Solar PV rebound effect on regional demand

Estimating the behavioural changes in consumptions

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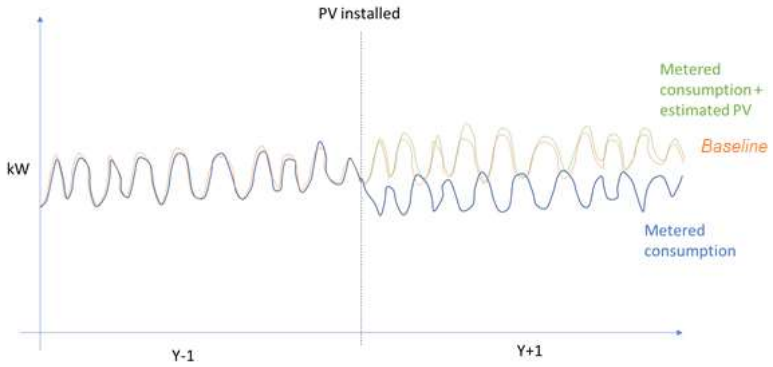
Australia's National Science Agency

PV rebound project



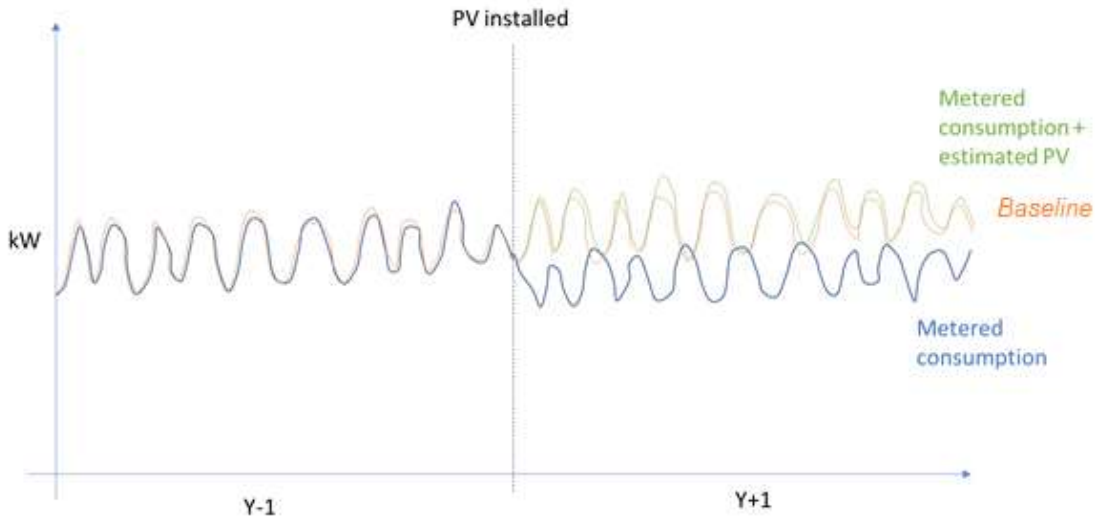
- Quantifying the hourly PV rebound effect by examining the changes in consumption after a rooftop PV installation
  - Leveraging a BTM PV estimation method
- A simple method for aggregated hourly PV rebound
- Part of the National Energy Analytics Research (NEAR) Program
- Deployed at AEMO's lab using MSATS data at NEM regions
  - Myself + two software engineers
  - Python codes have been shared with AEMO
- Final report will be publicly available

Motivation

- What is a rebound effect?
  - Taking advantage of a new lower price of the energy service to use more of that service (e.g., to have a cooler home after installing rooftop PV)
  - True savings << potential savings
- At regional level, e.g.,
  - Winter peak demand in 2021 was highest in a decade,
  - Actual demand well above forecast POE10 demand (2018 ESOO)

- How much of this increase is due to the solar PV rebound effect?

