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ENERGY TRANSITION HUB an Australian-German innovation partnership

Influence of household prosumage growth on utility generation and storage portfolios in Western Australia

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Electricity customers are changing.

The Sydney Morning Herald

Too much of a good thing: Solar power surge is flooding the grid

By Cole Latimer

June 6, 2018 — 4.42pm

Bloomberg

Australians Love Rooftop Panels. That's a Problem for Big Solar

By James Thornhill

December 16, 2019, 6:00 AM GMT+11

Updated on December 16, 2019, 10:00 PM GMT+11

- About one in four Australian households has solar panels
- Surge in residential uptake set to hurt profits of big plants

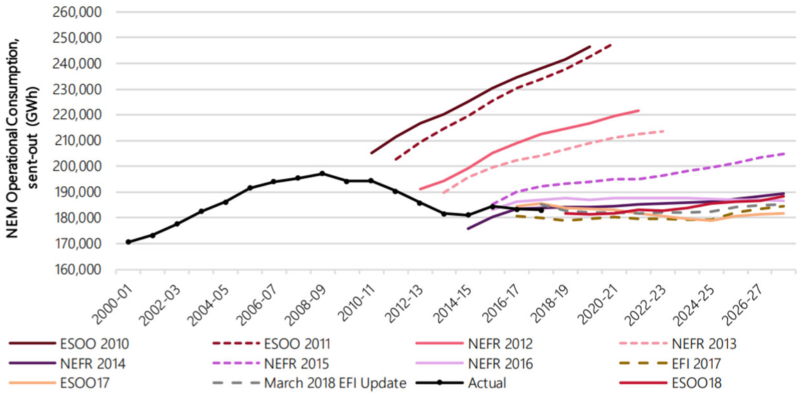
ABC NEWS

The rise of solar power is jeopardising the WA energy grid, and it's a lesson for all of Australia

By Daniel Mercer

Updated 4 Dec 2019, 5:28pm

Figure 41 Operational consumption forecasts versus actual, 2010-18



What could happen with household batteries?

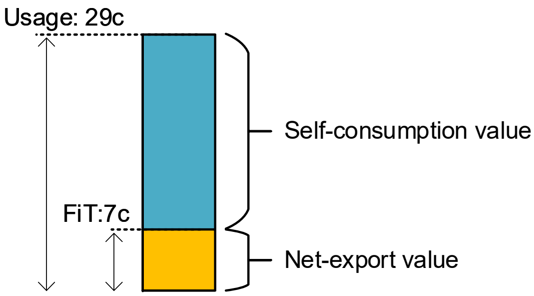
AEMO, 2018. 2018 Electricity Statement of Opportunities for the NEM.

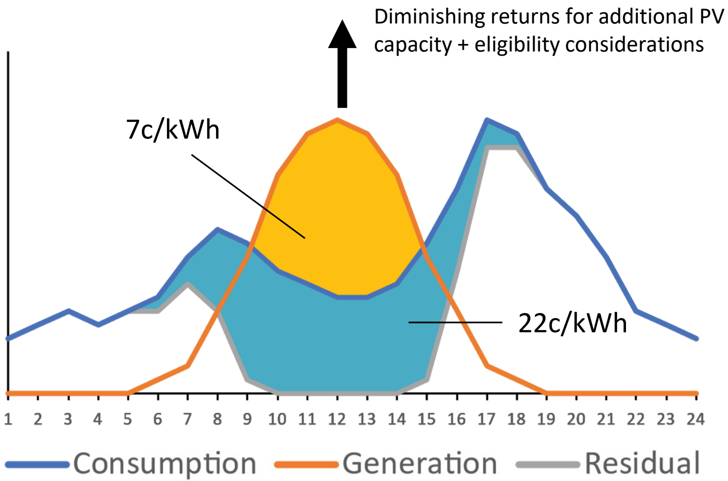
Outline.

- Introduction
- Research question
- Context of the case study
- Methodology
- Results
- Conclusions

Derivation of customer value.

Retail usage charges/kWh:





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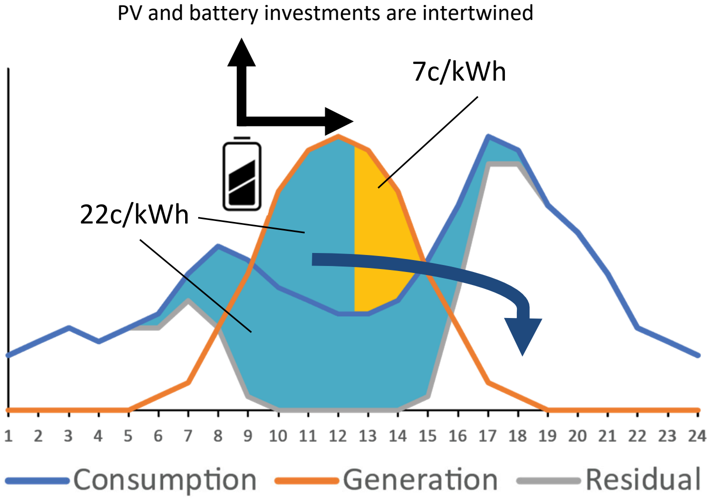
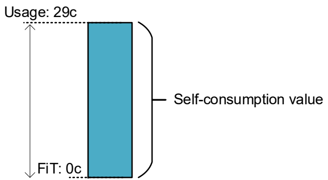
The value shifts with PV-battery prosumage.



- Batteries revalue excess PV generation (minus losses)
- Prosumage adoption becomes a combined consideration of PV and battery capacity
- Interaction with FiT eligibility
- FiT incentives are "flipped"



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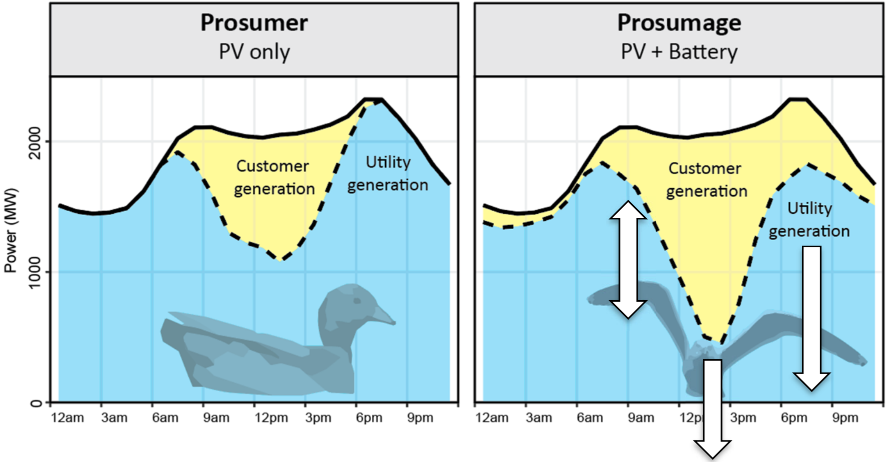
* Assuming batteries only operate to maximise self-consumption

Changing shape of residual network demand.



1. Batteries incentivise additional PV capacity
2. Declining minimum demand
3. Declining late-afternoon peak
4. Emerging residual morning peak
5. Increased morning to midday down ramping

Say, K., John, M. (2021). Molehills into mountains: Transitional pressures from household PV-battery adoption under flat retail and feed-in tariffs. Energy Policy 152

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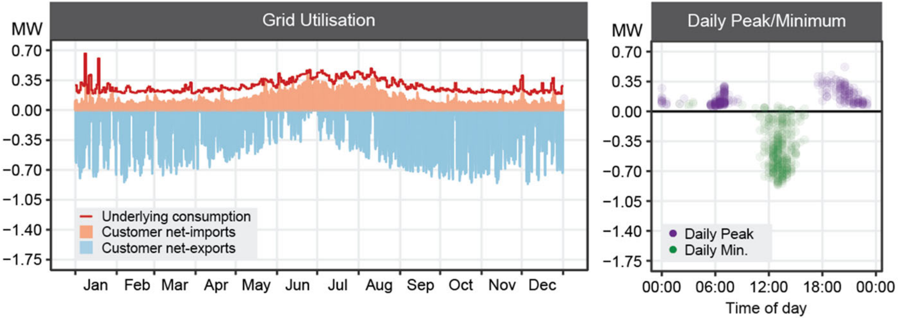
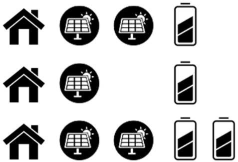
Changing shape of residual network demand.



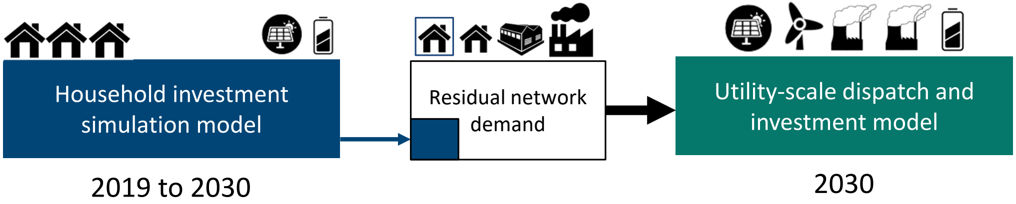


6. Shifting into winter dominant demand

Say, K., John, M. (2021). Molehills into mountains: Transitional pressures from household PV-battery adoption under flat retail and feed-in tariffs. Energy Policy 152

Research question.

