Analysis of Australian residential air conditioning

Simon Heslop
Research Associate
Centre for Energy and Environmental Markets (CEEM) UNSW
Solar Analytics

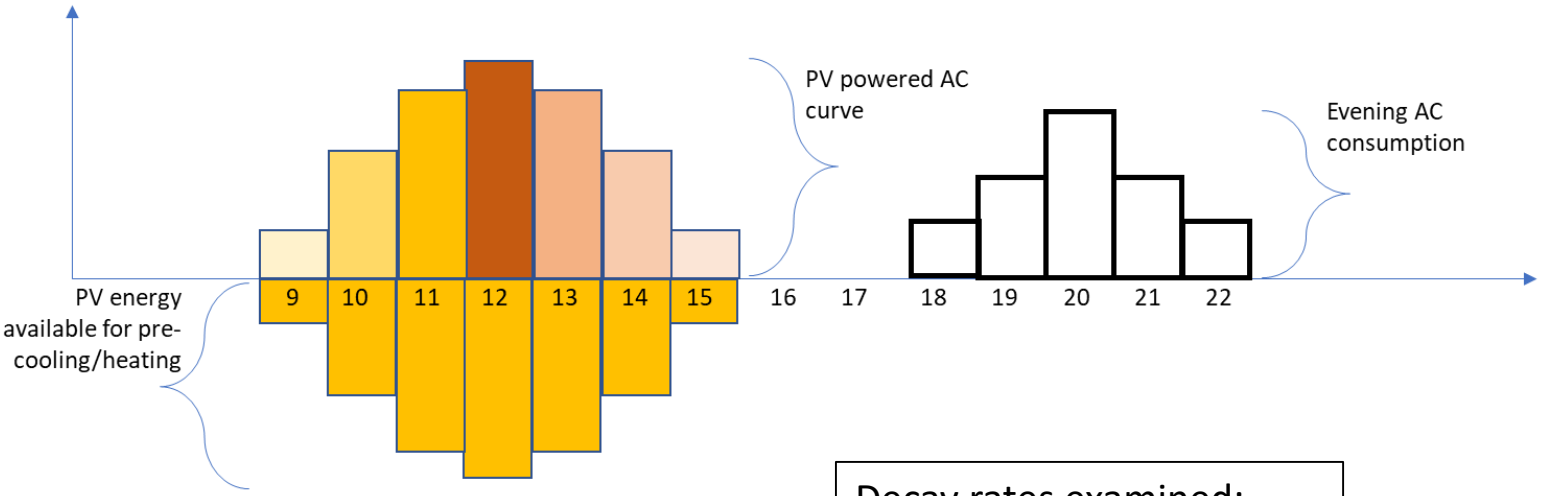
Energy data

		Number of households (478)
Data range	March 2018 – February 2019	
Postcodes	Sydney (2000-2200)	98
	Melbourne (3000-3200)	107
	Brisbane (4000-4200)	56
	Adelaide (5000-5200)	217
Energy data collected	AC consumption	
	PV generation	
	Site load consumption	
Sample rate	5 min	

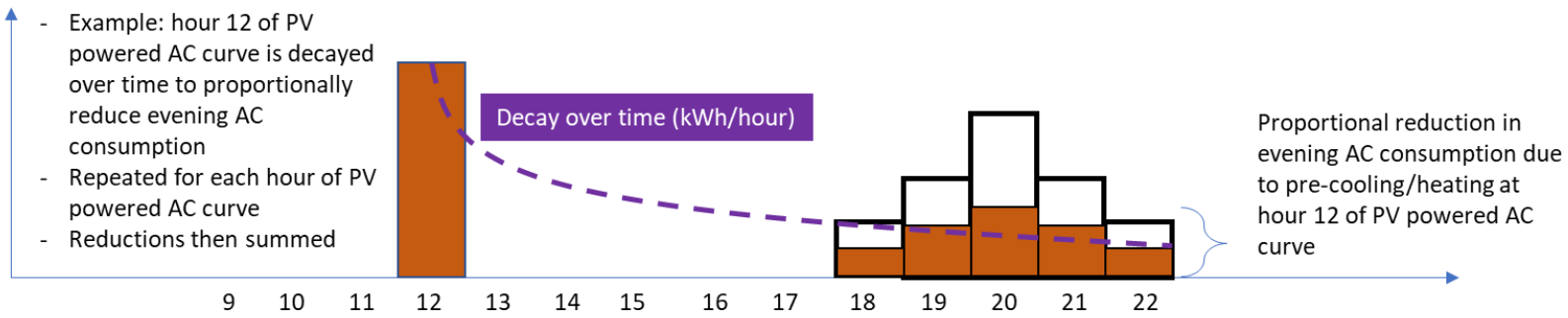
1) Does PV powered air conditioning (A/C) pre-cooling save households money?

