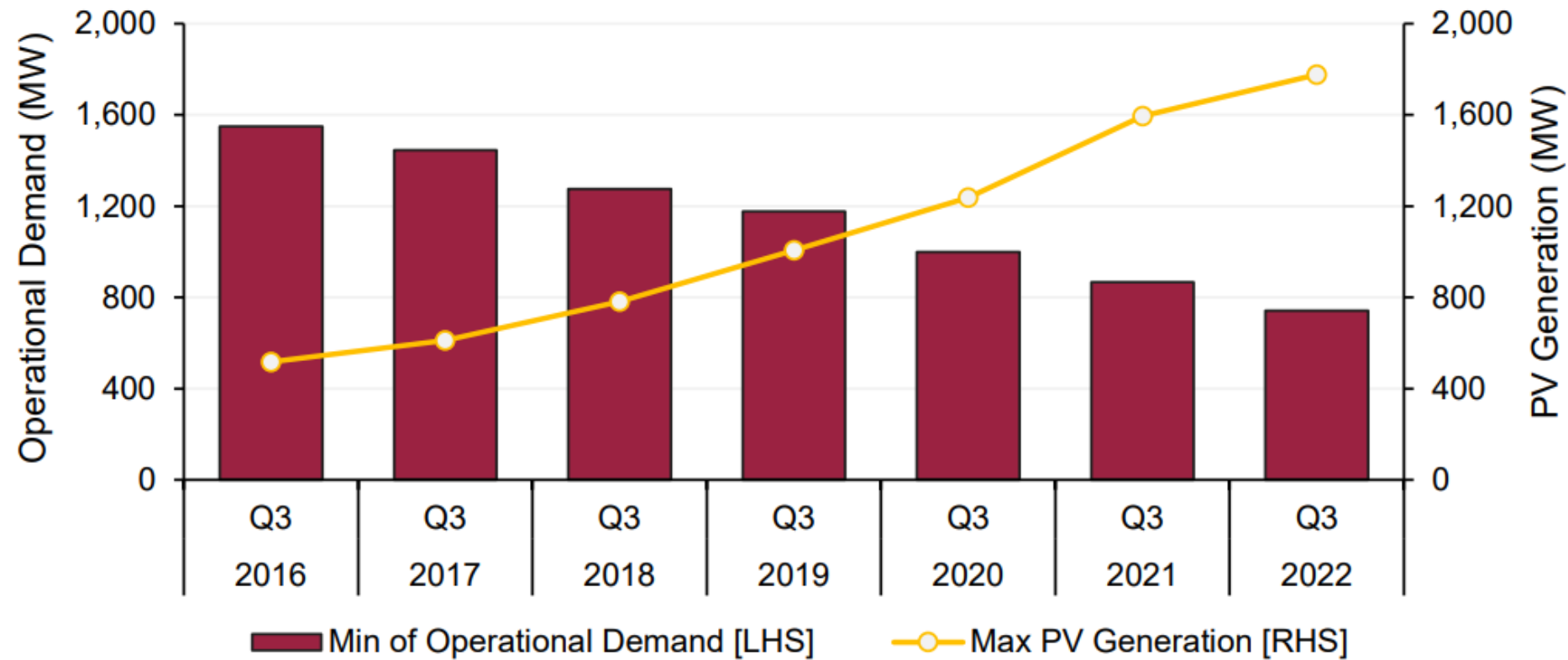


# The energy system need be designed for both minimum and maximum demand



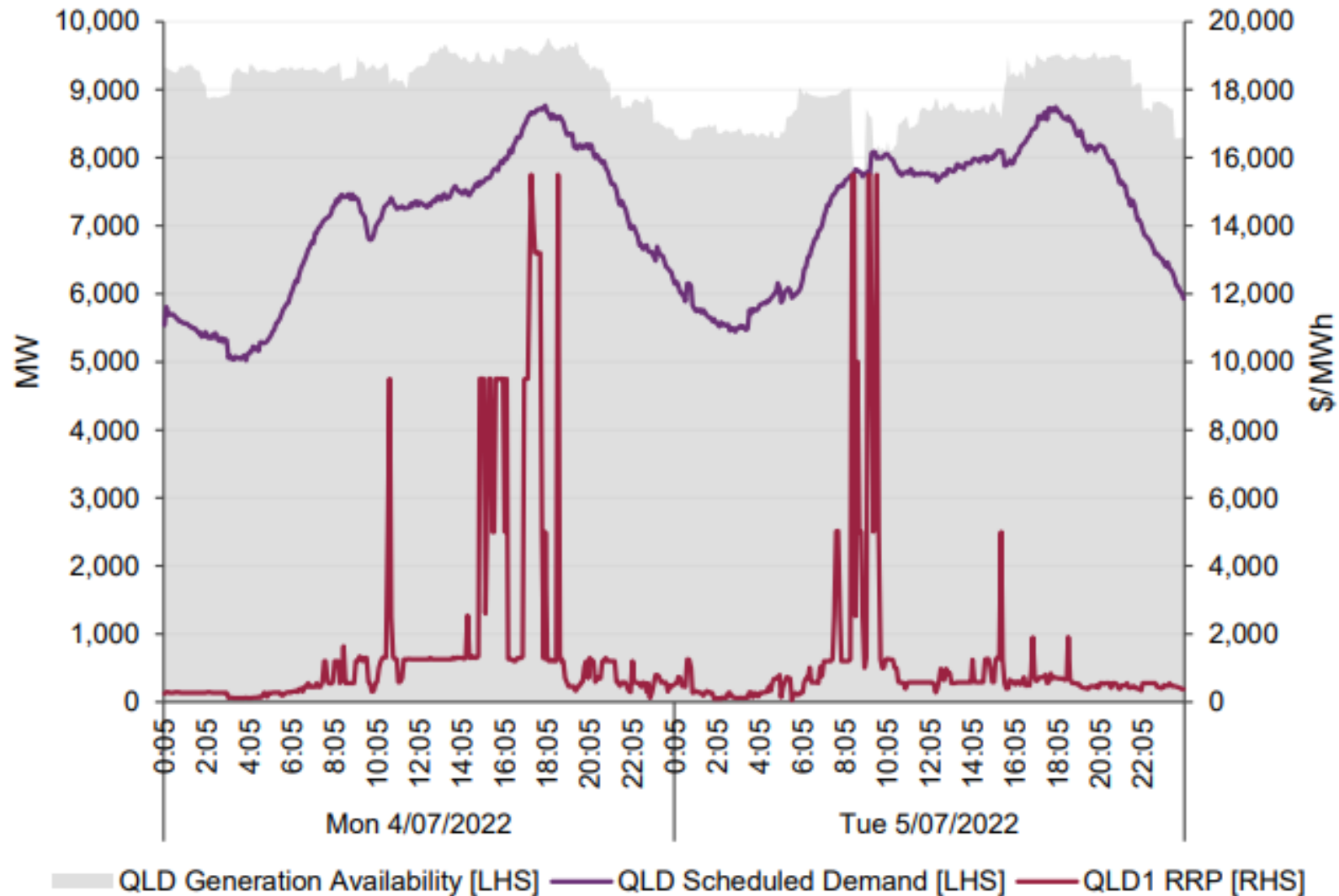
# Minimum demand a growing issue as self-consumption increases

Q3 minimum operational demand and maximum PV generation trend

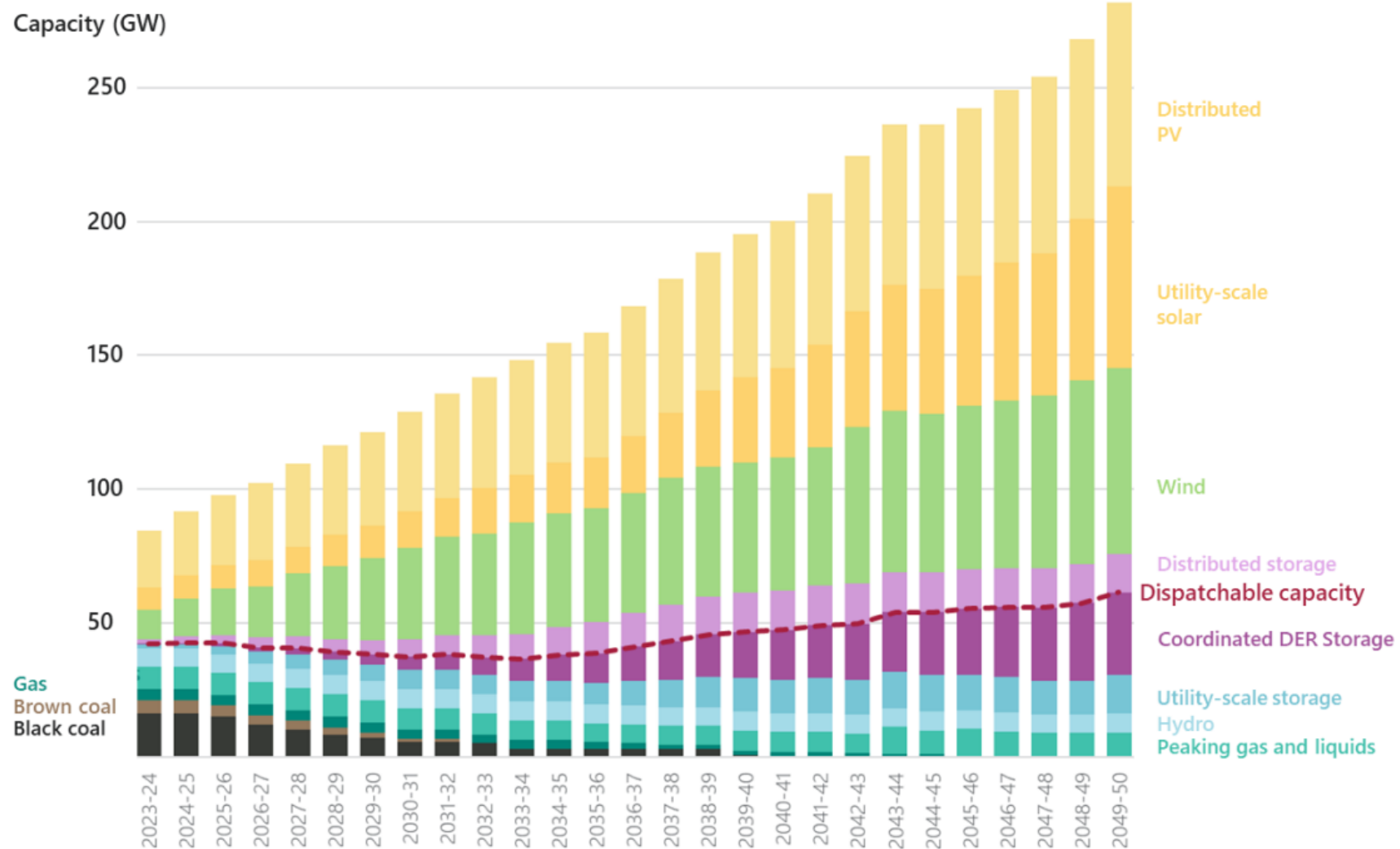


# Touch on pricing – it's complex, but there's an opportunity for transport

Queensland scheduled demand<sup>16</sup>, generation availability and spot price – 4 to 5 July 2022



