Accommodating household electrification within a growing city

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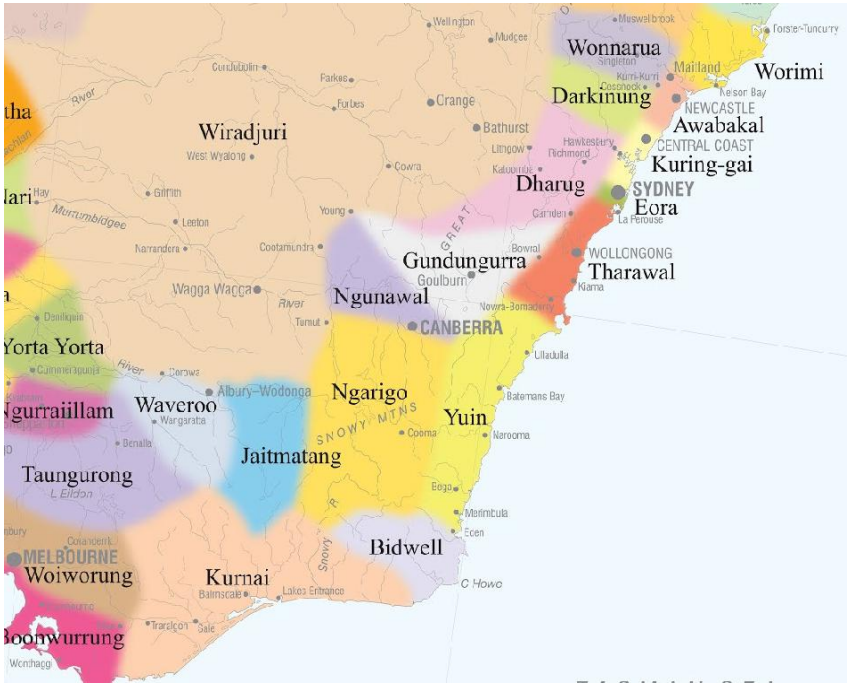
School of Engineering