With costs of battery systems declining and electricity prices rising,
what impacts could household PV-battery adoption have on the optimal least-cost portfolio of the power sector?



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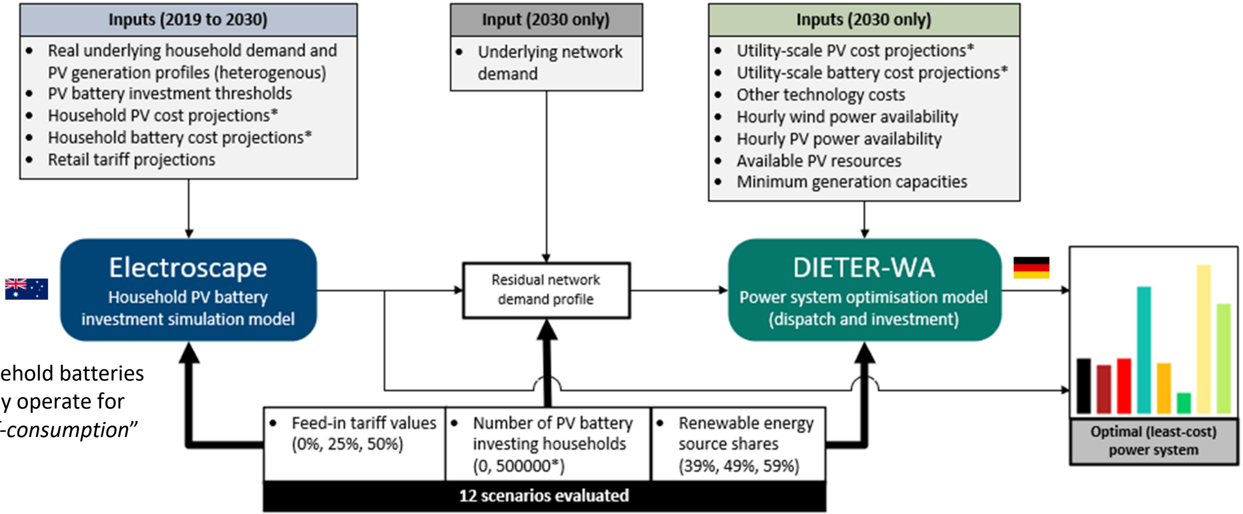
The case study.

Western Australia’s South-West Interconnected System (SWIS) Network

- Islanded network, currently unable to export elsewhere or curtail household PV
- Significant wind and solar resources
- Around 18 TWh of annual energy consumption (and 4.4 GW peak) with households consuming around 30%
- Over 1.5 GW of rooftop PV installed (2021) and growing
- Instantaneous contribution to underlying demand recorded above 60% (13 March 2021)
- In 2030 it is estimated that 50% of households will have PV installed

The research setup.



Household batteries only operate for *"self-consumption"*

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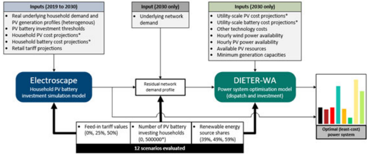

Data sources.

Input Parameters	Value	Source
Household underlying demand and generation (heterogenous)	261 Sydney homes via half-hourly *gross* meter data 2012-13	(Ausgrid)
Residential/utility PV cost projection curves	Scaled by 0.78	(Solar Choice, GenCost 2018)
Residential/utility battery cost projection curves	Scaled by 0.73	(Solar Choice, Schmidt et al. 2017)
Retail usage charge projections	29c/kWh +4%pa	(Synergy, ABS)
Underlying network demand	SWIS operational demand 2012-13	(AEMO)
Number of investing households	500,000	Forecasted number of PV installations in 2030 (AEMO)
Other technology costs	Conventional, wind, hydrogen, biomass	(GenCost 2018)
Wind resource	Time-series	(AEMO)
Solar resource	Time-series average of household insolation data	(Ausgrid)