# Pace and magnitude of change in generation is quite foreseeable...





- + C4NET

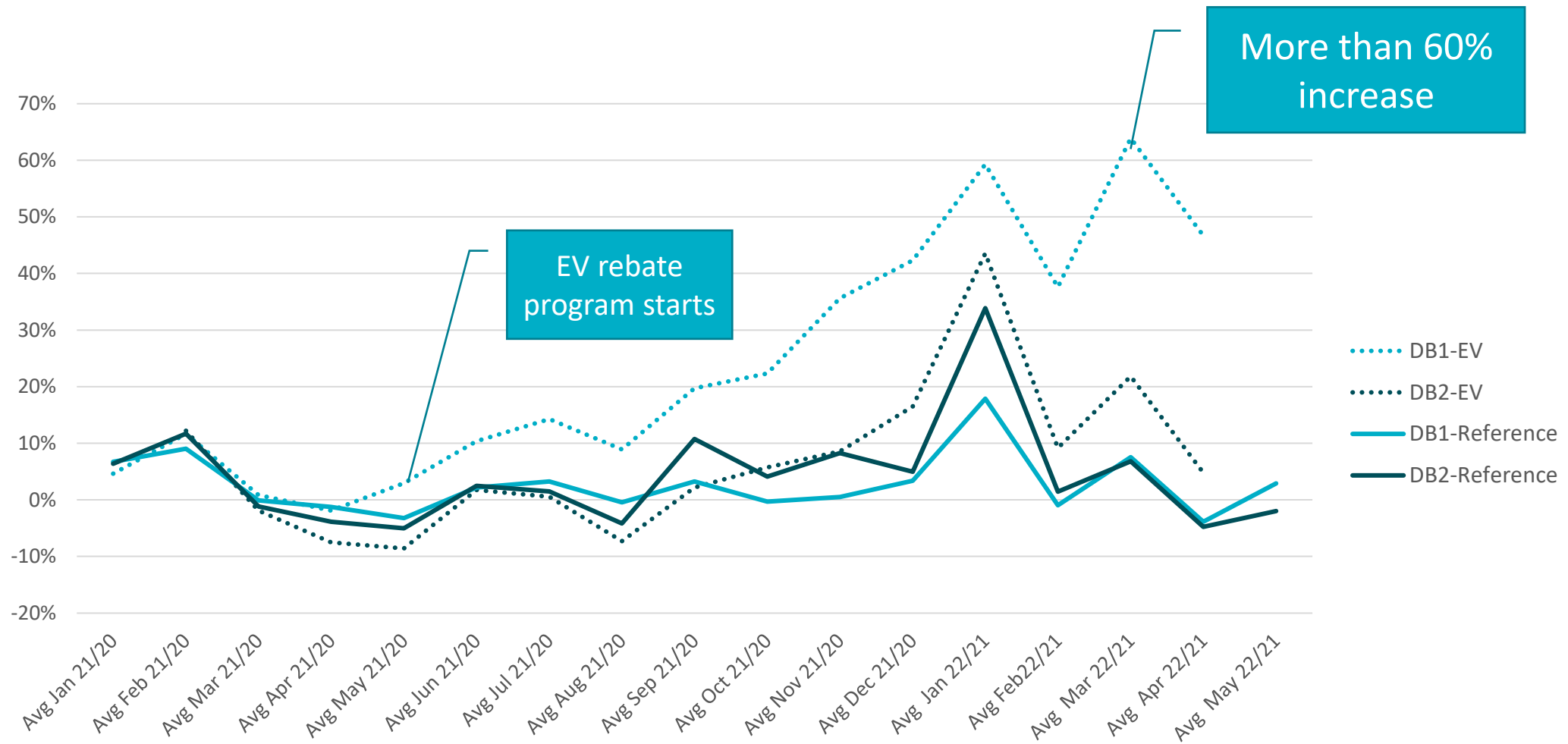
- + The National Electricity Market introduction

  - + Historical overlay

  - + Current dynamics

- + Impact of EVs

# Insights: EV Customers increased their consumption significantly...

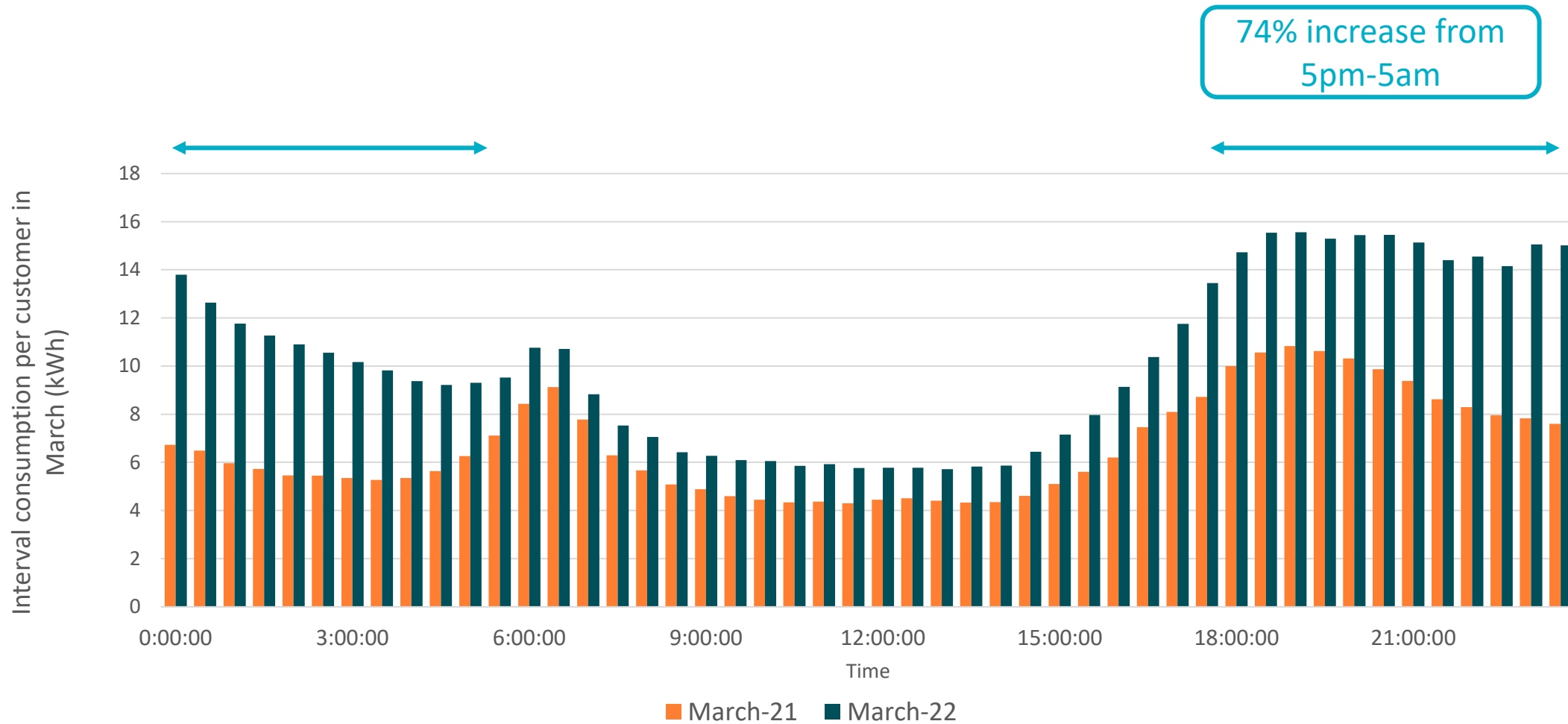


EV Cohorts by area | Change in grid energy use compared to same month in prior year (%)

\*EV refers to all EV Rebate recipients, regardless of the status of their EV Rebate application; including customers who will not have received their vehicle yet.