2) What is the potential for A/C demand response (DR) to reduce peak demand?

Does PV powered A/C pre-cooling save households money?



Decay rates examined:
10% and 25% kWh/hour



Does PV powered A/C pre-cooling save households money?

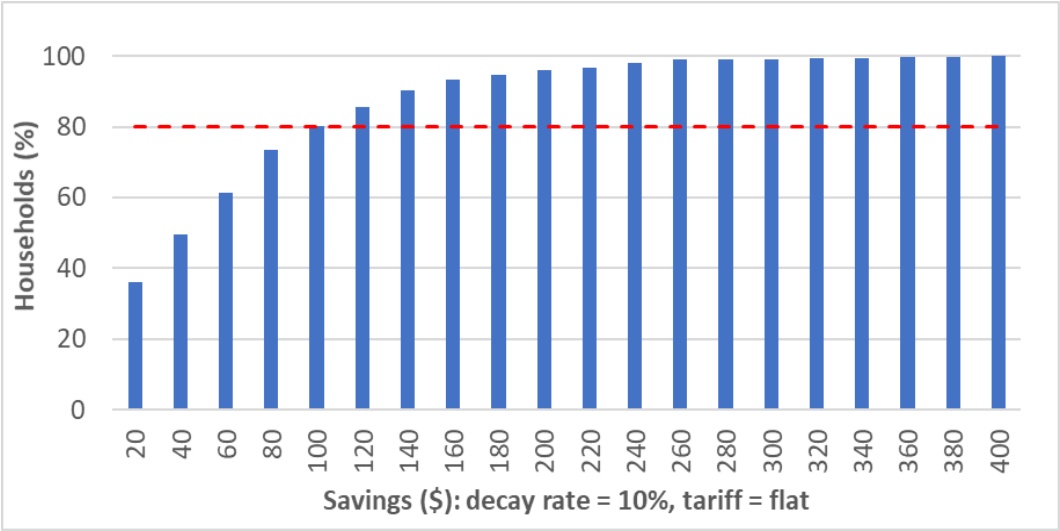
Decay rate: 10% kWh/hour

10% was assumed to represent a ~~well insulated~~ house

Modest

Tariff: Maximised savings from pre-cooling
Consumption = 53 c/kWh
Solar FiT = 11.6 c/kWh

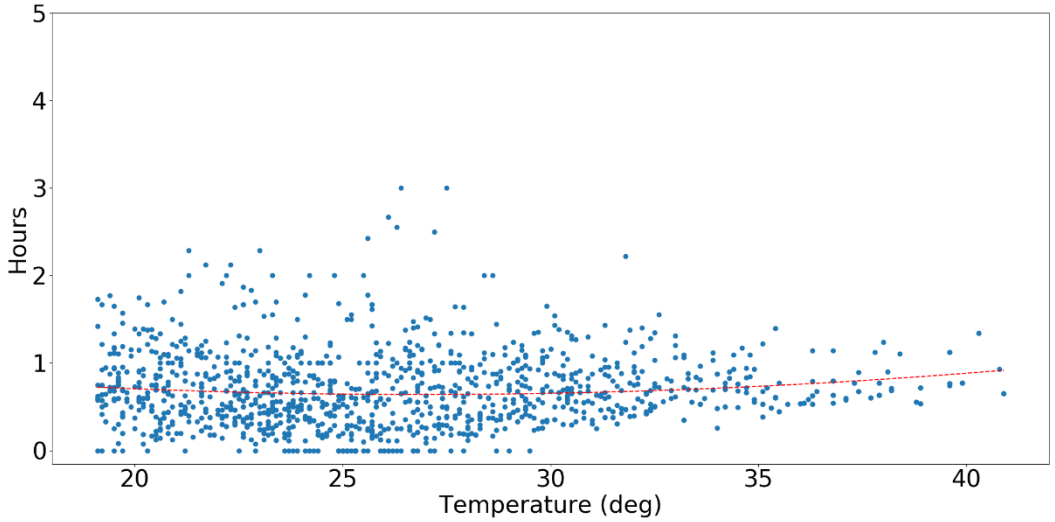
Savings occur when the reduction in cost of evening A/C consumption is greater than lost revenue from solar PV FiT

