Advances in solar research

Energy Spotlight
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Solar webtool: solarpower.cer.auckland.ac.nz

Auckland Rooftop Solar Energy Potential

1) An average Auckland household consumes about 7000 kWh of electricity a year. What’s your consumption?
2) Find your roof and click on it for your solar assessment.
3) Compare your electricity demand with your chosen PV system generation.
4) How much of the PV system generation would you consume yourself? This is your self-consumption rate.
5) Use the “Solar assessment tool” panel for generation and economic estimates.
Detailed analysis of *solar vs. demand* in one neighbourhood

- New approach:
  - Measured solar radiation data
  - Metered demand data

- Tested on 1 suburb: Pinehill
  - Roughly 1000 houses (~600 matched with demand)
Solar radiation data

- **NIWA 12*24**: 12 typical days, one per month
- **NIWA 8760**: typical meteorological year of hourly data
- **CliFlo**: measured global radiation at 10min time resolution for 2015
PV output

- 5 kW PV system on all roofs
- NIWA 12x24h solar radiation data

- Summer: roof orientation defines peak
- Winter: sun lower -> more impact from shading by nearby objects
Solar vs. electricity demand

Total annual PV output: 7.2 GWh

Total annual demand: 4.7 GWh

Quite a mismatch!
Demand data

Aggregated demand over Pinehill (top)

vs.

Average demand from individual households (middle)

vs.

Actual demand from individual households (bottom)
Self-consumption vs. selling to grid

3 example houses

**BLACK:** PV output
**GREEN:** Demand
**RED:** PV consumed
**BLUE:** PV sold
Demand vs. solar dynamics

**BLACK:** PV output  
**RED:** PV consumed  
**BLUE:** PV sold

Large share of PV generated is unused by PV owner.
Economics of PV per household

Assume for household:

- Buy: 25c/kWh
- Sell: 8c/kWh
  - 12 c/kWh
  - 16 c/kWh

**BLACK**: annual bill without PV

**RED**: annual bill after savings from self-consumption

**BLUE/GREEN/YELLOW**: annual bill after self-consumption and selling excess back to grid

![Annual energy bill (variable only) before and after 5kW PV](image_url)
Total annual savings

Total annual savings assuming buy-back rates of:

- 8 c/kWh
- 12 c/kWh
- 16 c/kWh

In how many years will your investment have paid itself?
## Better together?

<table>
<thead>
<tr>
<th>Per household (annual)</th>
<th>Individually</th>
<th>Together</th>
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</thead>
<tbody>
<tr>
<td>Demand (kWh)</td>
<td>6340</td>
<td>6340</td>
</tr>
<tr>
<td>PV output (kWh)</td>
<td>9708</td>
<td>9708</td>
</tr>
<tr>
<td>PV self-consumed (kWh)</td>
<td>2366</td>
<td>2570</td>
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<tr>
<td>PV sold (kWh)</td>
<td>7342</td>
<td>7137</td>
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<tr>
<td>SC rate</td>
<td>0.24 (min. 0.06, max. 0.65)</td>
<td>0.26</td>
</tr>
<tr>
<td>Bill (energy only) before PV (NZD)</td>
<td>1585</td>
<td>1585</td>
</tr>
<tr>
<td>Savings from SC (NZD)</td>
<td>591</td>
<td>(+8.8%) 643</td>
</tr>
<tr>
<td>Savings from PV sold at 8c/kWh (NZD)</td>
<td>587</td>
<td>(-2.7%) 571</td>
</tr>
<tr>
<td>Bill after PV (NZD)</td>
<td>406</td>
<td>421</td>
</tr>
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Next steps and take-home messages

• Understand impact of different solar radiation data sources
• Expand analysis to different neighbourhoods
• Understand optimal PV sizing & battery placement; impact of aggregation

• Timing matters: residential solar economics
• Prosumer opportunities matter: How can you sell at a better price?
Thank you!