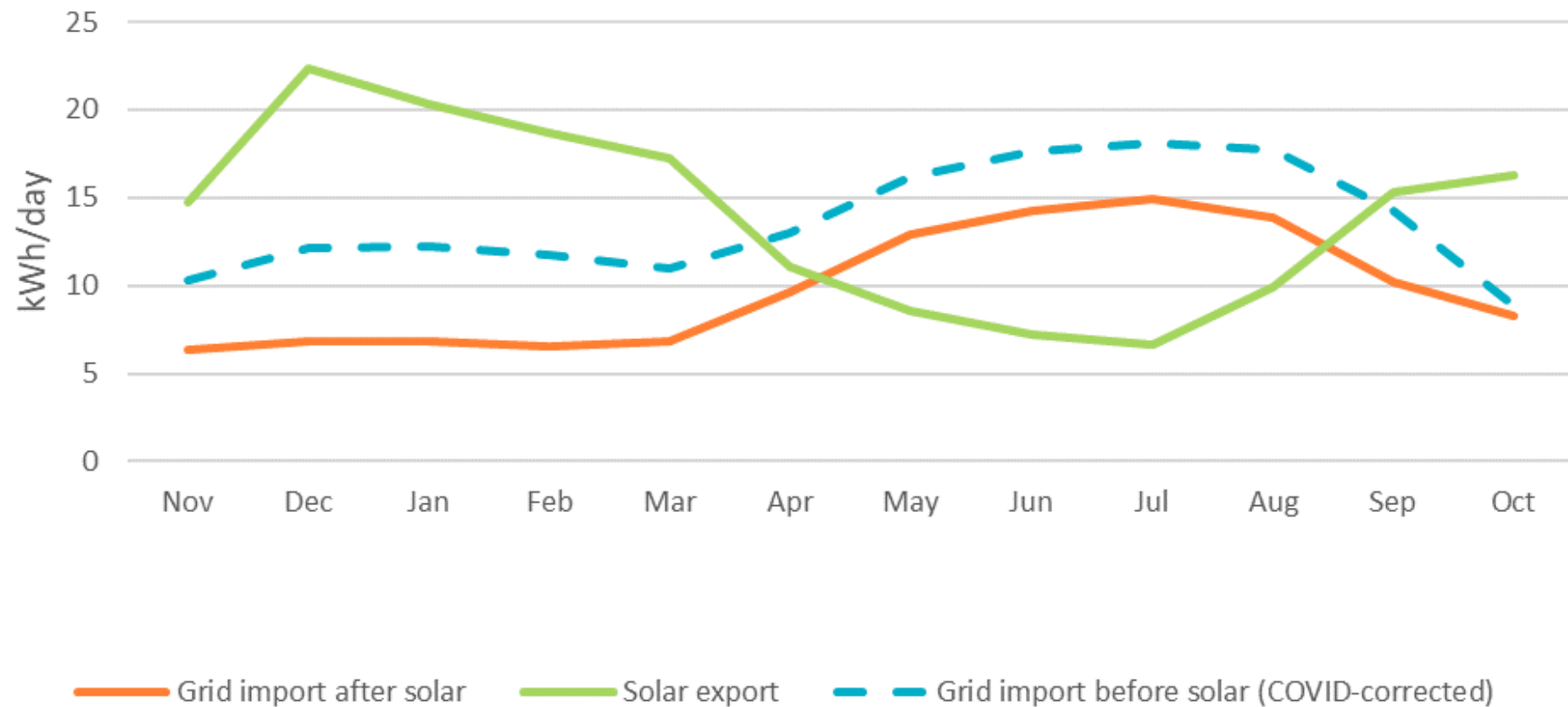


# Insights: The greatest additional use is overnight.



Note – single area of analysis shown for simplicity and consistency (~30% of overall sample data)

# Solar households exporting 50% more than they consume from the grid

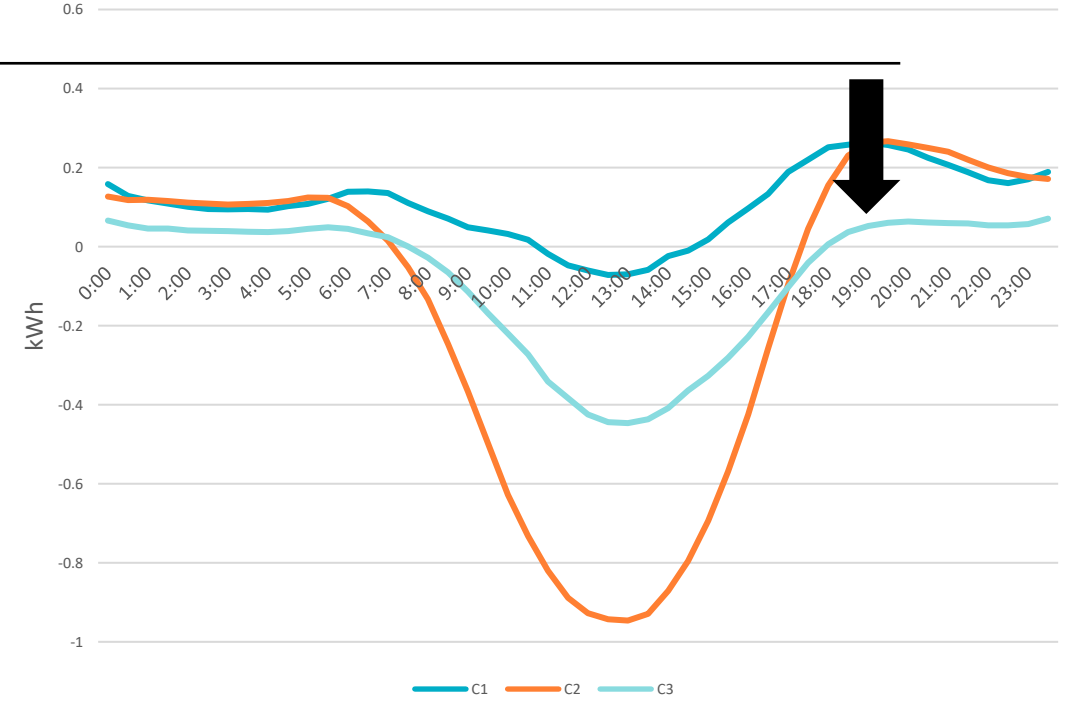
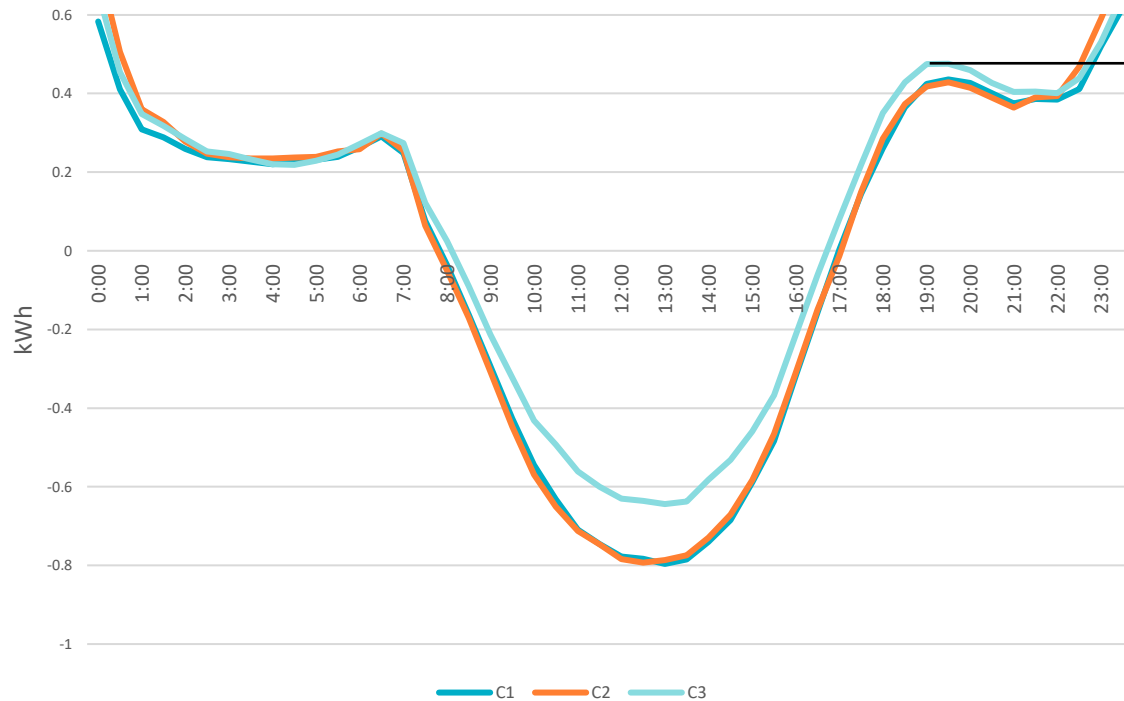


C4NET analysis of >100 Victorian homes of solar installed within the same week in October 2019 for Solar Victoria

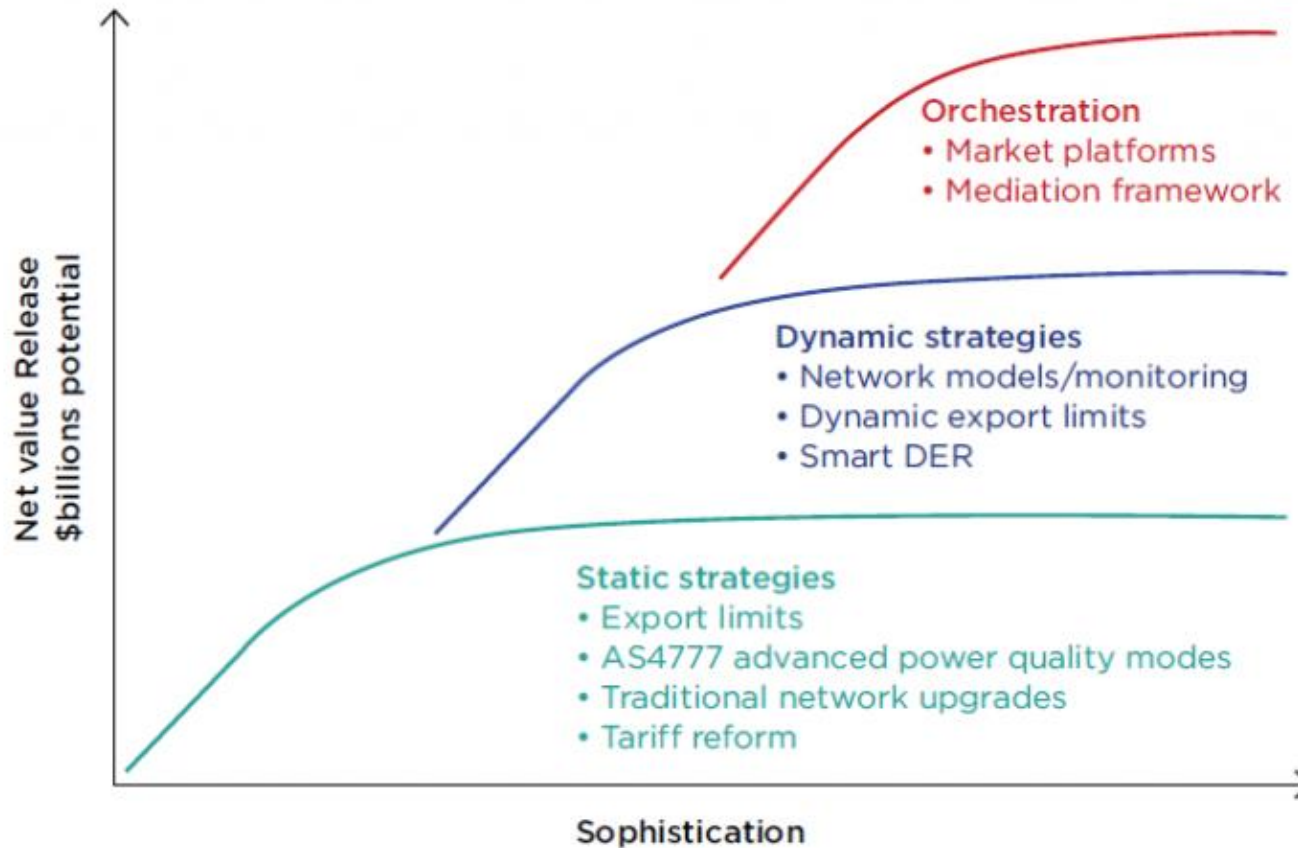
# Household batteries are a tool to change evening peak loads