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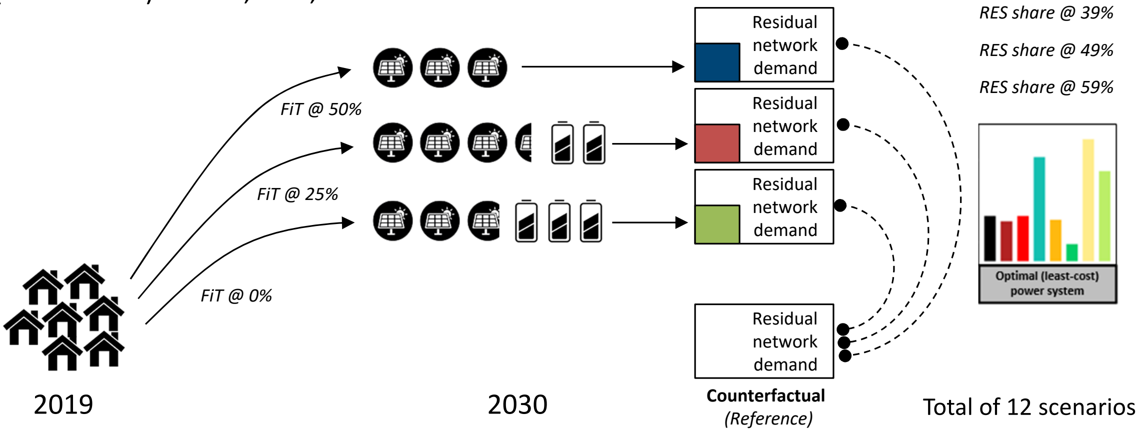
The scenarios investigated.

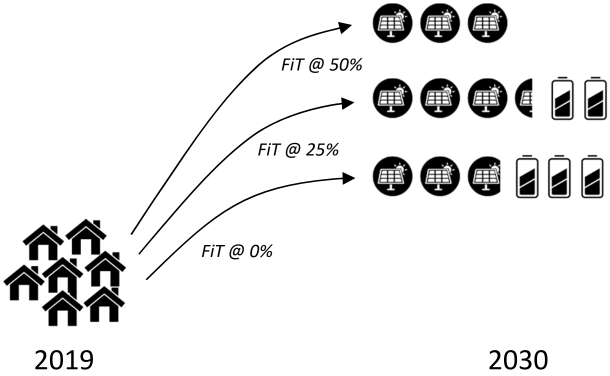
We compare scenarios with varying FiT and RES shares to a counterfactual setting without prosumage.

- FiTs at 0%, 25%, 50% of retail usage charge
- RES share (constrained) at 39%, 49%, 59%



Various degrees of prosumage.

- 261 real household load and PV generation profiles
- Path dependency evaluated through a brownfield investment simulation
- Investment opportunities run annually using a 10-year financial horizon
- The PV-only, PV-battery, battery-only configuration with the highest NPV is selected, but only after a perceived risk check



Various degrees of prosumage.

- Higher FiTs discourage battery adoption and keeps households at the eligibility limit (5 kW_P)
- Lowering FiTs encourages battery adoption
- Larger consumption households may exceed FiT eligibility limit

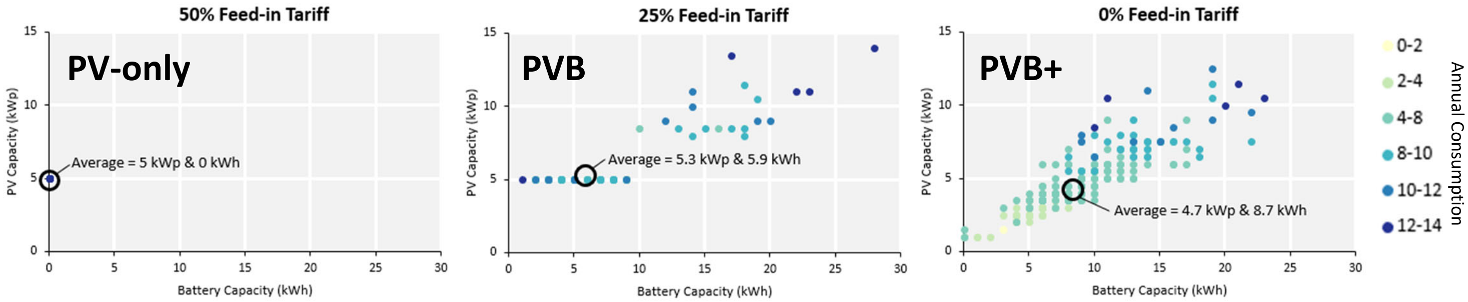
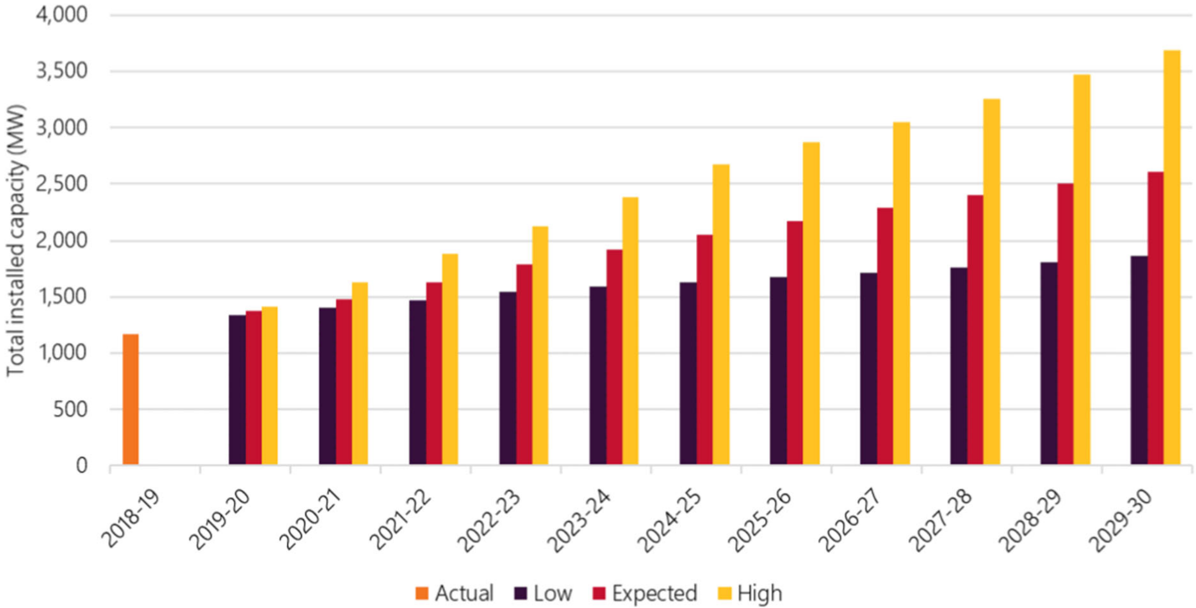