Approach



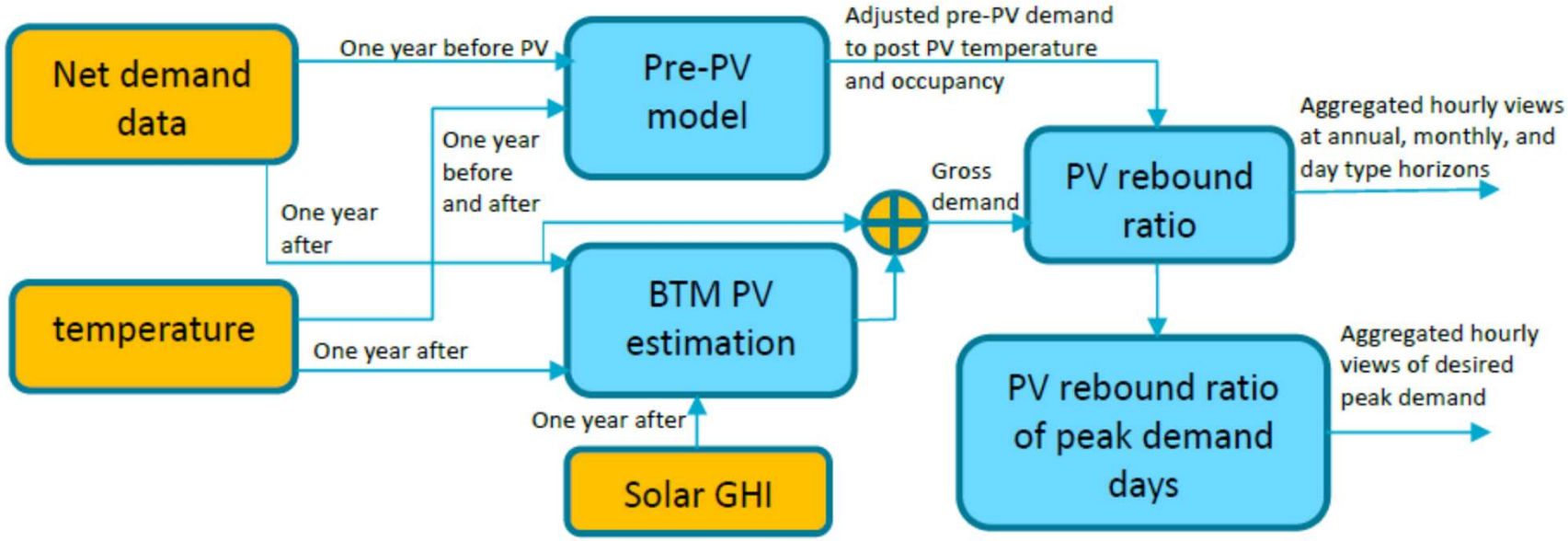


Figure 1 Overall process of calculating PV rebound ratio for a single customer

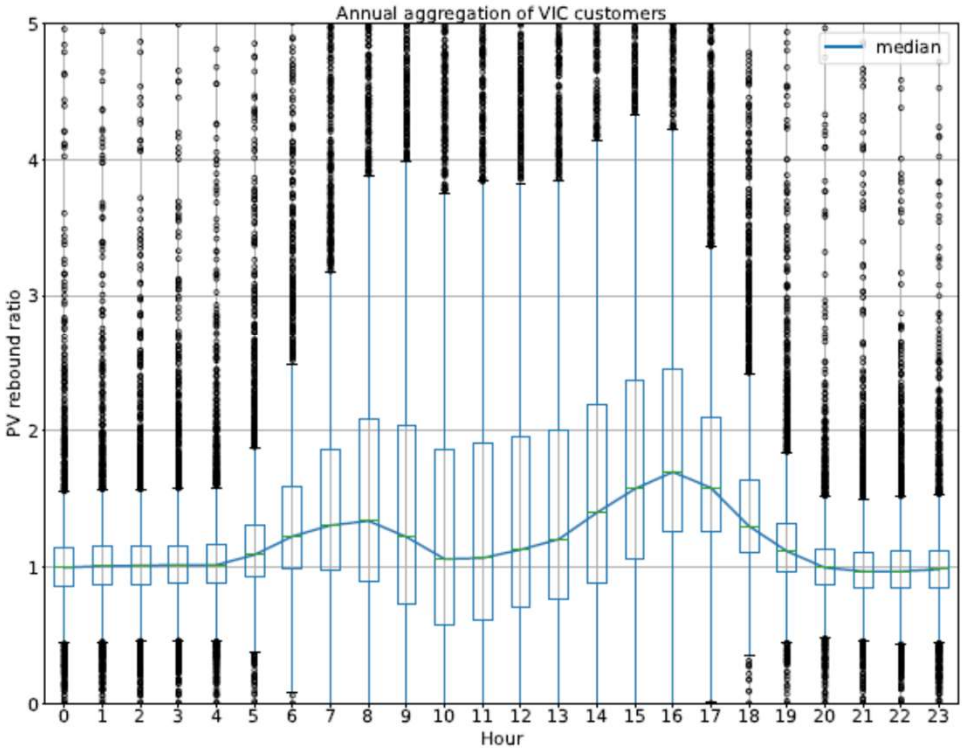
$$R_2(h) = \frac{\sum_{t=0}^{N-1}(\hat{PV}(24t+h) + P_{post}(24t+h))}{\sum_{t=0}^{N-1} P_{pre}(24t+h)},$$