Observed data: Hot weekday (temp 35-40°C)

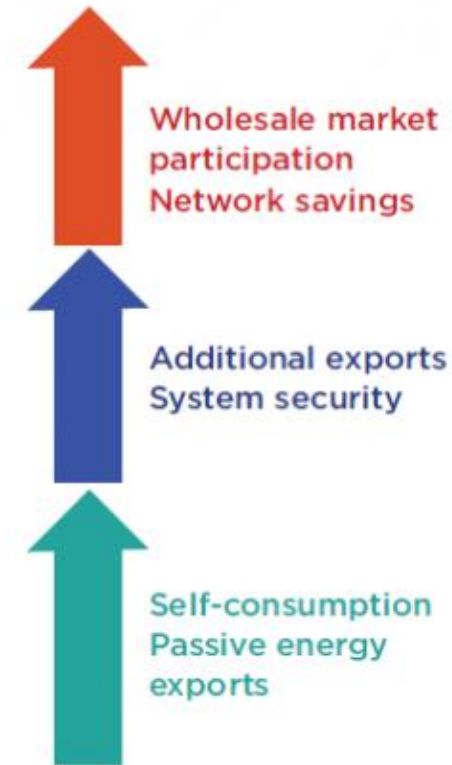
## Houses with PV only



# Opportunity for transport and electricity



## Value release





C4NET

Thank you

Centre for New Energy Technologies Ltd  
ABN 56 626 202 480

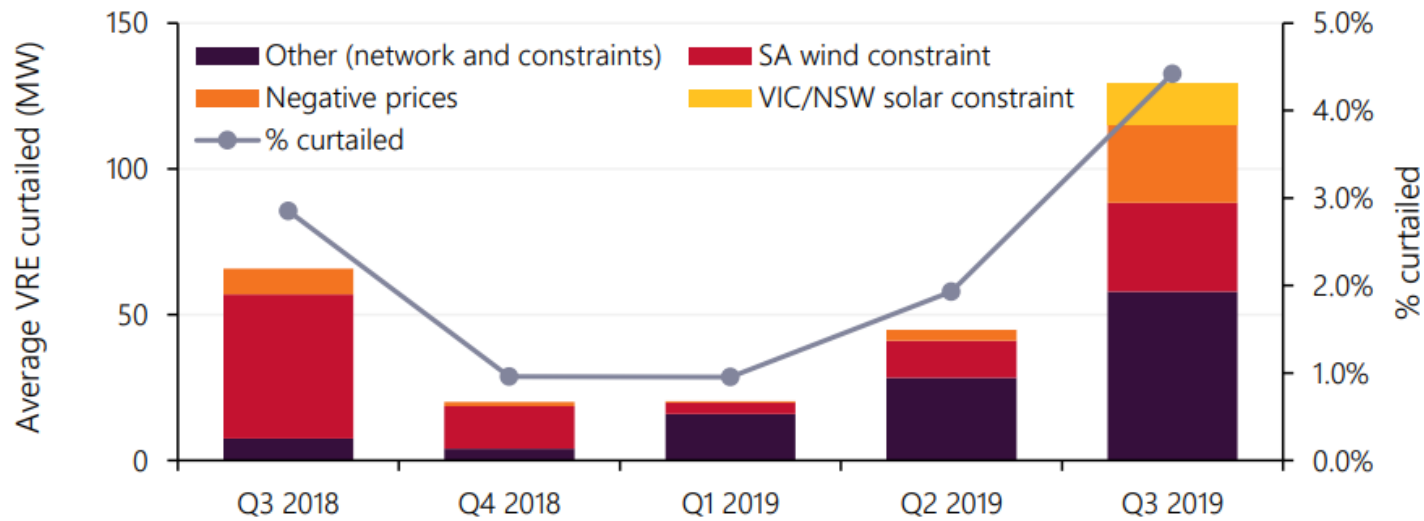
[C4NET.com.au](http://C4NET.com.au)

# APPENDIX – back up slides

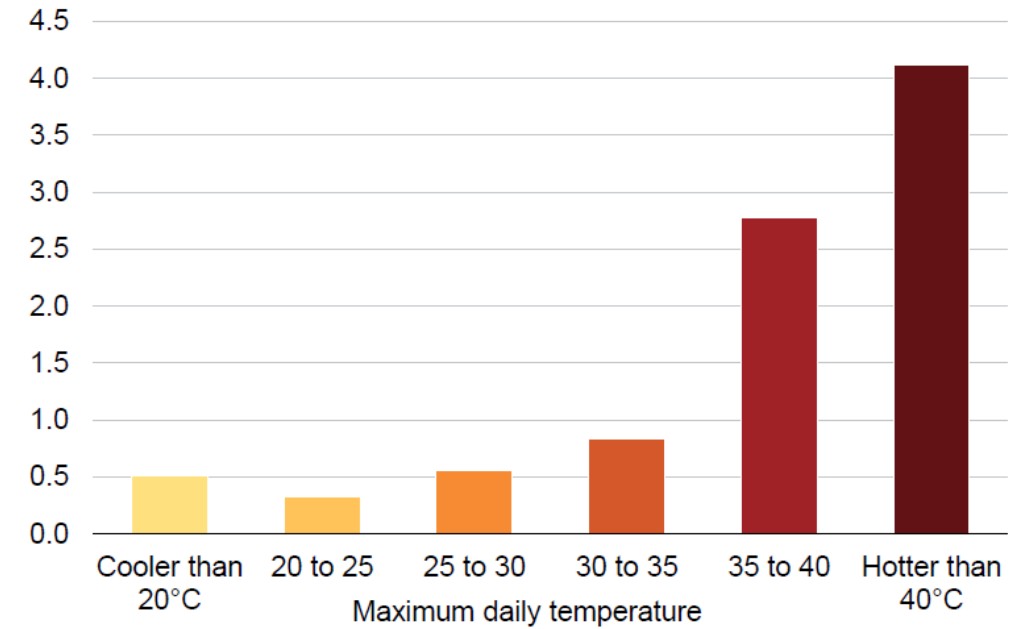


# VRE curtailment – an emerging issue

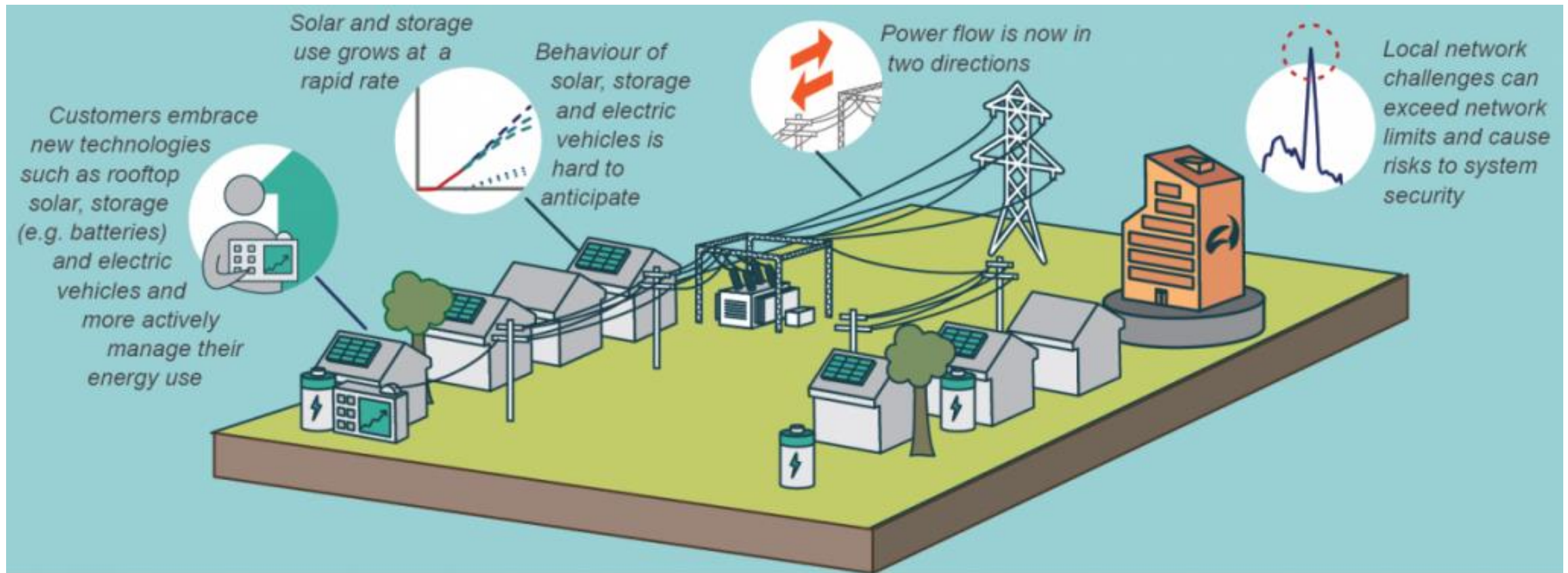
**Figure 34 NEM VRE curtailment increases to record levels<sup>27</sup>**



**Figure 4.5: Networks are highly sensitive to temperature**  
Average daily minutes of outage per customer, 2009 to 2018



# The distribution system mix





## Key aim and scope

- + ESP-V is being developed as a collaborative research project that involves multiple universities, industry partners and government stakeholders.
- + The key aim is to methodologically inform *post-2030* electricity system planning downstream to the transmission level:
  - + Providing quantitative inputs into future planning strategies;
  - + Addressing the *impact* across the whole distribution system and its implications for the transmission system, particularly measured in terms of changing profiles of loads profiles and distributed energy resources and relevant implications for asset requirements;
  - + With focus on the impact of the electrification of transport and domestic gas and its interaction with localised renewables and distributed energy resources.
- + The project is organised through different work packages that bring together different multi-partner subprojects that are cohesively developed to ensure consistency in outputs and methodologies that could then be used for business-as-usual implementations by different stakeholders.
- + The methodologies and outcomes are designed to allow scaling up to other states beyond Victoria.
- + The project will NOT provide forecasts, but rather outcomes, insights and input data based on *what-if scenarios* that could be used by relevant stakeholders in their studies and general business as usual decision-making.