Australian National University

Acknowledgement of Country




Distribution Network
30-40% of bills
50% for sunk costs

Demand **forecast** → Infrastructure build → Costs **locked in**

Demand growth **forecast** ≈ population growth

Demand growth **forecast** ≈ population growth **+ ELECTRIFICATION**

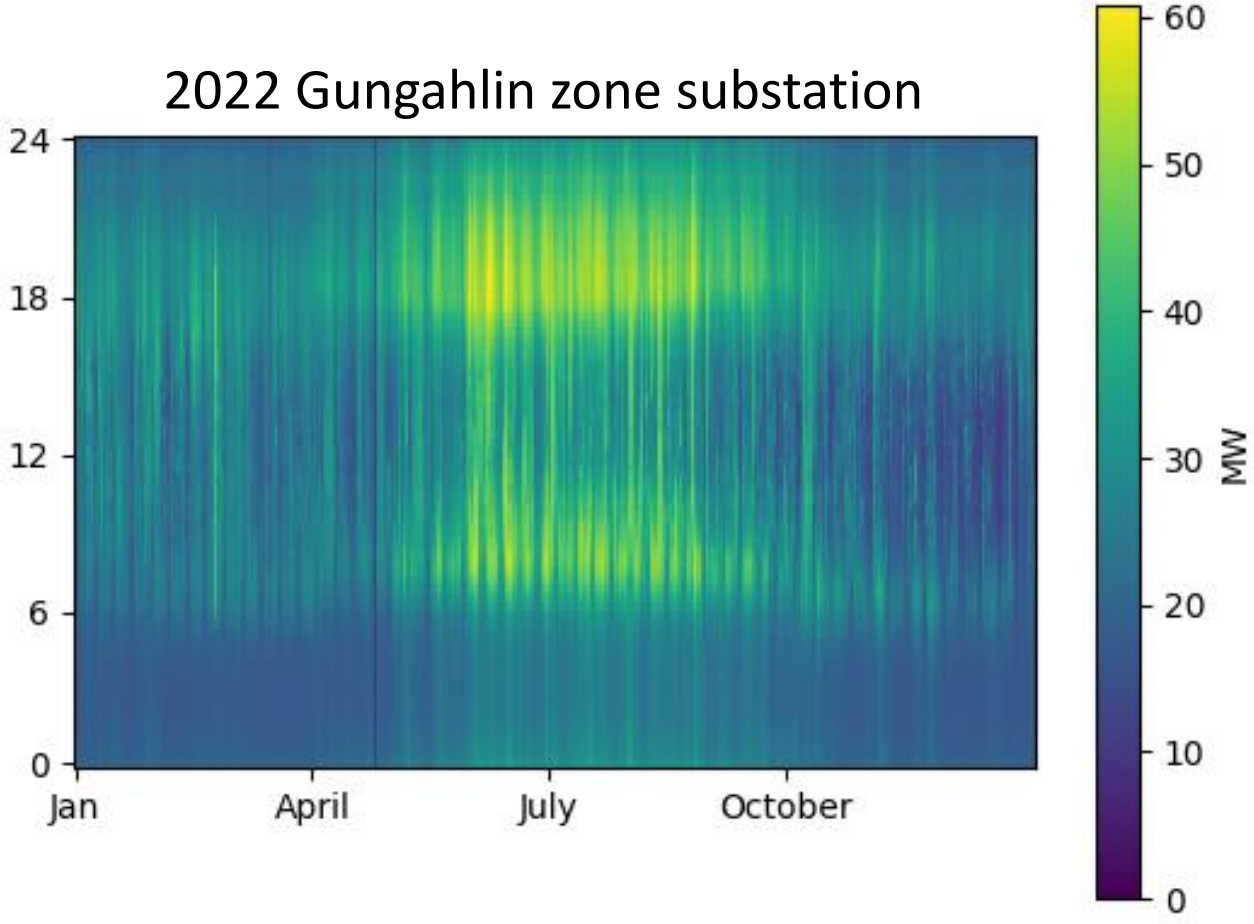
Peak

^ Demand growth **forecast** ≈ population growth

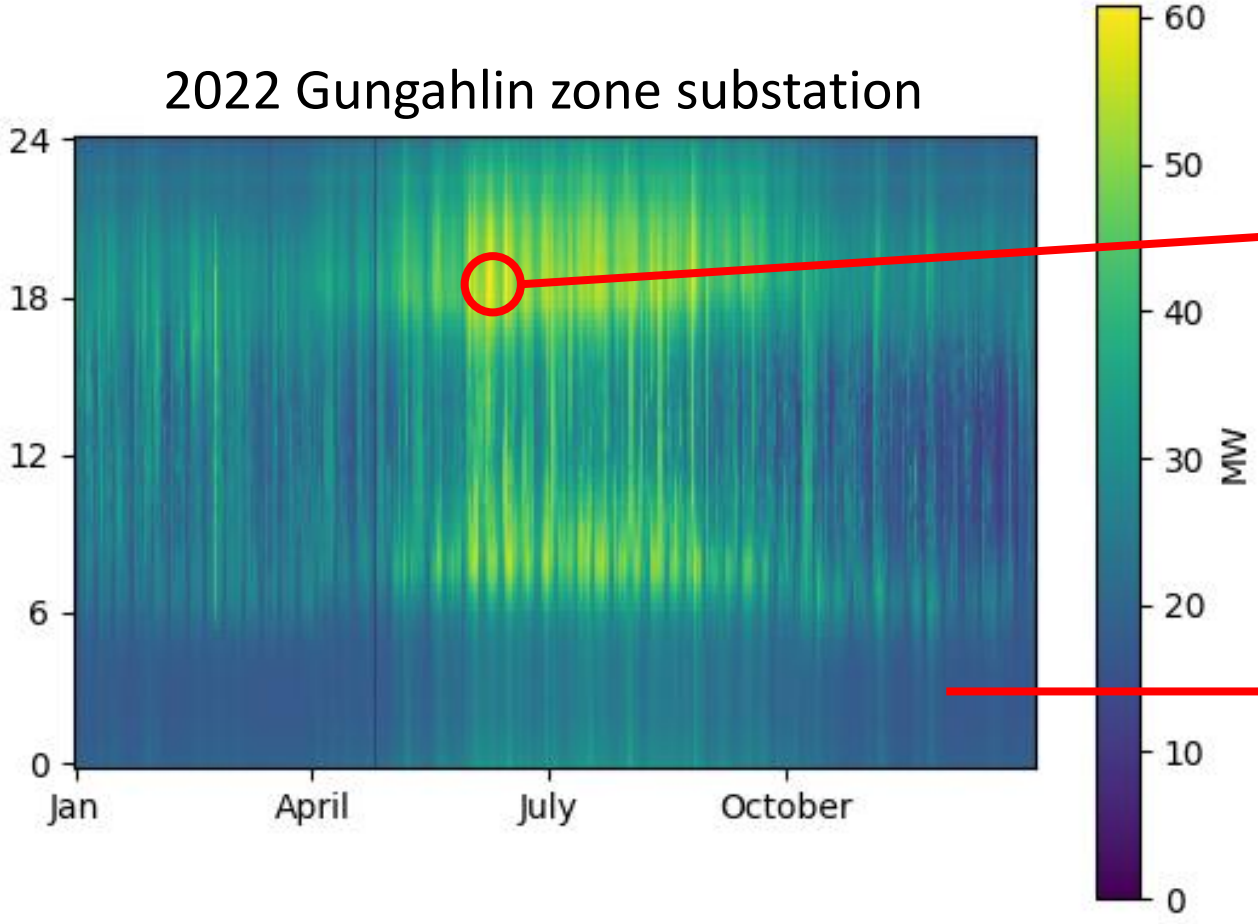
+ ELECTRIFICATION

+ BEHAVIOUR

Demand is highly variable



Networks have spare capacity

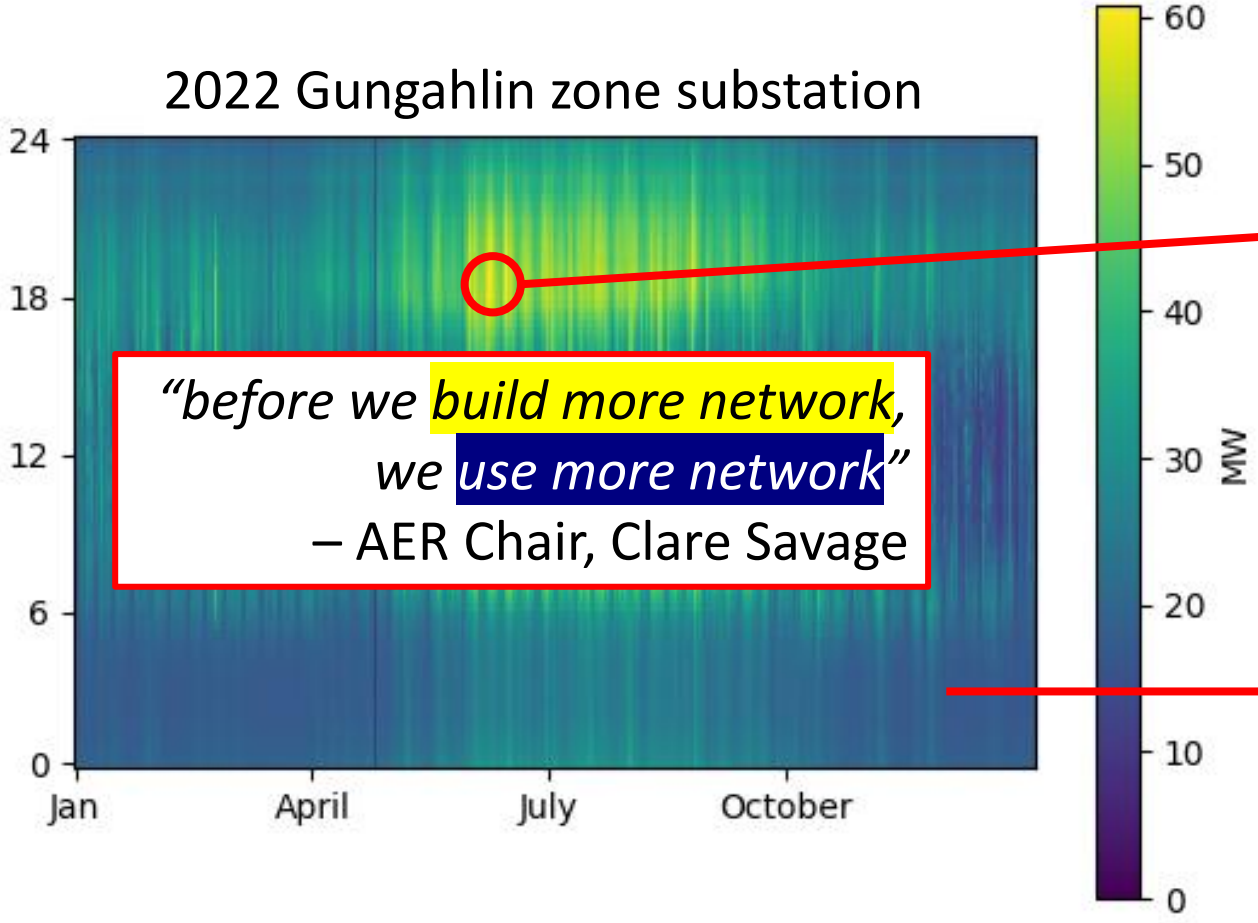


build for this

this is underutilised

av. ~40% capacity

Networks have spare capacity



Our research

How much electrification *could** fit into spare zone substation capacity?

*plausible not a forecast, see “Cone of possibilities”, https://thevoroscope.com/2017/02/24/the-futures-cone-use-and-history/

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ACT in 2045:

- 100% private electric vehicles,
- 100% electric hot water,
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Our approach: simple & practical

Schedule vehicle charging & water heating at **fixed times each day**

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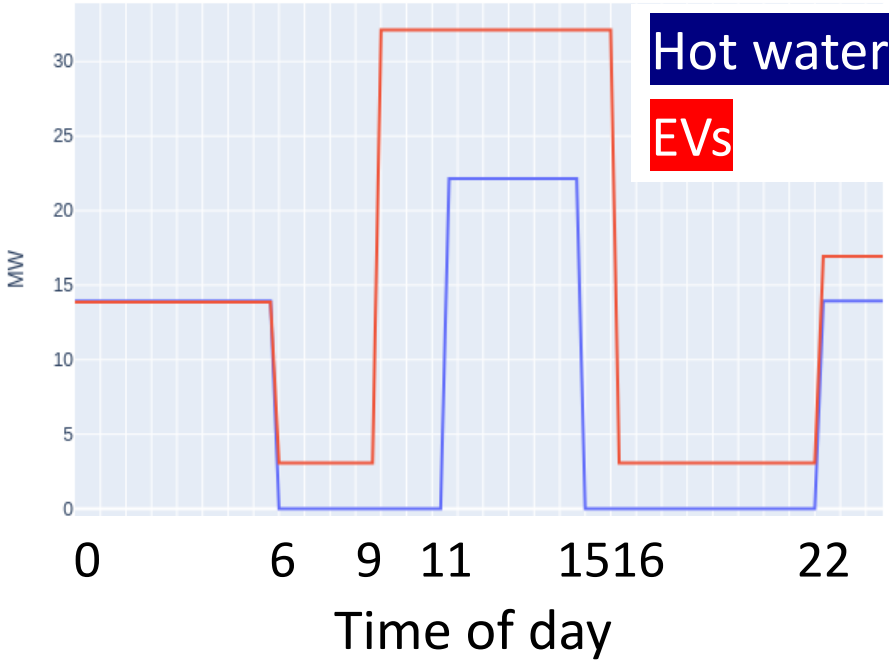