Figure 23 Installed behind-the-meter PV capacity, 2018-19 to 2029-30 financial years[A,B]



A. Cumulative installed capacity forecasts account for degradation of solar panel output over time. CSIRO applied a degradation rate of 0.5% per annum and GEM applied a degradation rate of 0.7% per annum.

B. Historical monthly behind-the-meter PV capacity data is provided in the 2020 WEM ESOO Data Register.

Source: CSIRO and GEM

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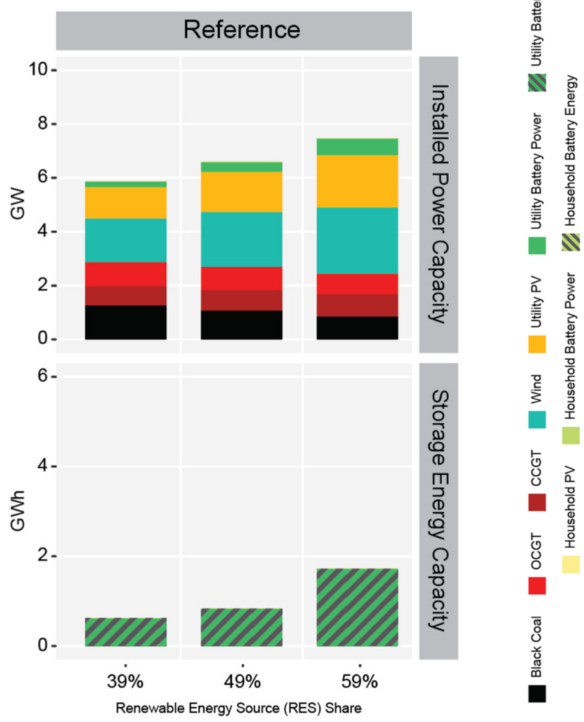
AEMO. 2020. Electricity Statement of Opportunities for the WEM.

Capacity impacts.

<u>Reference</u> (counterfactual) scenario

No PV battery investing households

- More wind than utility PV capacity
- Increased utility battery capacity as RES share rises