# ESP-V Essential Building Blocks

The programme collaboration will build and increasingly leverage a shared data asset that captures the key technical, operational and economic characteristics and performance of our complex and rapidly evolving energy system

## SYSTEM CHARACTERISATION

# C4NET

## COLLABORATIVE PROGRAMME

### ■ ARCHITECTURE

- Technology
- Topology
- Capability
- Capacity
- Costs
- Constraints

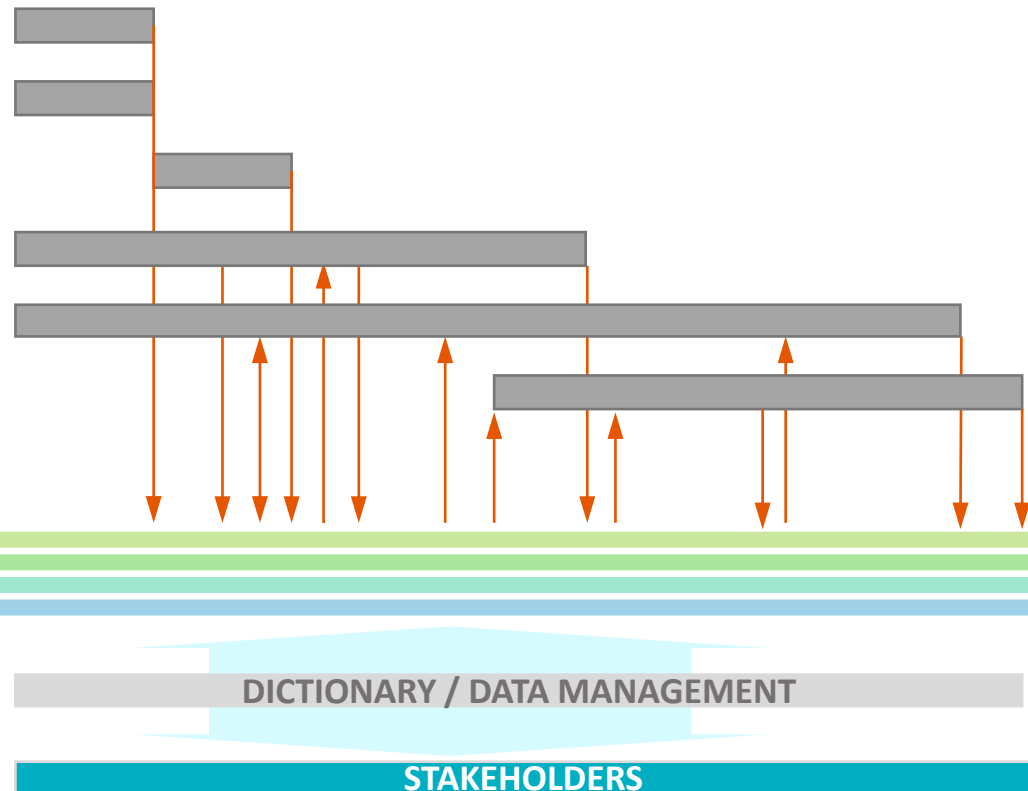
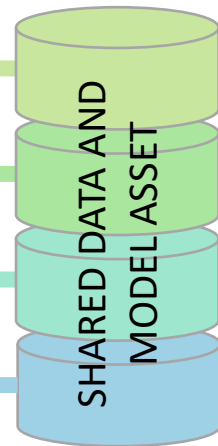
### ■ DYNAMICS

- Supply/Demand
- System response and parametric functions

### ■ SCENARIOS

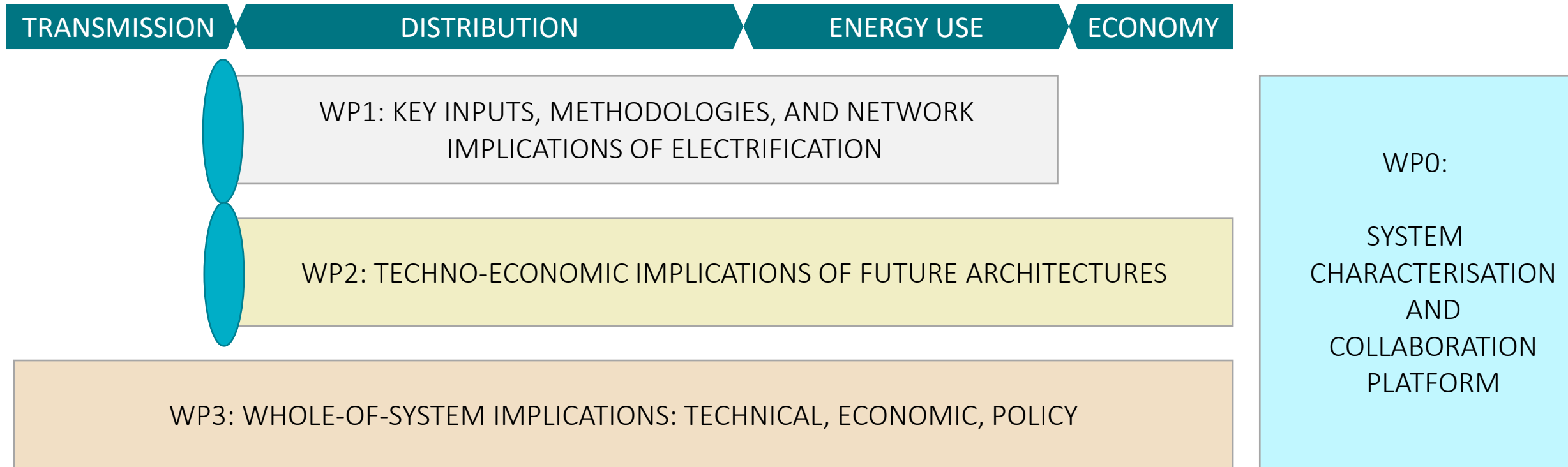
### ■ PERFORMANCE

- Technical
- Operational
- Planning
- Economic



# Program Focus

The program builds on a core understanding of the network implications of electrification to explore the implications for stakeholders of future technical and business architectures – and their ultimate implications for *national* markets and stakeholders.



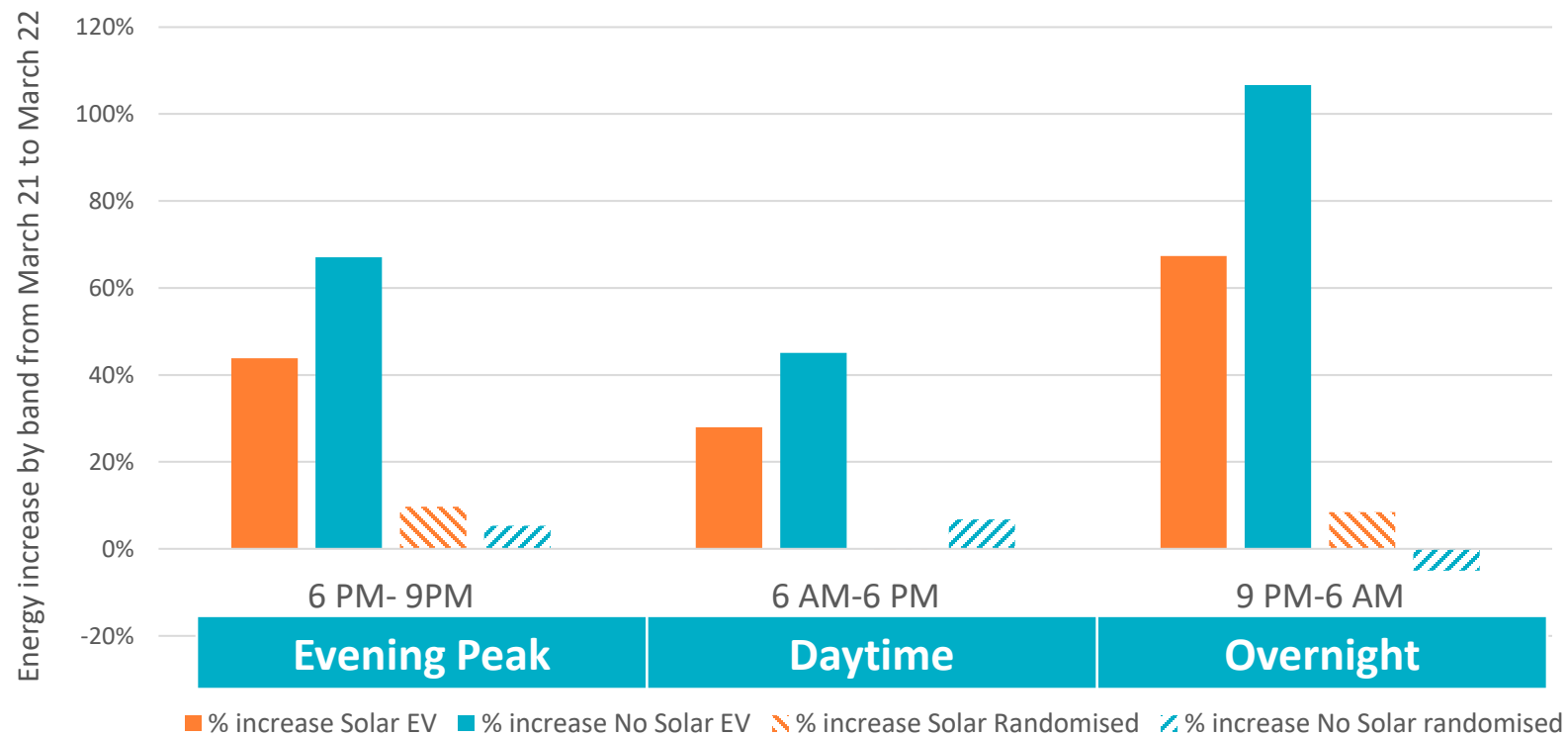
# Stakeholder Application

The project and its components are being shaped to deliver:

- + Policy makers – Better informed policy positions through modelled outcomes with a foundation of the system physics at high, medium and low voltage distribution networks and opportunities/impacts for consumers.
- + DNSPs – Longer-term detailed modelling beyond the capacity of existing internal resources based on generic distribution system topologies that they could then match up with their own systems.
- + AEMO – A means to assess more nuanced modelling outcomes against the ISP methodologies for further improvement and consideration of the depth of modelling needed at the distributed level and Australia-wide, and insights into the distribution systems ability to address/reduce transmission level challenges.
- + Research partners – collaborative research opportunities, direct industry engagement, nationwide exposure and direct & live technology transfer
- + All – Harmonised assumptions, consistent methodologies, and modelled outcomes of scenarios to inform more efficient planning and policy discussions between multiple industry partners, regulators and policy makers to help steer towards the more desirable scenario outcomes;
  - + Hence freeing up diverse groups to focus the debate on the issues, not the numbers; and
  - + Insight into impact of alternatives to unmanaged growth and consumer use of different technologies.

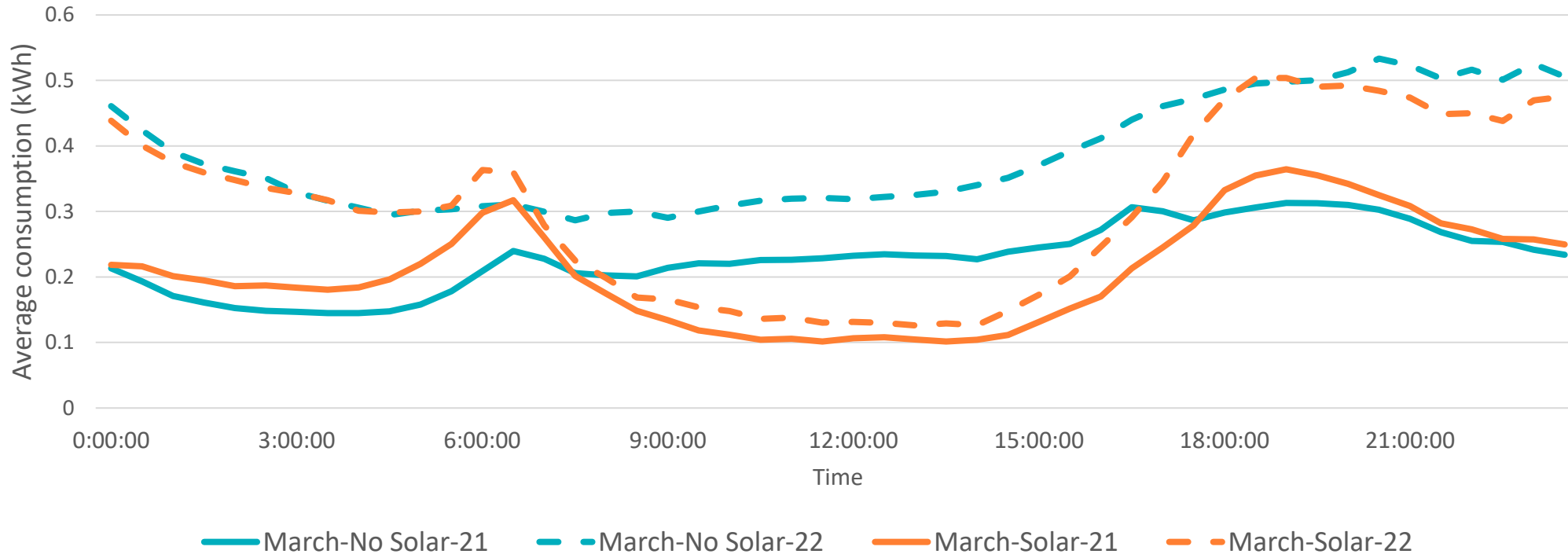
# Insights: Overnight charging appears to be the predominant behaviour

- + EV charging behaviour corresponds to the majority of usage increases from Mar 2021 to Mar 2022.
- + EV charging is not predominant during solar hours
- + Prolonged charging into the night rather than just a short sharp peak



# Insights: Comparing solar (70%) and non-solar customers

+ Still to be determined is the extent to which solar customers are using their solar to charge their EV.

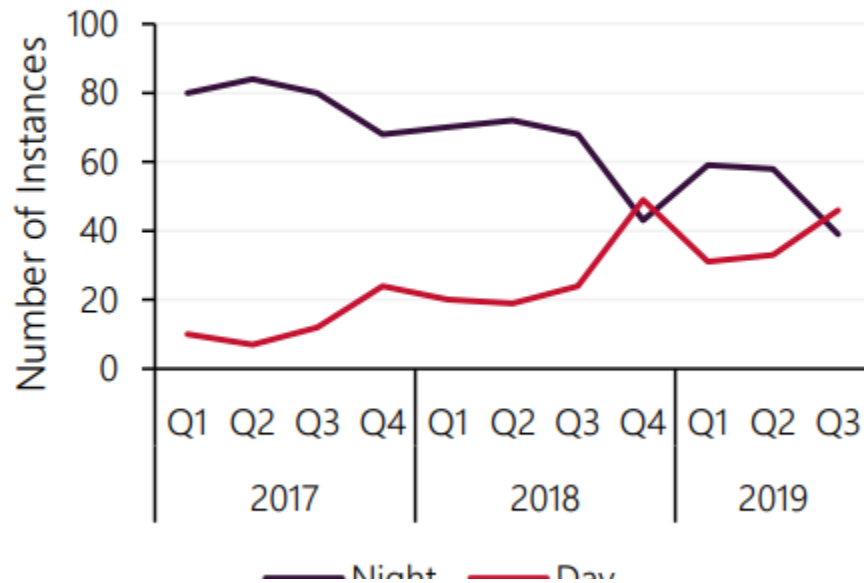


Note – Powercor EV customers who have had their Rebate status noted as “Processed”