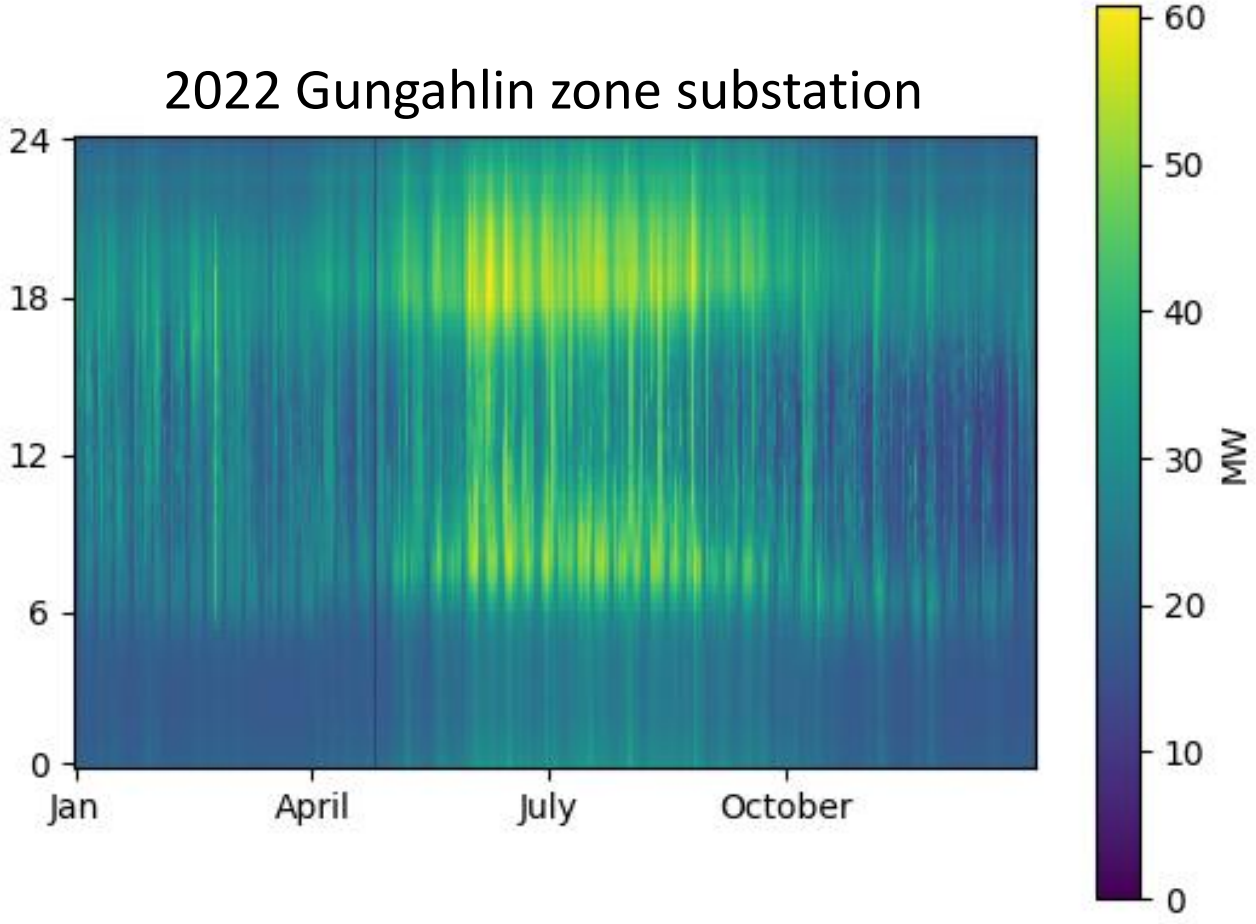
Notes

Mostly solar hours

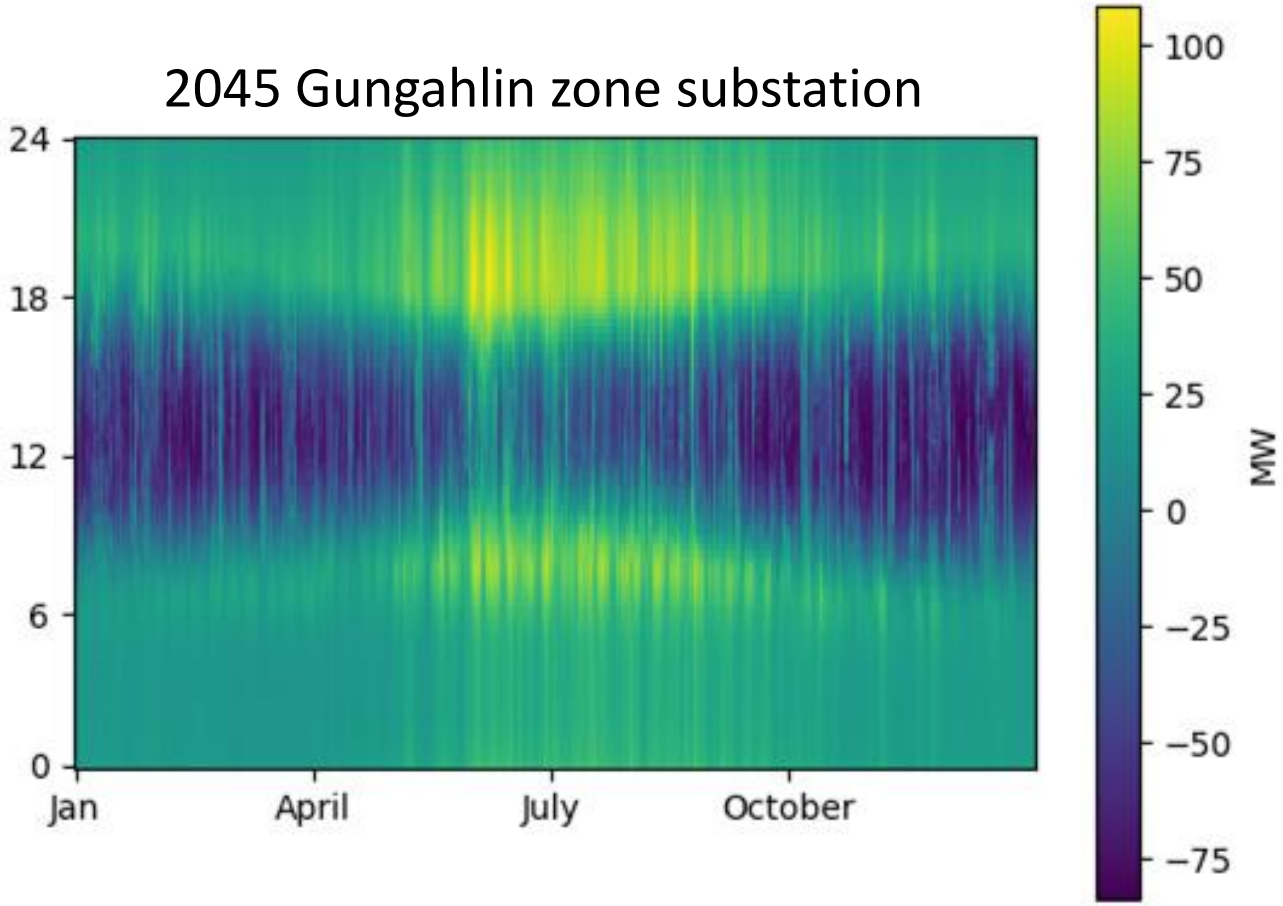
Remainder overnight

Some EVs at peak times – at public rapid chargers

Current demand



Population growth + new solar



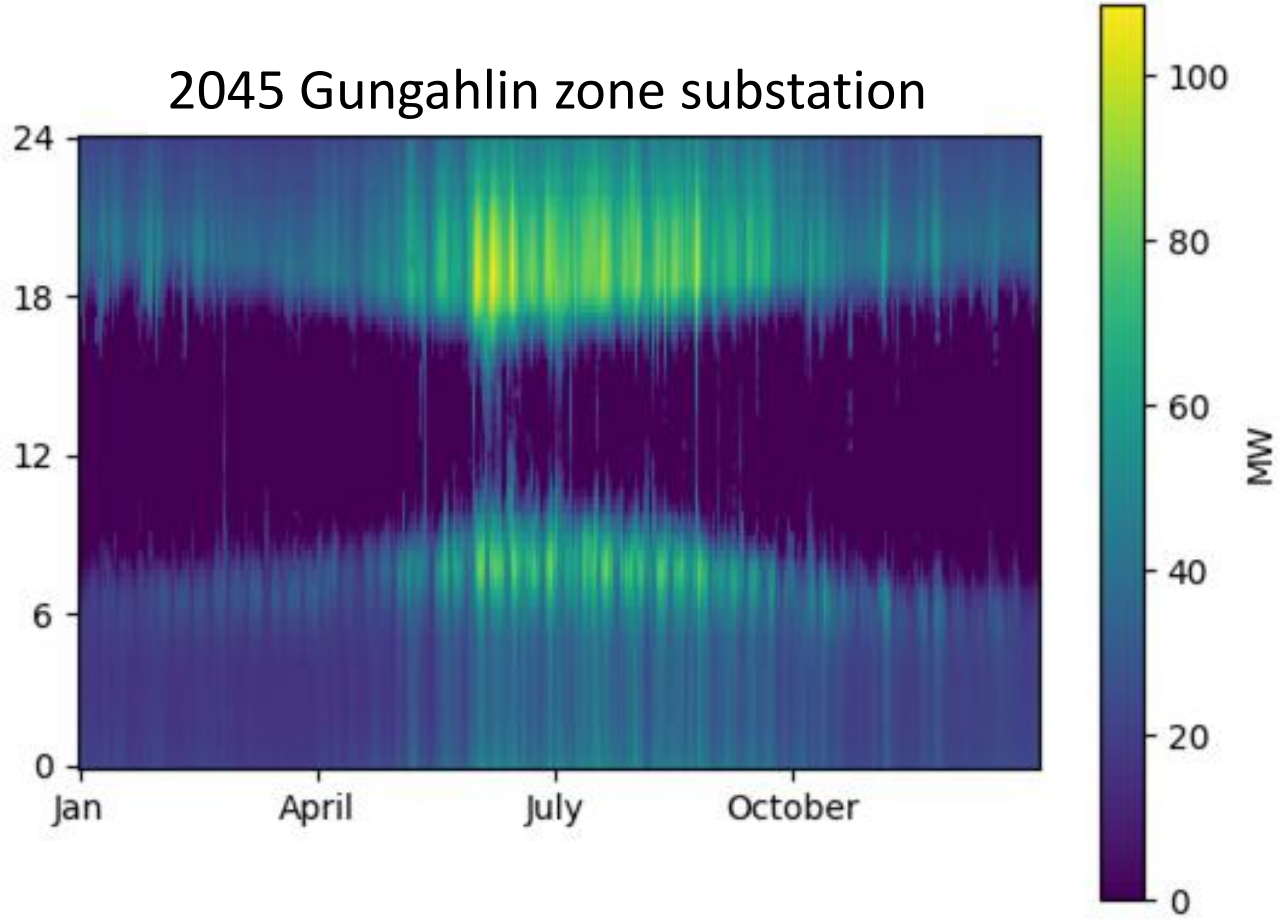
Notes

2022 electric water heating removed