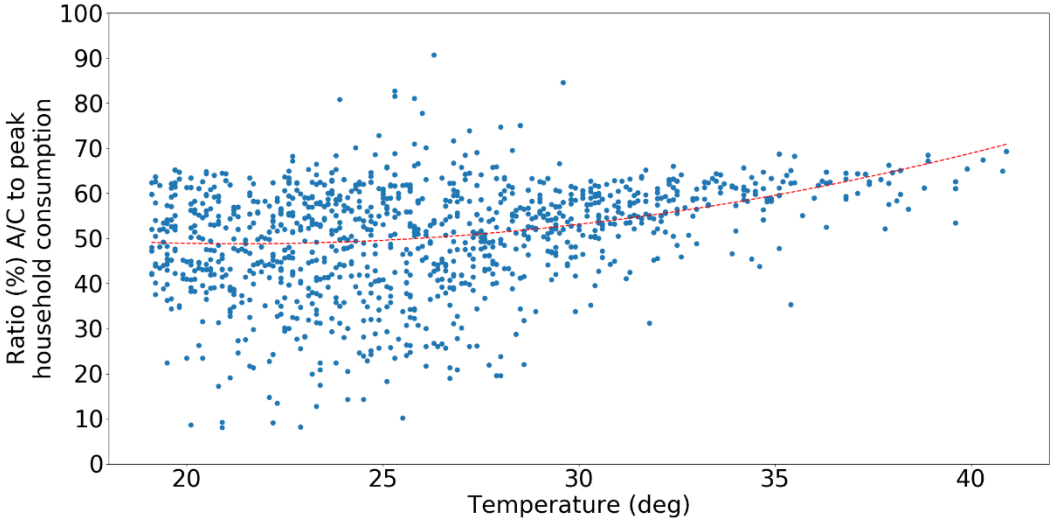


- Difference between Solar FiT and consumption rate is too low
- Decay rate of 10% is too high
- Not enough A/C consumption

- Good household insulation
- Reduction in Solar FiT
- Households paid for solar soaking + peak reduction

What is the potential for A/C DR to reduce peak demand?





- Difference in hours between peak A/C demand and peak household demand versus temperature
- Average difference < 1 hour for all temperatures

High coincidence between A/C and peak demand

Good potential for A/C DR to reduce peak demand

- Percentage contribution of A/C demand to peak household demand versus temperature
- A/C contributes around 50-60% of household peak demand on average

A/C DR trials in Australia

Title	Companies	Data from period
Peaksmart	Energy Queensland (EQLD)	Current
CoolSaver	Ausgrid	2013-17
Curb your power (ARENA)	Powershop, Reposit, ThinkPlace, Behavioural Economics Team of Australia (BETA)	2017/18
Zen Ecosystems (ARENA)	Zen Ecosystems, RACV	2017/18
Peak Energy Rewards (ARENA)	AGL	2018
Air conditioner program (ARENA)	AGL	2018
EnergyAustralia (ARENA)	Energy Australia	Jan 2019
PeakSaver – Rooty Hill	Endeavour	2010
CoolSaver – Rooty Hill	Endeavour	2010
PeakSaver – Glenmore Park	Endeavour	2010
CoolSaver – Glenmore Park	Endeavour	2010
Energy Partner	Powercor, CitiPower, Senseco, RACV	May 2018-April 2019
Summer Saver	United Energy	Ongoing (Dec to Mar)
Peak Partners	AusNet	Jul 2017 to Jul 2018
Power Changers	Jemena	Aug 2017 to May 2018

- 15 trials since 2010
- 6 DNSPs
- 5 Retailers
- 5 received ARENA funding

- All trials encountered difficulties
  1) Accurately calculating the change in A/C consumption during an "event"
  2) Recruiting participants

Event: Household is asked by DNSP to reduce A/C consumption

Problem 1) Accurately calculating change in A/C consumption

Change in A/C consumption = Baseline A/C consumption – A/C consumption on event day (baseline = forecast)