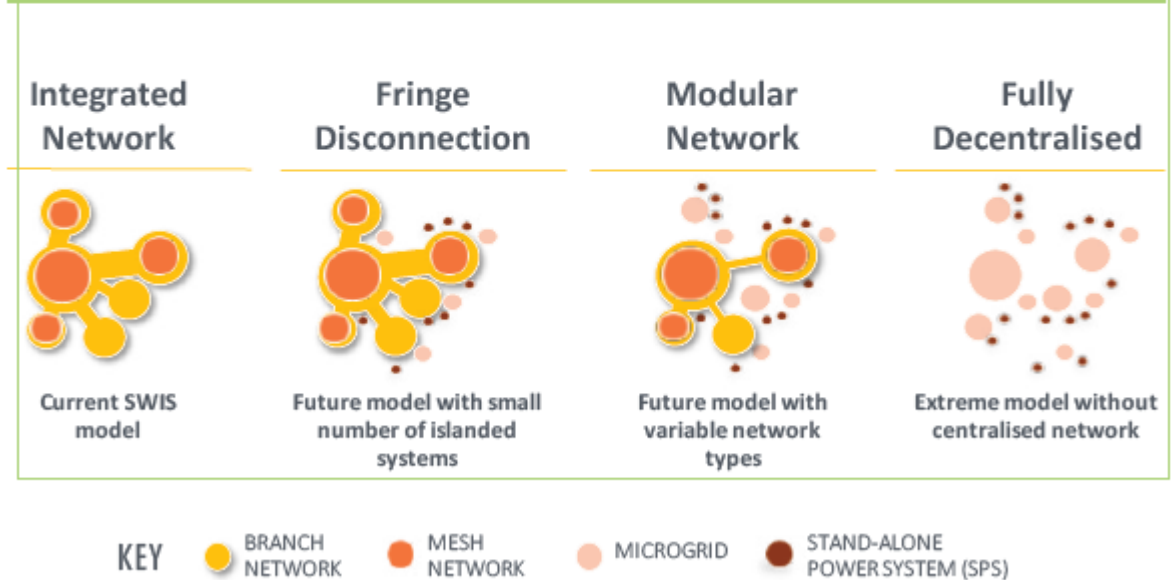
# Emerging market opportunities

**Figure 49** WEM minimum demand increasingly occurs during the day

Instances of min demand



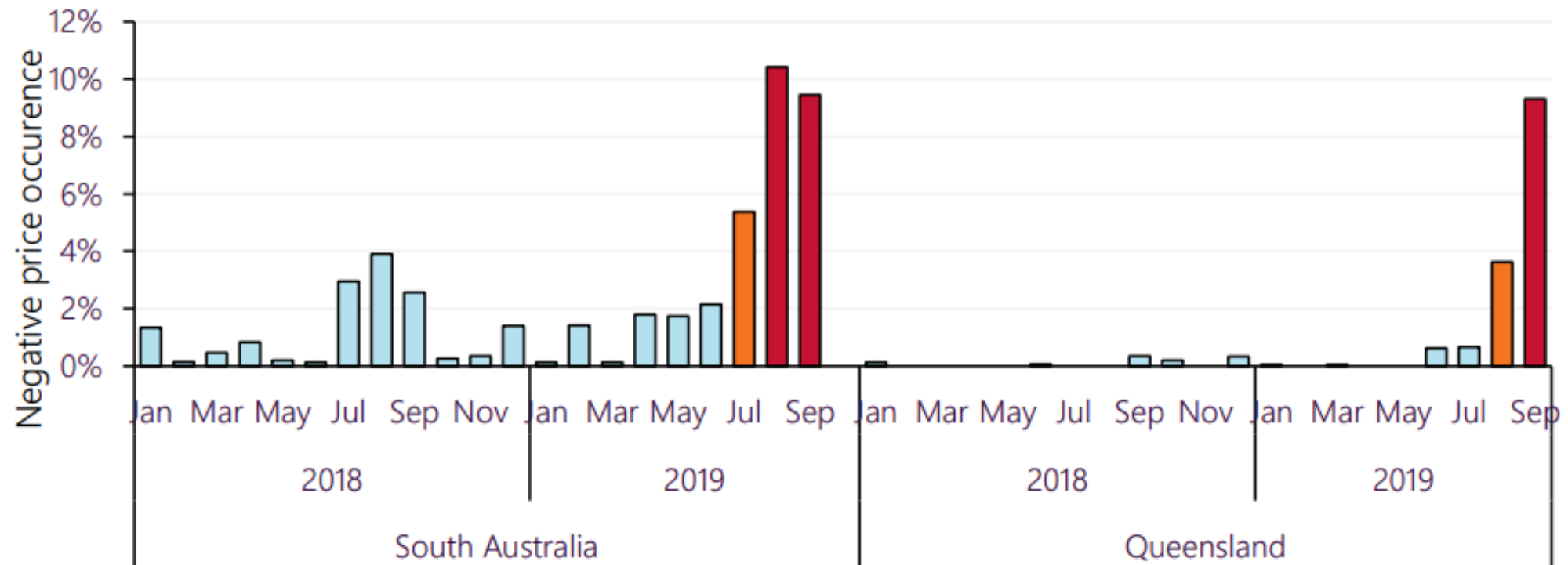
Network evolution is reliant on community behaviour, technology advancement rates, regulation and policy



# Negative price events make balancing a market increasingly difficult

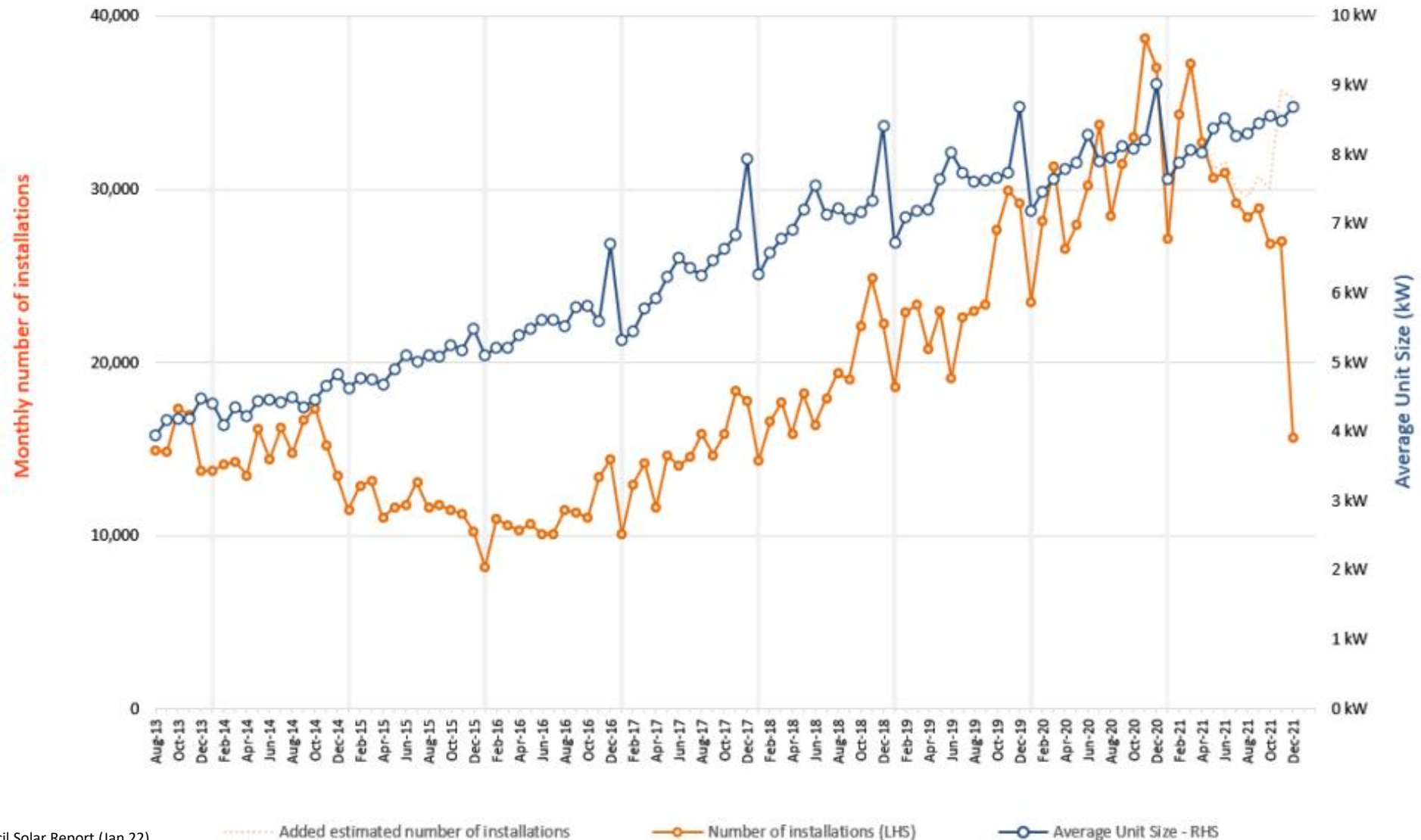
**Figure 20 Record occurrence of negative prices in South Australia and Queensland**

Frequency of negative or zero spot prices in South Australia and Queensland.



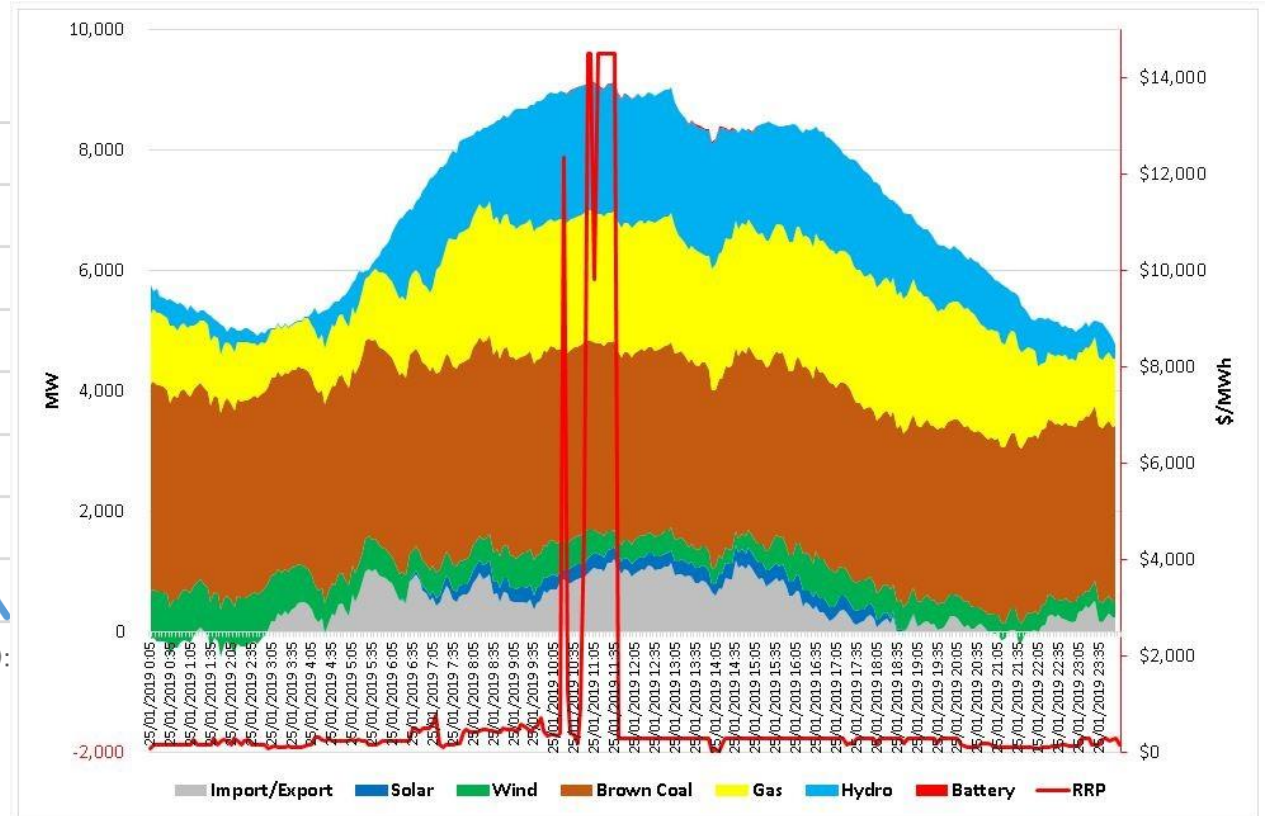
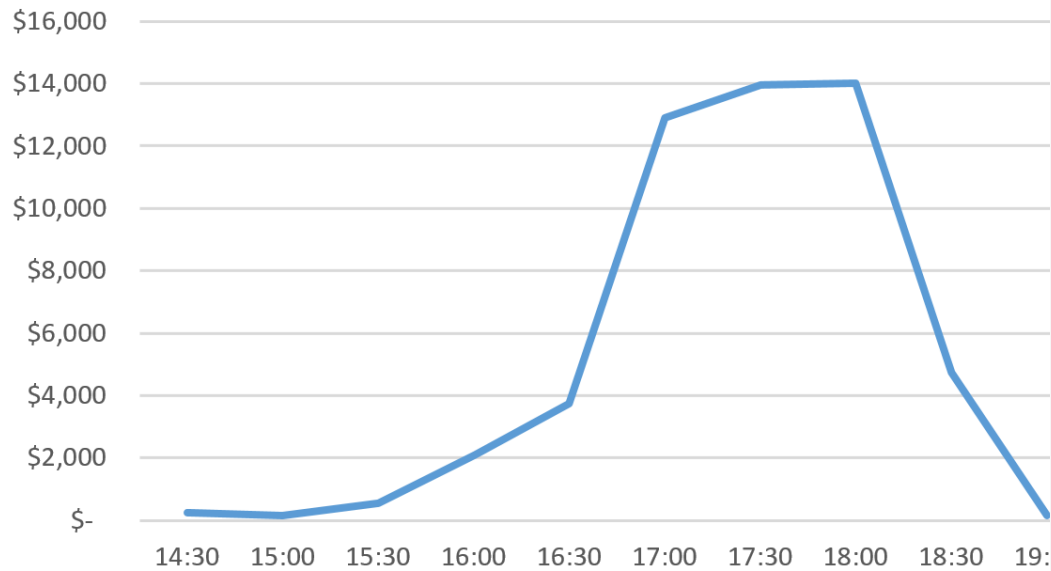