Demand scaled by population growth

1500MW new solar

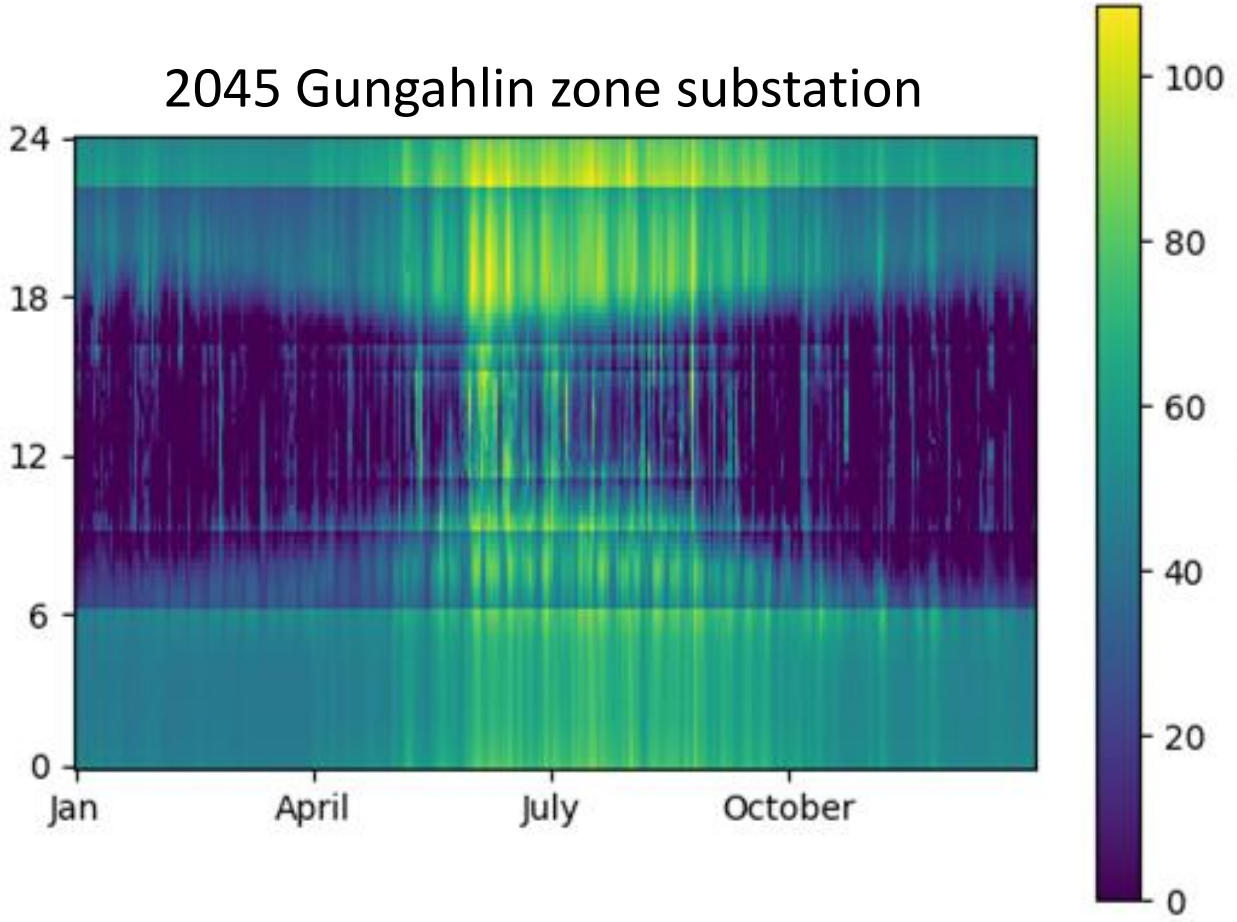
Population growth + new solar



Notes

Trim plot at zero demand

With vehicle charging & water heating



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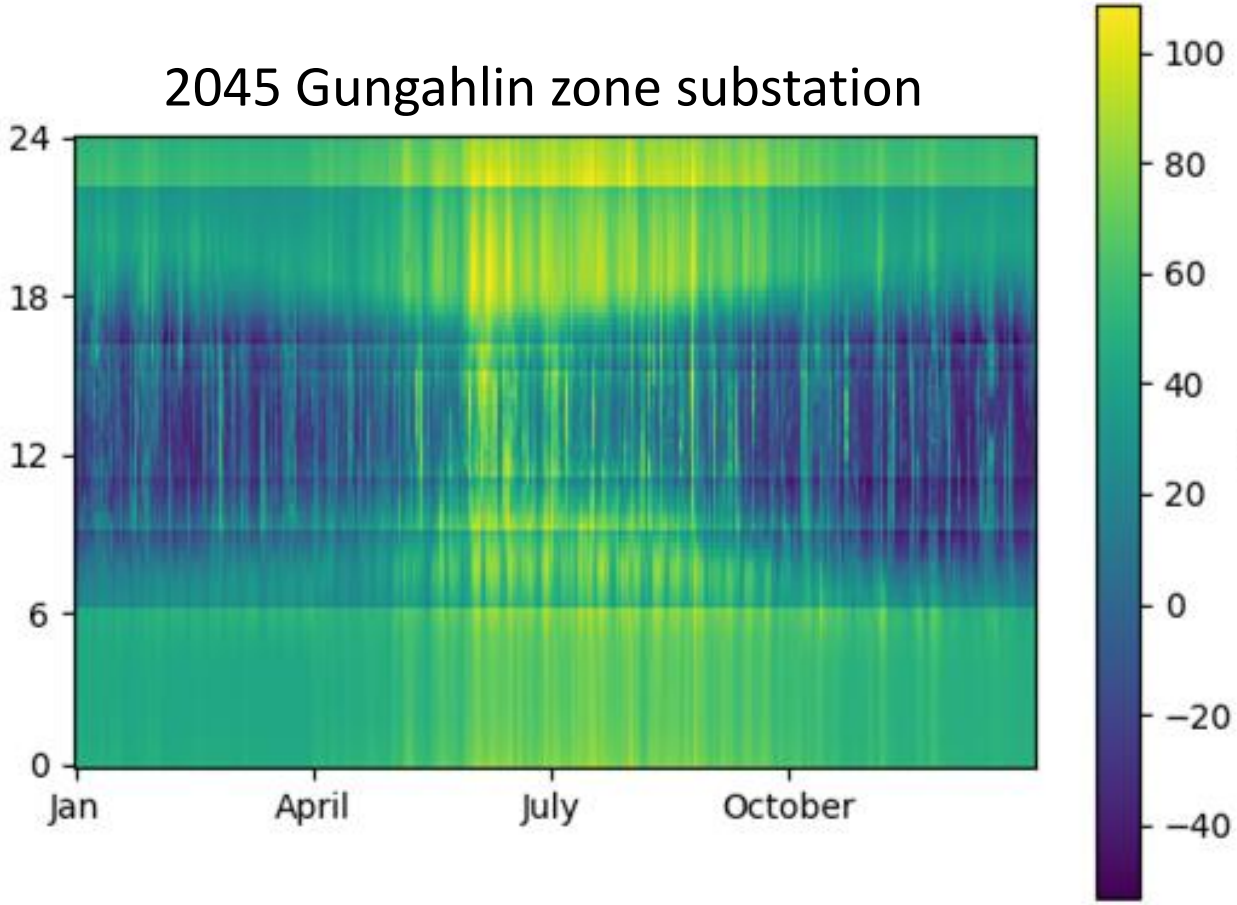