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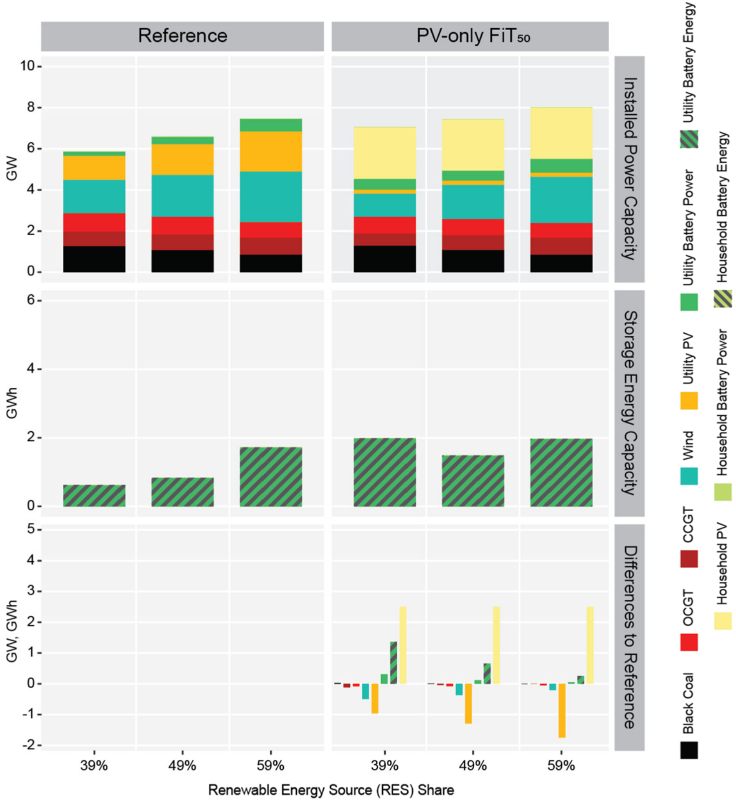
Capacity impacts.

PV-only FiT$_{50}$ scenario

Average 5 kW$_P$ with no batteries

- Displacement in both utility PV and wind capacity
- Wind capacity recovers as RES increases
- Greater utility PV capacity displacement as RES increases
- Further utility battery capacity added

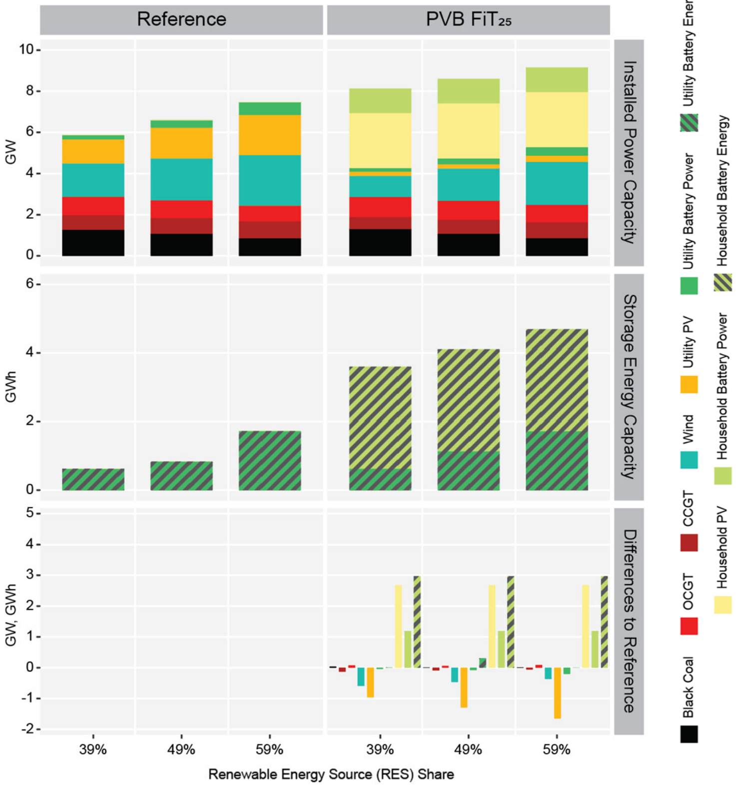


Capacity impacts.

PVB FiT$_{25}$ scenario

Average 5.3 kW$_p$ + 5.9 kWh

- Displacement in both utility PV and wind capacity
- Wind capacity recovers as RES increases
- Greater utility PV capacity displacement as RES increases
- Little effect on utility battery capacity