# Solar continues to grow, both in popularity and size of system



# Most participants can't respond to price volatility, and don't have the knowledge

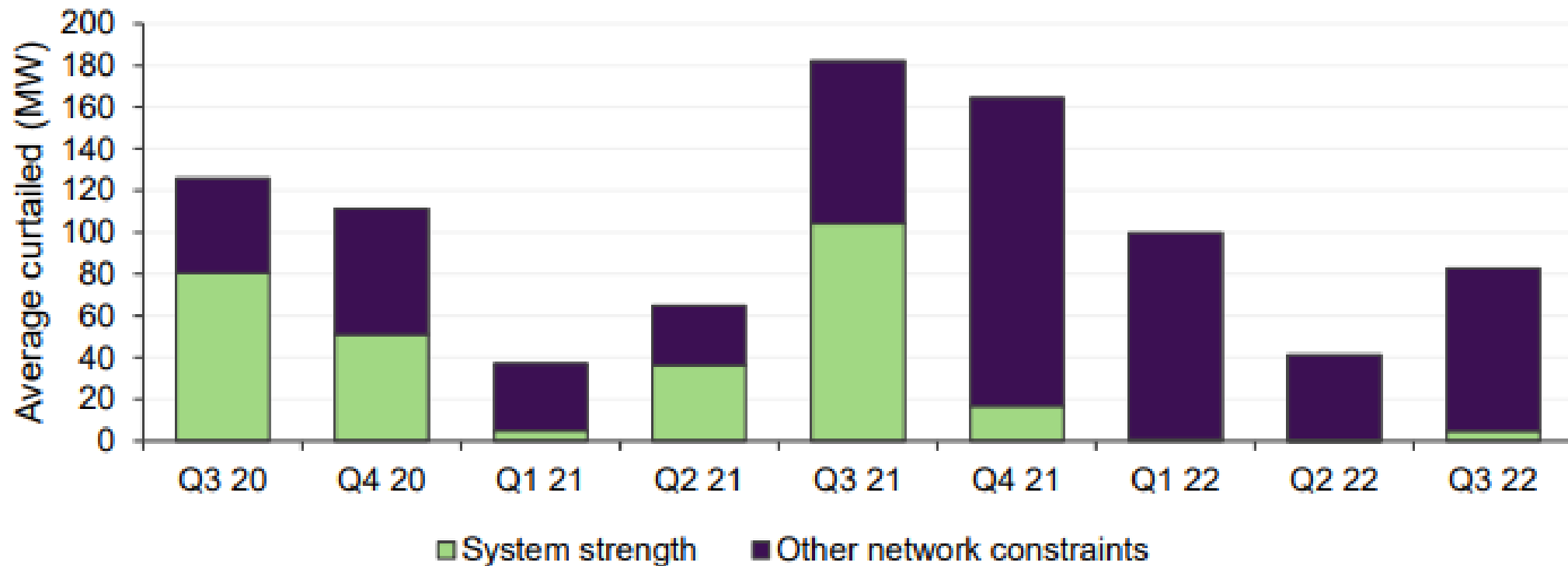
### Spot market price in NSW on 10 February 2017



# The level of curtailment is an orchestration opportunity

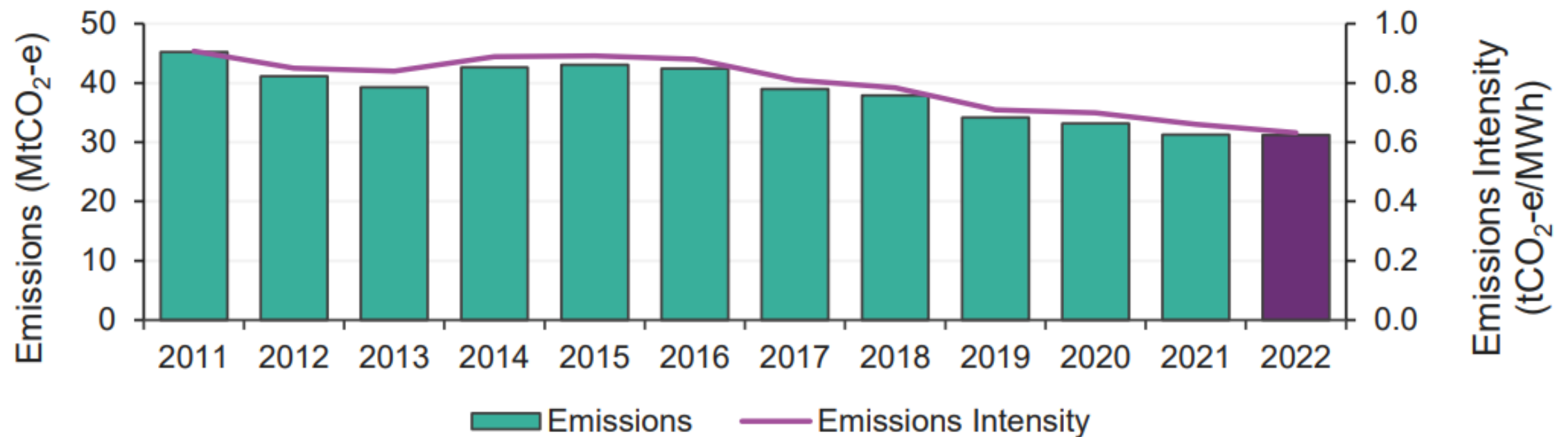
Figure 36 VRE system strength curtailment remains minimal since Q3 2021

Average NEM VRE curtailed by constraint type



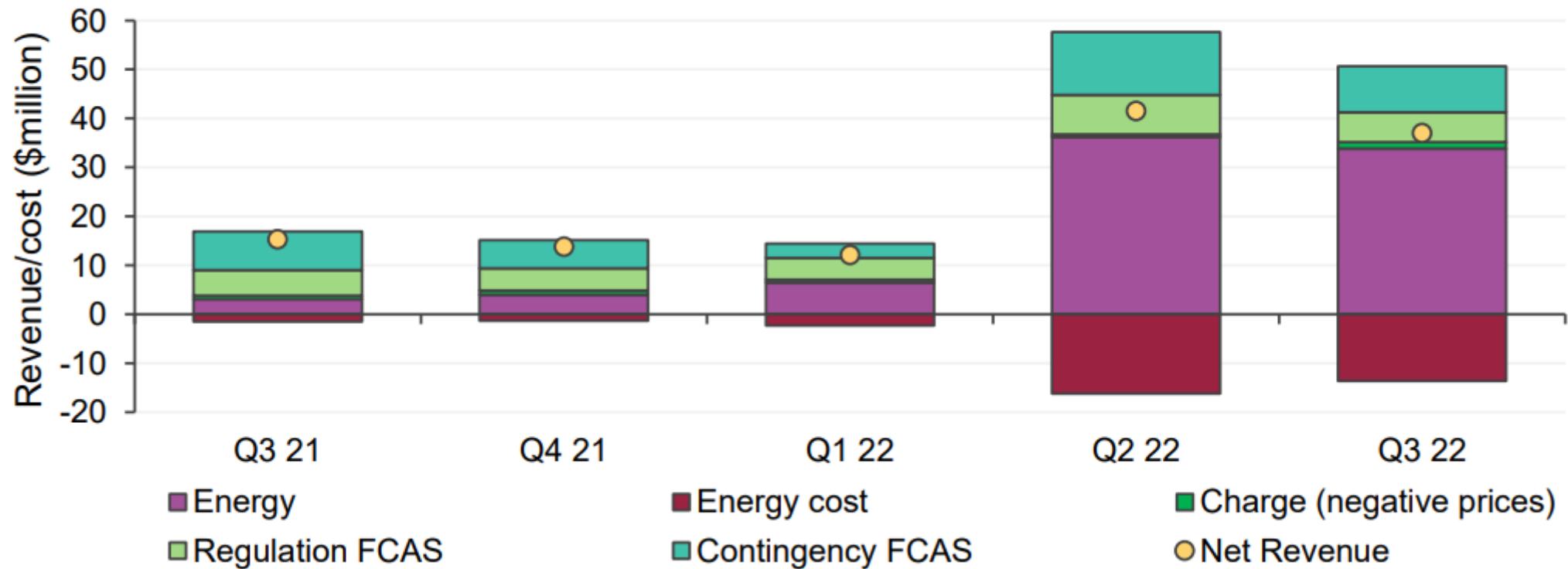
# Emissions are on the path down, but a long way to go to meet government goals

Quarterly NEM emissions and emissions intensity (Q3s)



# Batteries offer an insight to EV opportunities in the energy market

Estimated battery revenue sources – quarterly



# Change in daily net demand curve is driven by uptake of solar