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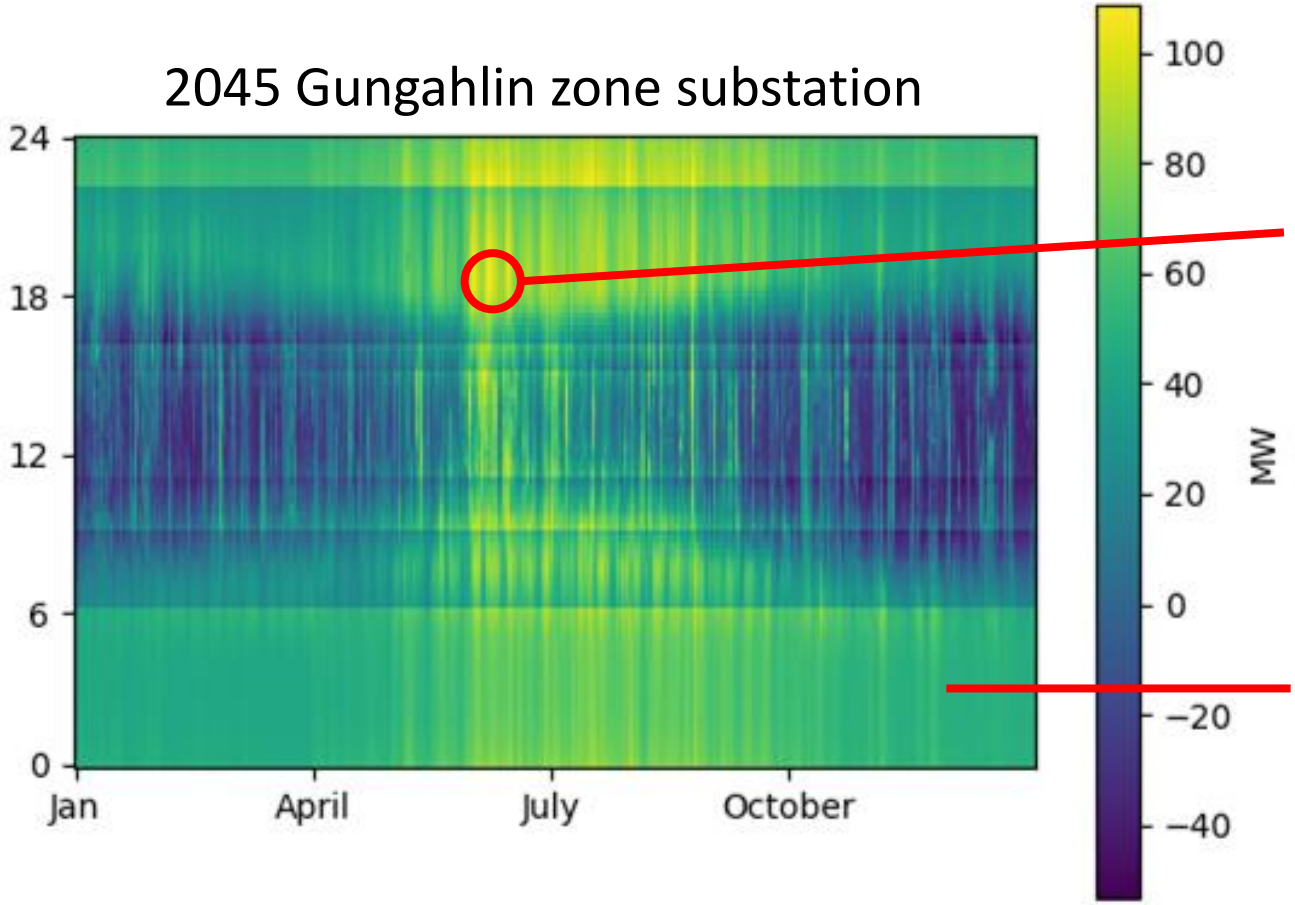
Add electric hot water & vehicles

Min demand from -80MW to -50MW

With vehicle charging & water heating



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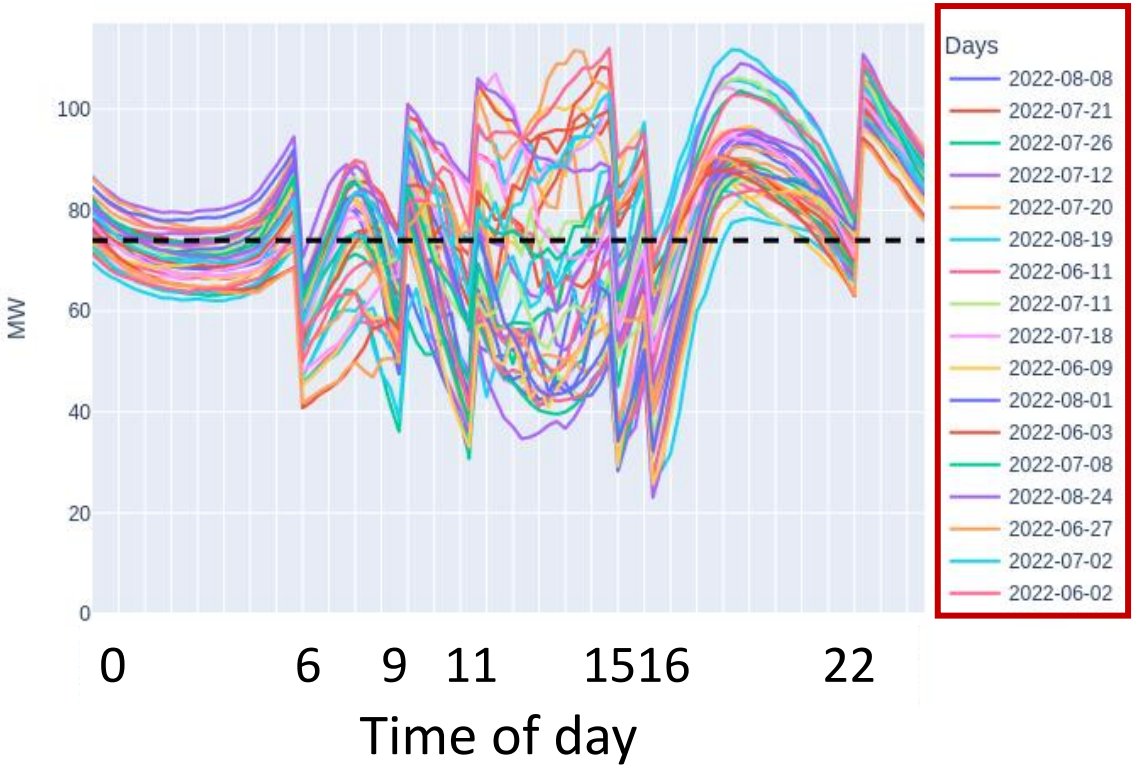
Peak demand events are still in winter

- Population growth exceeds current limit
- Peak demand continues to **occur in winter**



(Gunghalin: Low Solar, High Home EV)

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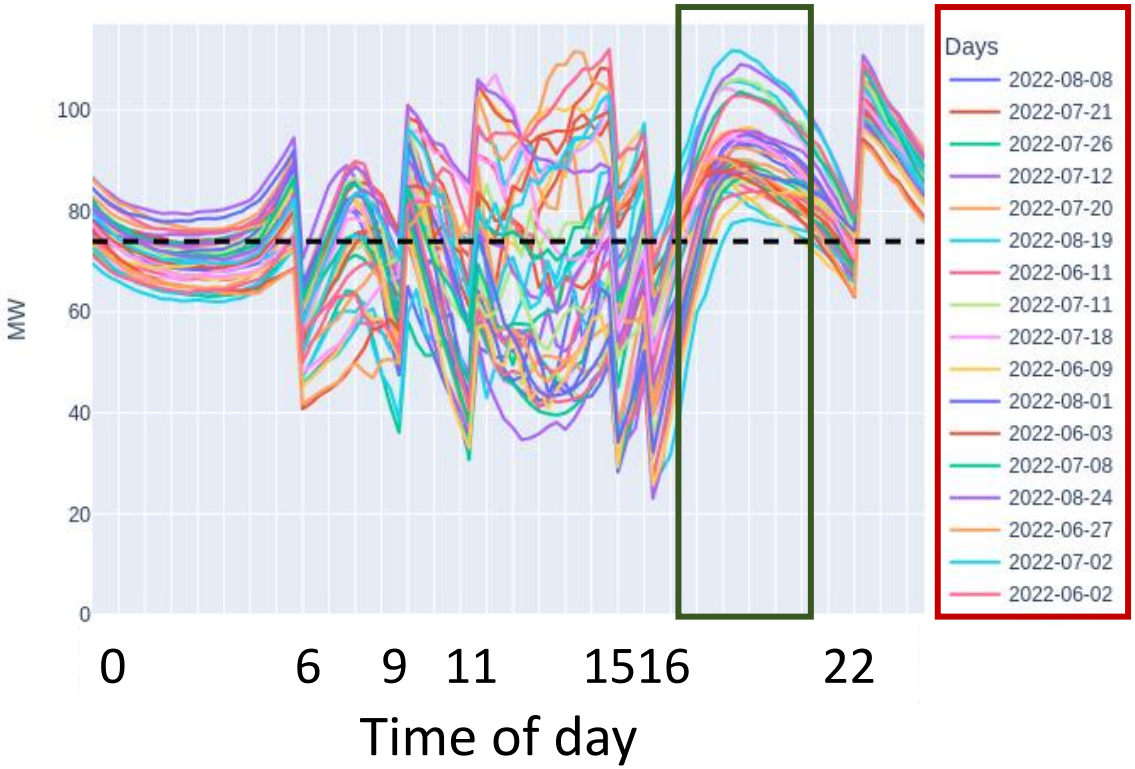