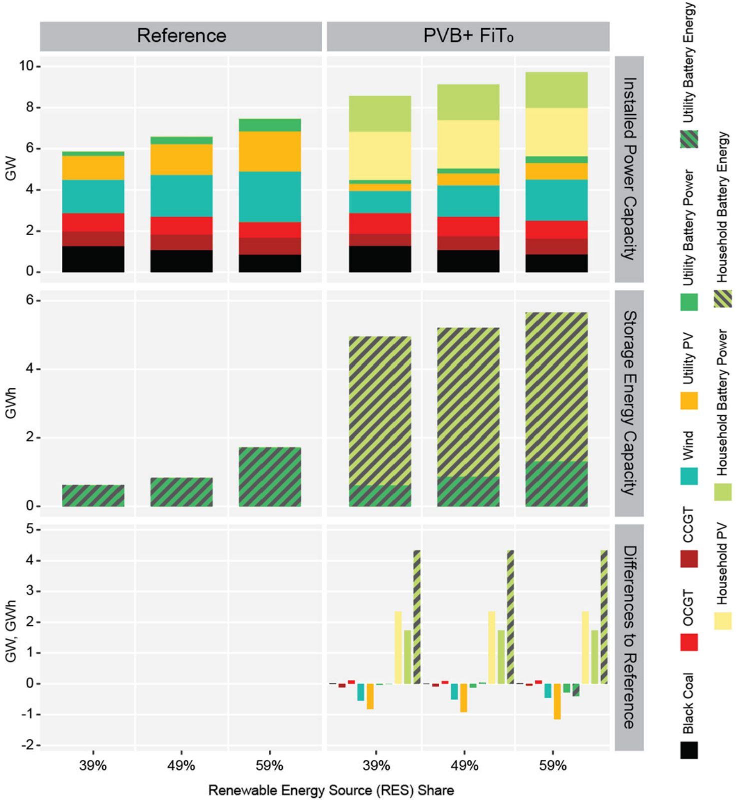


Capacity impacts.

PVB+ FiT$_0$ scenario

Average 4.7 kW$_P$ + 8.7 kWh

- Reduced displacement of utility PV capacity
- Wind capacity recovers as RES increases
- Greater utility PV capacity displacement as RES increases
- Little effect on utility battery capacity



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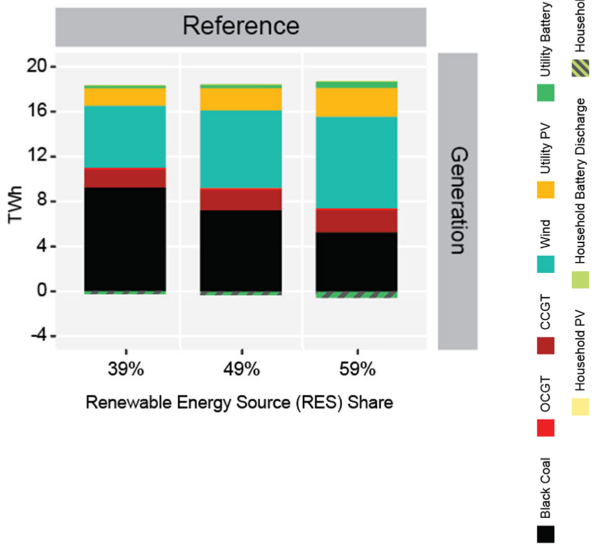
Generation impacts.

Reference (counterfactual) scenario

- No PV battery investing households
- Wind is an increasingly important resource, higher capacity factor of wind means that wind contributes more to the generation mix
- Coal has greatest reduction
- OCGT, CCGT generally unaffected



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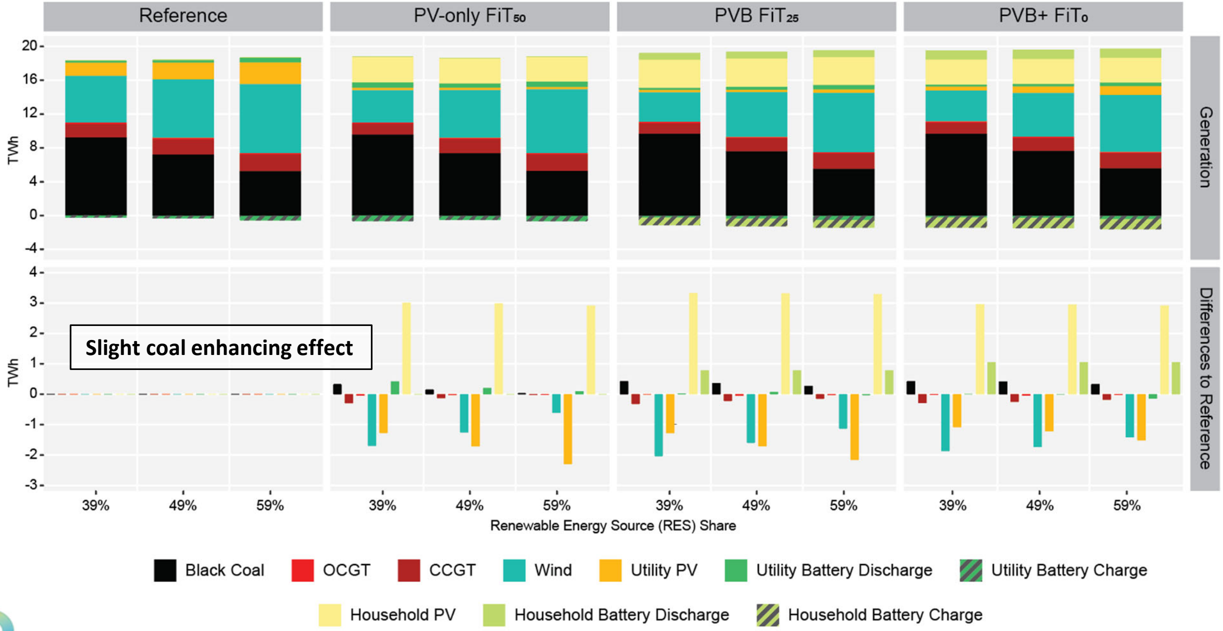
Generation impacts.