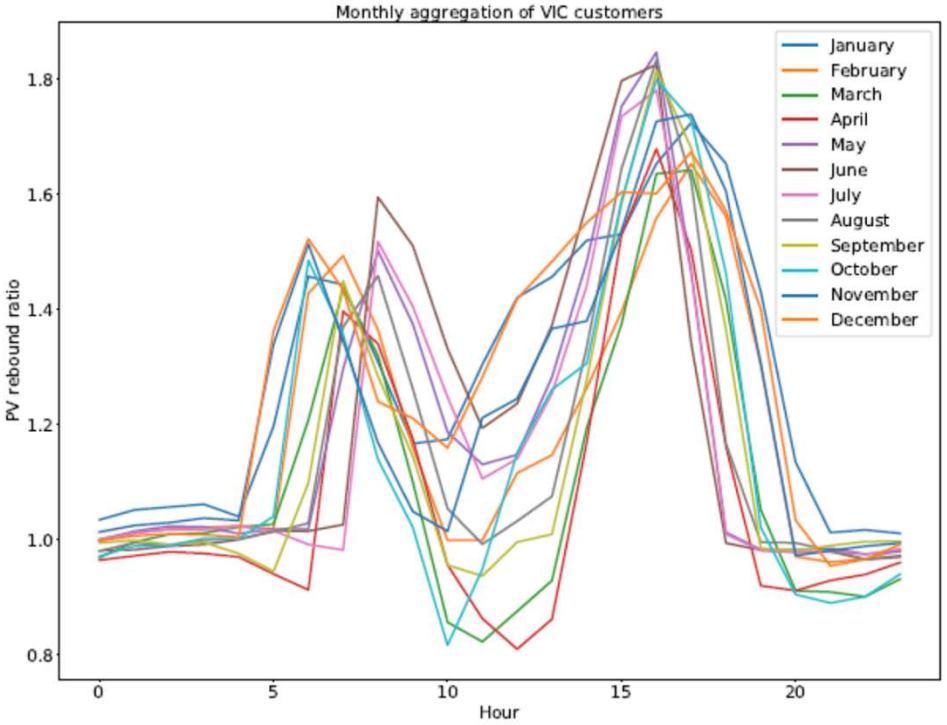
Data

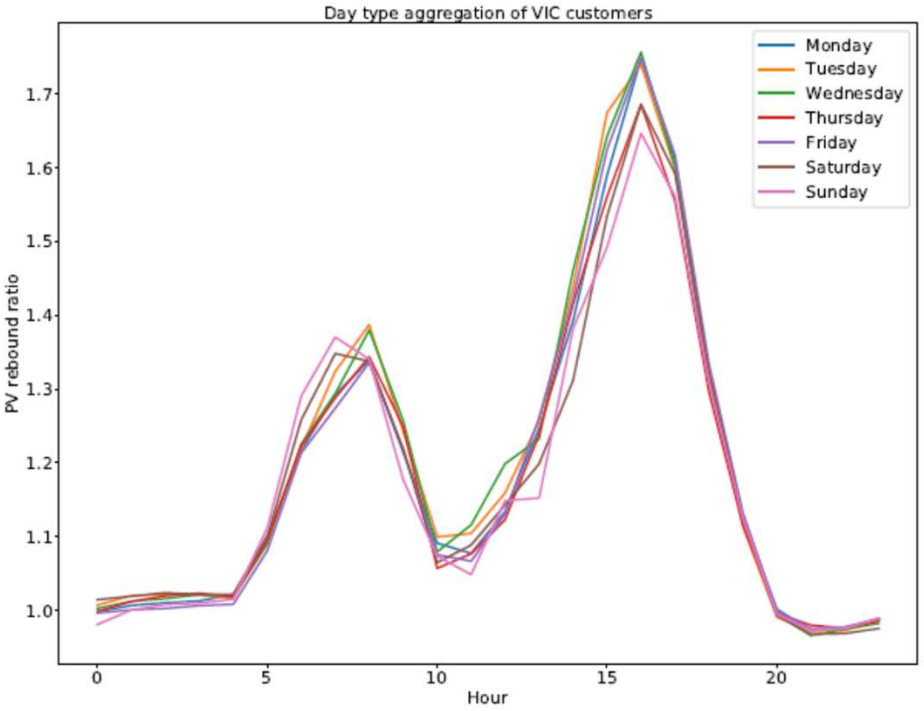
State	# Households satisfying query
SA	2111
NSW	12747
QLD	2690
VIC	48027
TAS	0*

State	Insufficient net generation	Insufficient temperature	Insufficient GHI	Total remaining
SA	30	719	1076	631
NSW	141	10808	6227	959
QLD	28	1640	978	529
VIC	1547	40251	24487	3180