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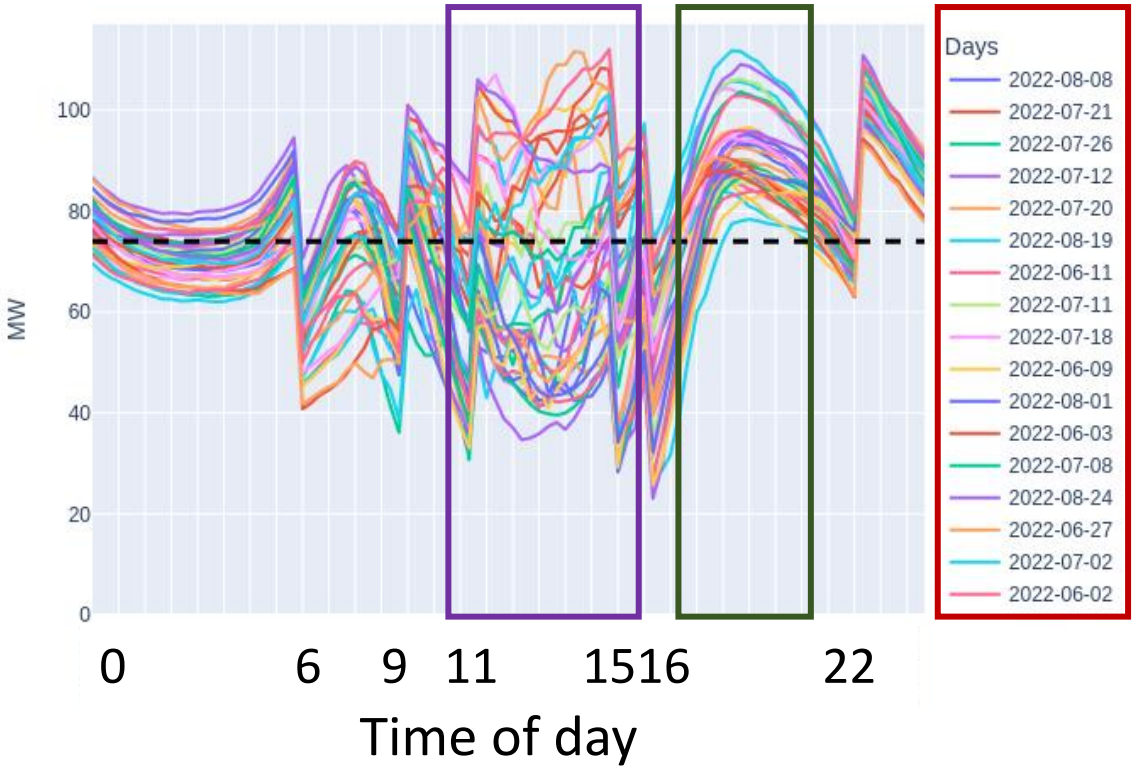

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- **Coincident EV charging** creates new peaks

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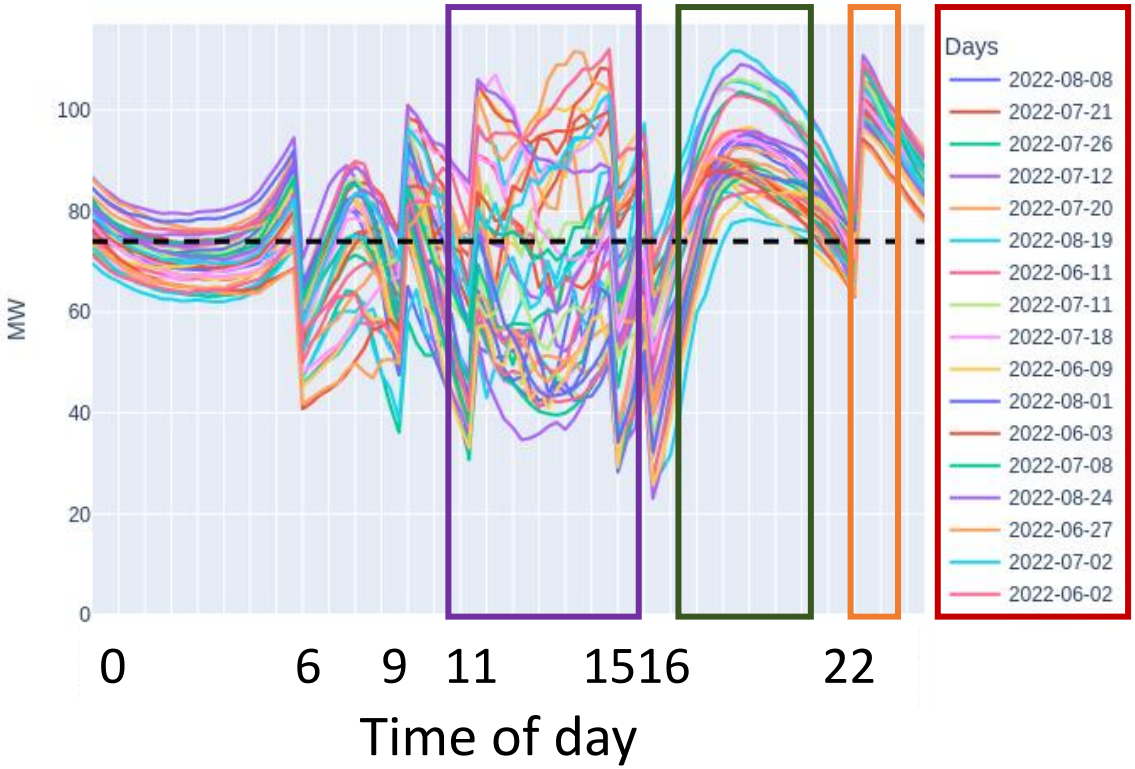

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Caveats:

- 100% customer participation @ fixed times (causes step changes)
- **Electric A/C will extenuate peak demand** beyond our modelling…
  … creating more headroom for flexible loads
- Electrified loads lift min demand by 30MW
  (to -50MW if 1.5GW new solar, -20MW if 1GW new solar)

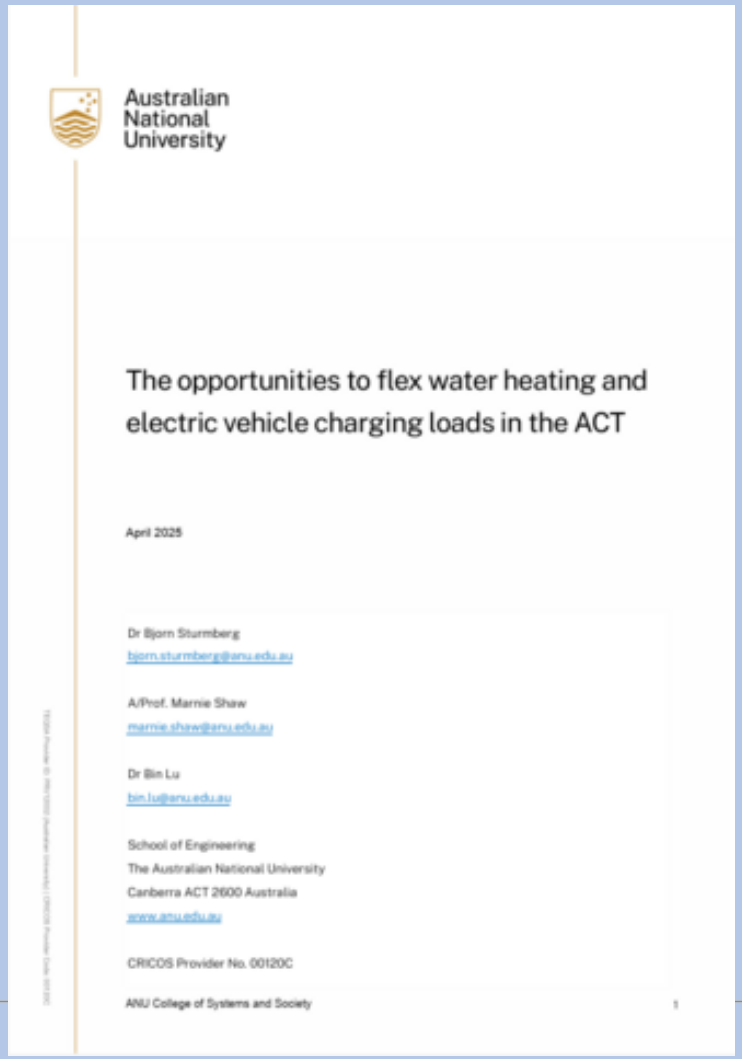
Policy goals

Harness the flexibility of electrified appliances

- **Simple** scheduling achieves majority of benefit
- **Feasible now**: control loads, tariffs, incentives
- Dynamic approaches nice to have

Invest in reducing air-conditioning demand

- Inflexible peaks in underlying demand will drive large costs
- **Feasible now**: insulation & efficiency



Australian National University

The opportunities to flex water heating and electric vehicle charging loads in the ACT