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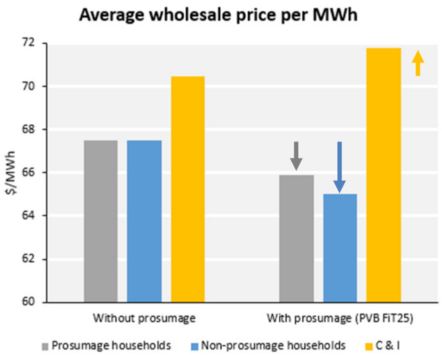
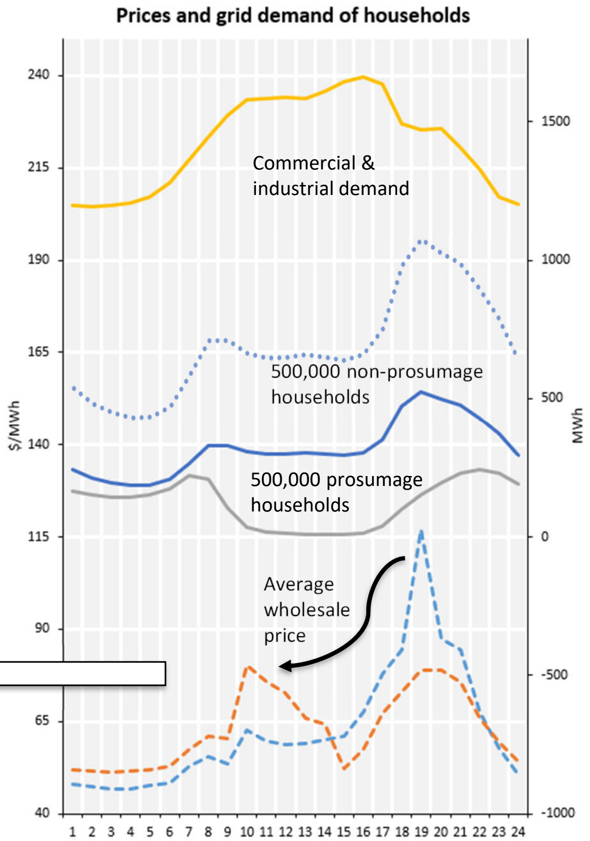
Wholesale price impacts.

Considering PVB FiT_{25} and 49% RES share:

- Late-afternoon peak prices fall
- Mid-morning prices rise
- Wholesale prices for non-prosumage also falls slightly
- Cost of supply to C&I rises slightly





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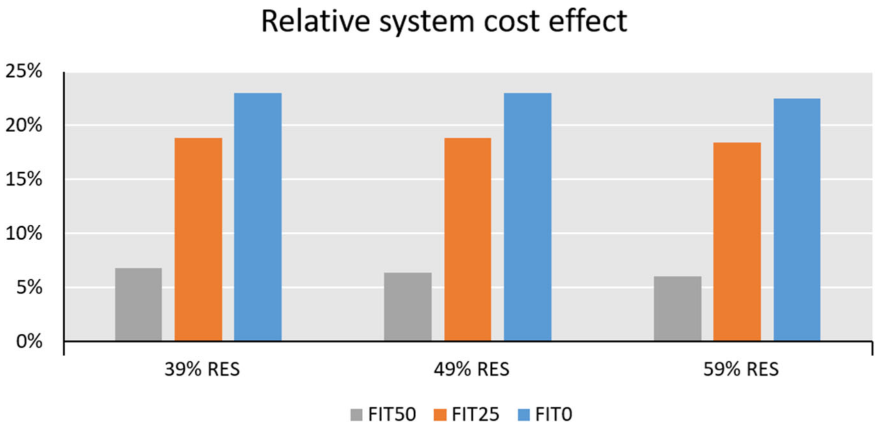
Overall system cost effects.

- Higher PV battery investment costs for customers leads to sub-optimal allocation of capital across the power sector



Conclusions.

- Utility PV generally substituted by household PV capacity
  but less so as additional household batteries are installed
- Wind power is less affected
  especially in scenarios with higher shares of renewables
- Utility battery capacities are hardly substituted
  with household batteries operating to maximise self-consumption
- Slight decrease in wholesale prices faced by non-prosumage households
  less so with prosumage households, while other consumers are slightly increased
- Potential system benefits from more system oriented household battery operations
  that have near-zero marginal costs (from the consumer perspective)

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