IF

A/C consumption on event day < Baseline A/C consumption

THEN

Household gets paid ☺

ELSE

Household doesn't get paid ☹

California Independent System Operator (CAISO) 10 of 10 baseline calculation

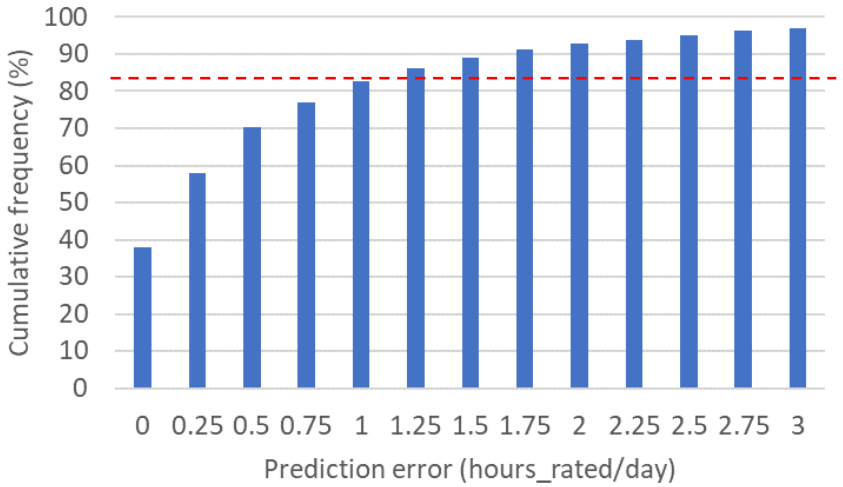
- Baseline A/C consumption = Average of the last 10 weekend or weekday days.

Problems

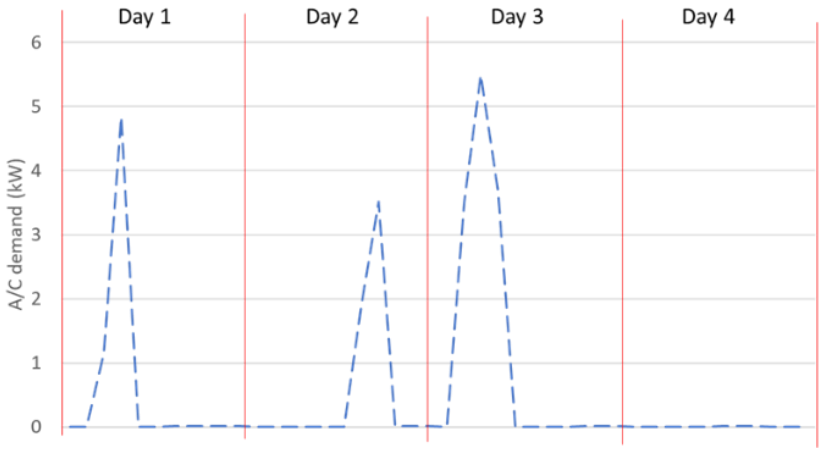
- If previous 10 days are mild, then baseline will be low, making it too hard for customer to show a reduction in consumption
- If previous 10 days are hot then baseline will be high, making it too easy for customer to show a reduction
- Smart meters measure household consumption, no dedicated A/C measurements. So households with solar PV installed caused problems.

Is there a better method for calculating baseline?

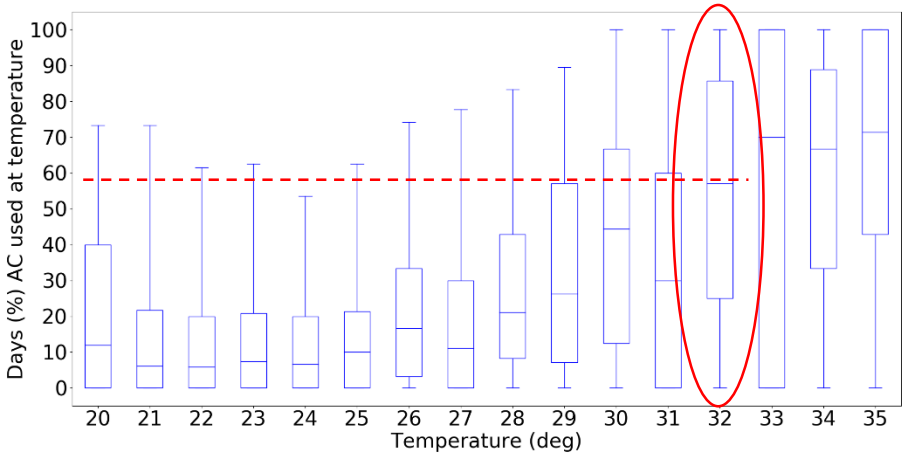
Simple A/C consumption forecasting model
- Model: Linear regression
- Input: Maximum daily temperature
- Output: A/C consumption (kWh) per day



Residential A/C consumption is discontinuous



Re-trained the model, excluded days where A/C consumption < 0.5 hours_rated/day



Summary

- Solar PV powered A/C pre-cooling can be cost effective if:
  - House has good insulation
  - Solar PV FiT is low
  - Households get paid for solar soaking and peak reduction

- A/C DR programs can be effective if:
  - Households are willing to participate
  - Change in A/C consumption can be accurately calculated

Questions?