April 2025

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1

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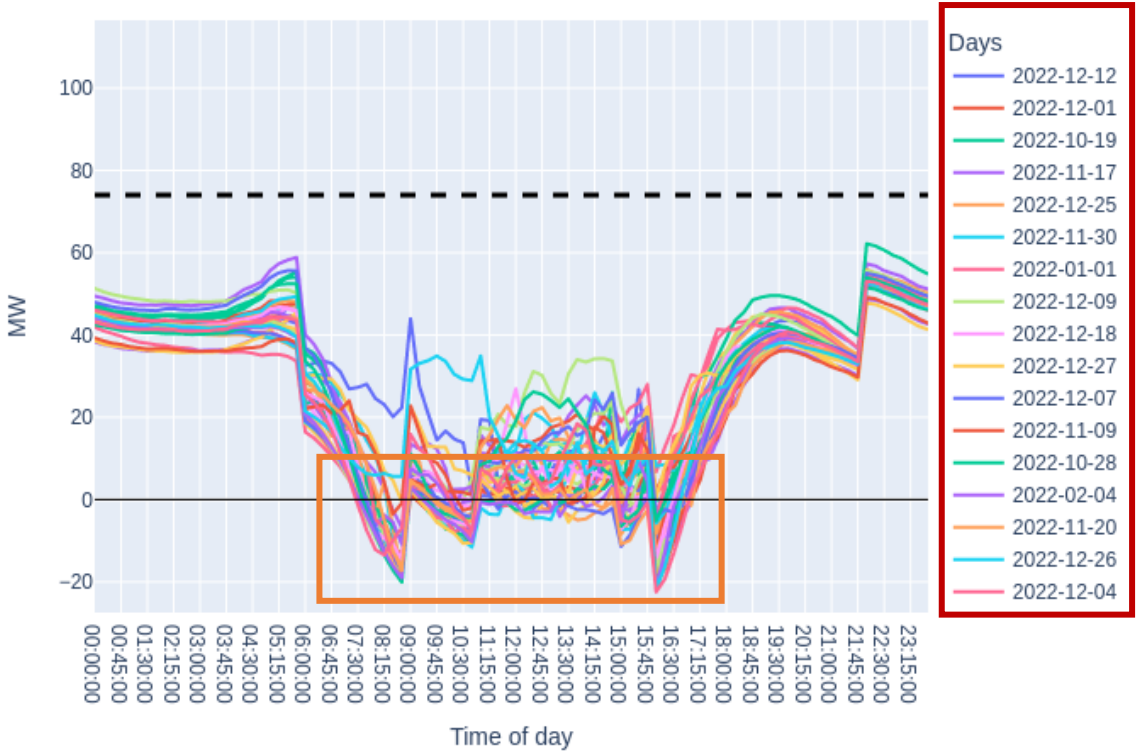
bjornsturmberg.com.au/electricity/
for a recording of this presentation

Minimum demand is less extreme

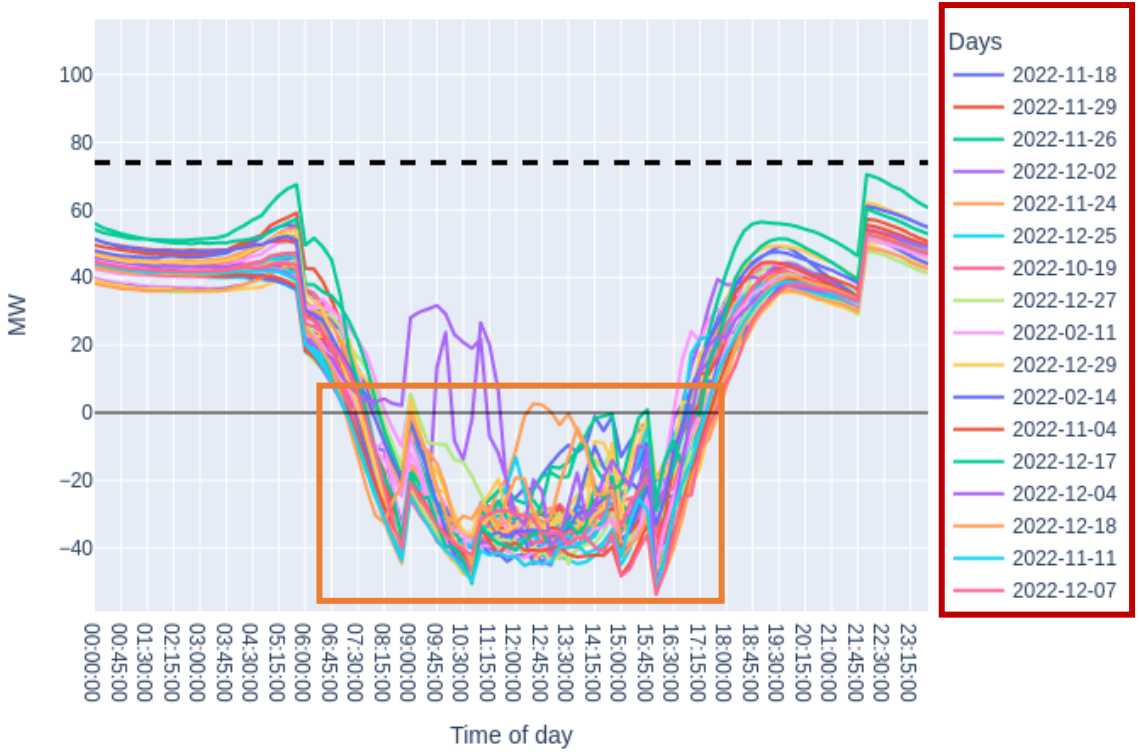
- Minimum demand continues to **occur in summer**
- **Coincident, non-dynamic EV charging**

(Gunghalin: **Low Solar, Low Home EV**)



Minimum demand is less extreme

- High Solar scenario emphasises solar impact over EV impact



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ACT in 2045:

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- 4 scenarios: solar uptake, EV charging locations (home/away)

*plausible not a forecast, see “Cone of possibilities”, https://thevoroscope.com/2017/02/24/the-futures-cone-use-and-history/

4 scenarios

We consider two values for rooftop solar additions:

1. a ***High solar*** scenario, and
2. a ***Low solar***.

The values for these are discussed in the ACT rooftop solar by 2045 subsection below. Similarly, we consider two values for EV charging:

1. a ***High home charging*** scenario, and
2. a ***Low home charging*** scenario.

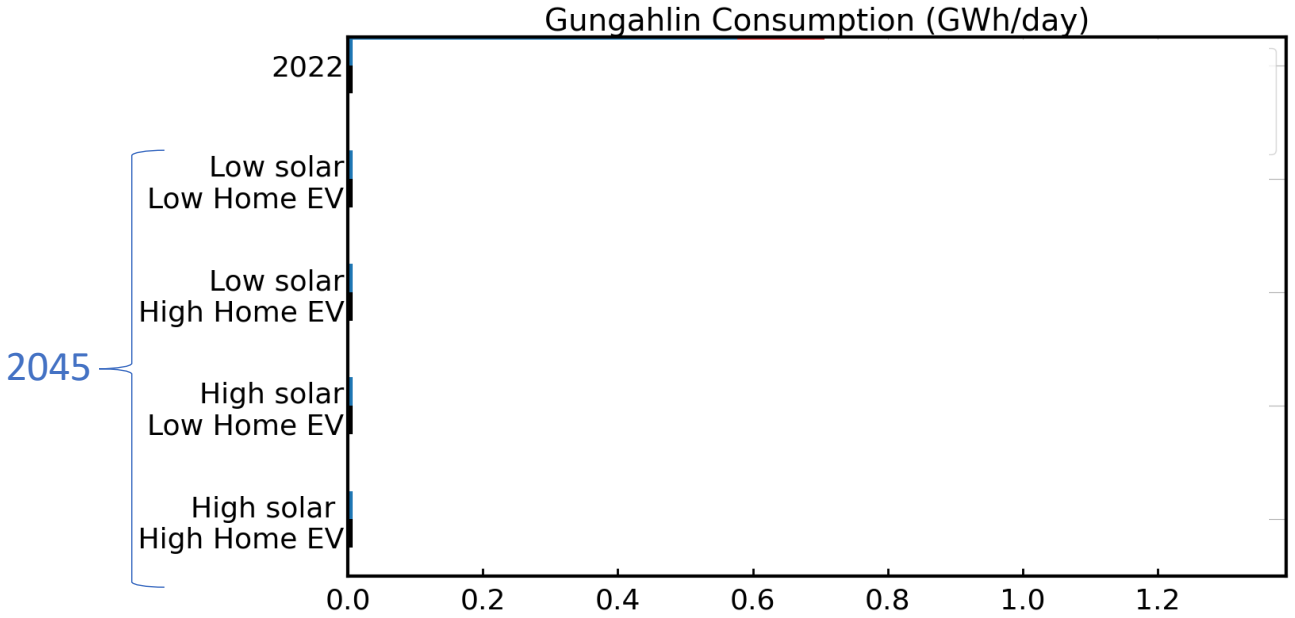
The values for the ***High home charging*** scenario are the Step Change scenario in AEMO's 2024 ESOO (which in turn come from the CSIRO 2023 EV forecast). In the ***Low home charging*** scenario, 20% of charging is shifted from homes to work/public charging, which doubles the prevalence of work/public charging.