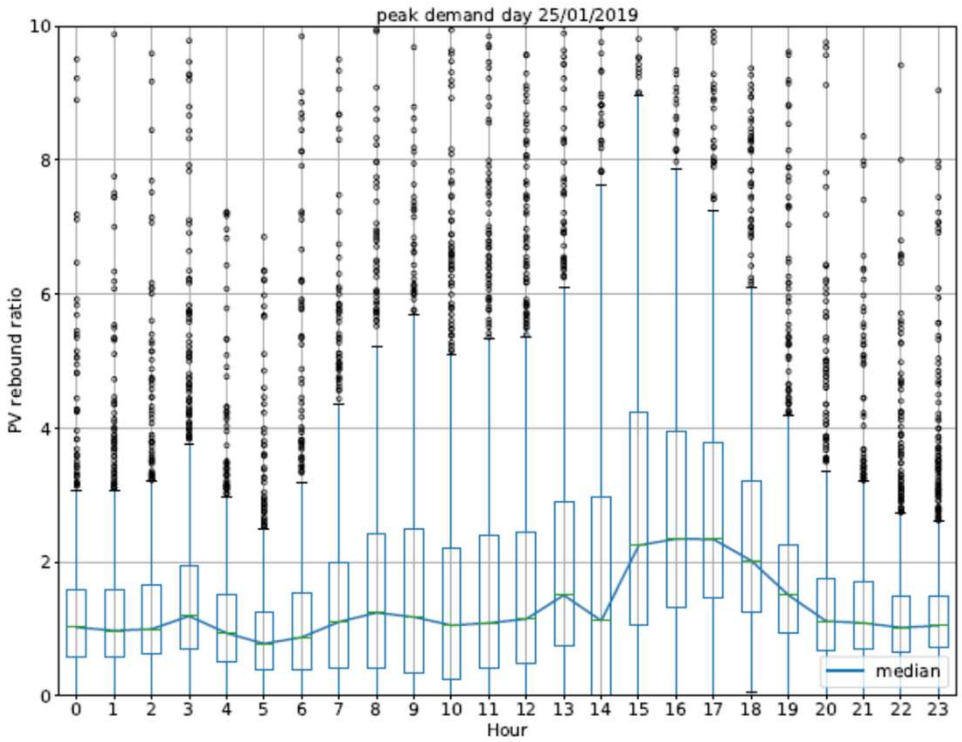
Results: Victoria

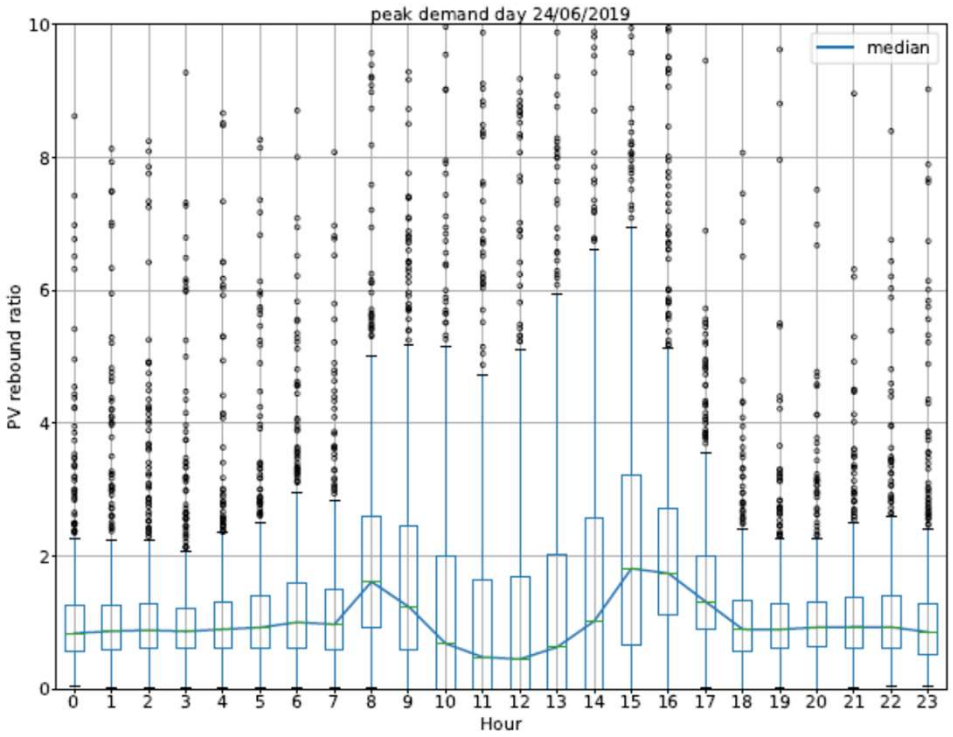






Results: Victoria's peak demand day





Results: summary

- All regions show a morning peak at around 7-8am and an afternoon peak around 4-5pm,
- Annual hourly PV rebound ratios in SA and VIC are always above 1,
- Annual hourly PV rebound ratio in NSW and QLD are below 1 between late morning and midday,
- In all regions, early morning peak in the PV rebound has been shifted to mid-morning by moving from summer to winter,
- In all regions, PV rebound has lower peak values in shoulder seasons,
- In NSW and QLD, there is a significant midday rebound ratio drops to below 1 for shoulder seasons, while there is only a mild drop in SA and VIC,
- PV rebound ratio has distinctive weekend pattern in NSW, but not in QLD, SA, and VIC,
- In all regions, peak demand days have higher PV rebound ratios than the annual pattern,

Results: summary

- Based on the all-hour average of the ensemble medians in the annual PV rebound ratio, VIC, SA, NSW, and QLD have respectively experienced 18%, 17%, 30%, and 13% increase in their gross consumptions after PV installation.

PV REBOUND MEDIAN STATISTICS IN THE NEM REGIONS.

NEM region	Night hours average	All hour average	Max	Max Summer peak	Max Winter peak
VIC	1.01	1.18	1.7	2.35	1.82
NSW	1.01	1.3	2.12	2.52	2.29
QLD	0.98	1.13	1.91	1.81	2.5
SA	0.99	1.17	1.71	1.26	2.75

Challenges, Future works

- Code optimisation to run on large numbers of data
  - Software engineering problem
- Understanding the root causes of consumption changes, e.g.,
  - Demographics (ABS Census data),
  - Switching from gas to electricity,
  - Effect of controllable loads,
  - Size of the installed PV or battery systems,
- Considering the distributed PV rebound ratios at lower scale, e.g., at zone substation level

Thank you

Energy
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