Table 1: Defining variables of solar and EV charging scenarios

Solar scenarios	***High solar***	***Low solar***
Rooftop solar additions by 2045	1500 MW	1000 MW
EV charging scenarios	***High home charging***	***Low home charging***
Home charging (L1, L2)	68%	48%
Work/public charging (L2)	20%	40%
Public fast charging (L3)	12%	12%

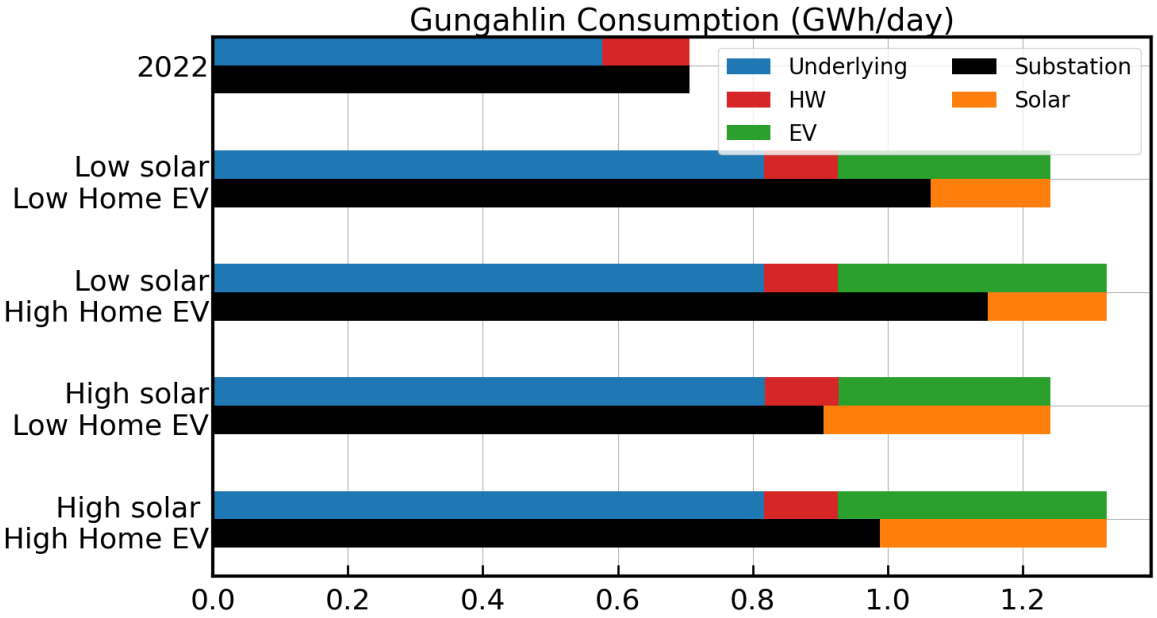
Demand growth

- 4 scenarios



Demand growth

- EV add ~45% to demand!
- Heat pump efficiency counterbalances electrification
- Charging EVs away from home reduces substatior demand
- High rooftop solar reduces substation demand



Comparison to evoenergy modelling

Marsden Jacobs for evoenergy

ACT peak from 650 MW to 1600MW = **150% increase**

ANU modelling

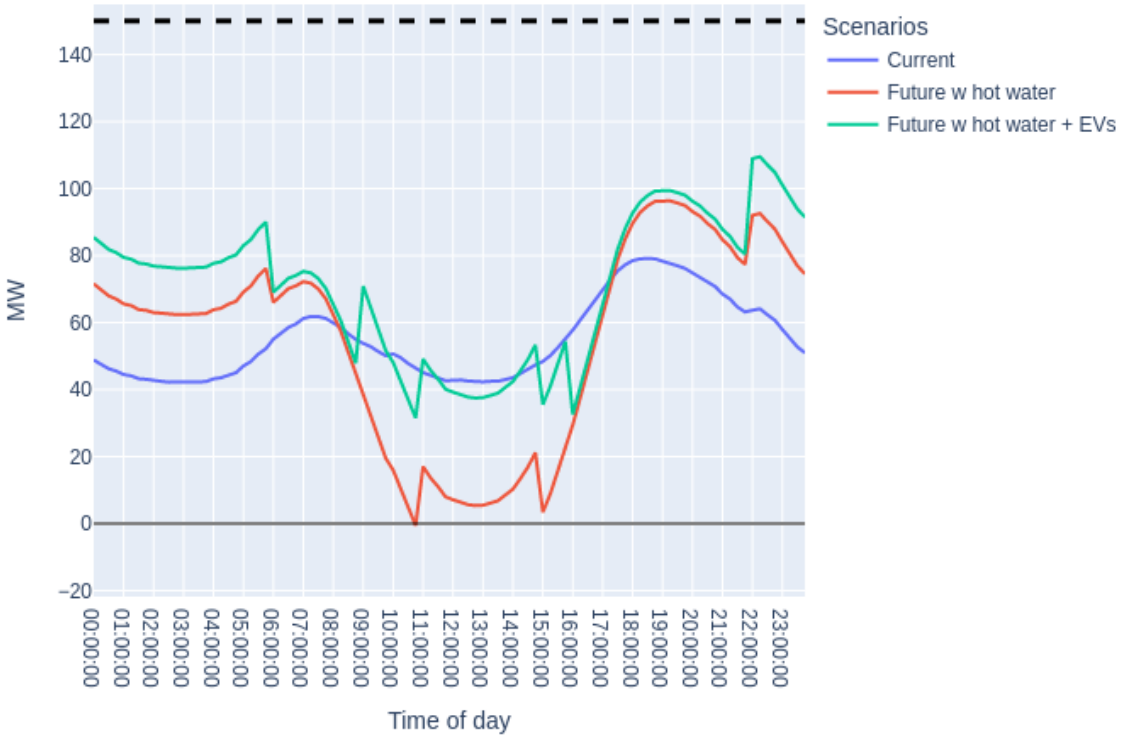
Zone substation peak demand from 133MW to 175MW = 32% increase

10% PoE from 107MW to 154MW = **44% increase***

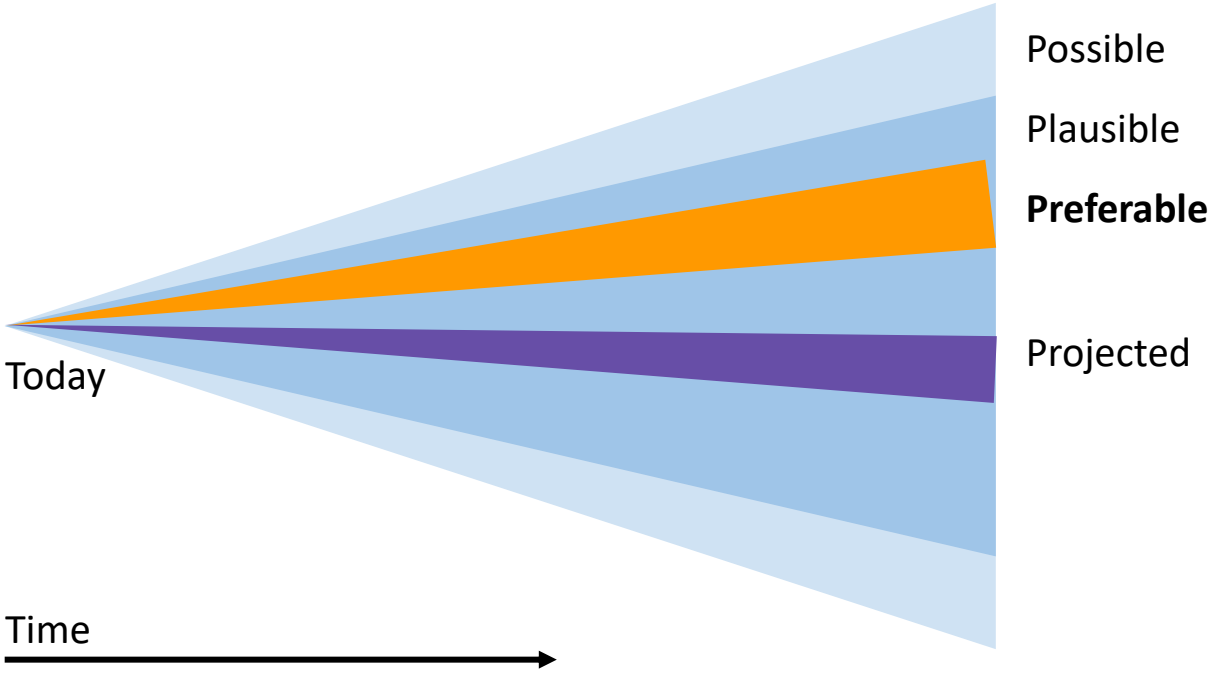
*only electrifying water heating & private vehicles, excl space heating

Modelled demand scheduling

- Empirically schedules to fit average low demand times
- Creates **flattish demand** profile **on average**, but isn't responsive to specific circumstances



Not projected; what's plausible & **preferable**



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