



BUSINESS SCHOOL
ENERGY CENTRE

Advances in solar research

Energy Spotlight
29.11.2018

Kiti Suomalainen
k.suomalainen@auckland.ac.nz

Topics

Developments in solar energy research on:

1. Auckland urban area

Kiti Suomalainen, Sofia Schroder Langhaeuser

2. Solar and Pacific island grids

Peter Wilson (NZIER), Basil Sharp, Kiti Suomalainen, Gareth Williams
(Nexgen Energy Solution)

Auckland Rooftop Solar Energy Potential

Solar radiation (kWh/m²/year): 100-250 ■ 250-400 ■ 400-550 ■ 550-700 ■ 700-850 ■ 850-1000 ■ 1000-1150 ■ 1150-1300 ■ 1300+ ■

- 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.

[About the project](#)

Search for

Solar assessment tool
 273 Mount Albert Rd, Sandringham, Auckland

Annual average solar radiation on roof:
 Top 14 m²: 1386 kWh/m²
 Top 20 m²: 1384 kWh/m²
 Top 28 m²: 1383 kWh/m²
 Top 36 m²: 1380 kWh/m²

Annual solar radiation on roof:
 303,894 kWh

Solar installation specifications

Installation size (m²): 20 m² approx. 3 kW system ▾
 Default efficiency: 19% with premium PV ▾
 Customised efficiency: %
 Annual energy generation is: 4628 kWh

Economic assessment

Self consumption rate: 50 %
 Electricity rate: 27 cents/kWh
 Buy-back rate: 8 cents/kWh
 PV system economic lifetime: 25 years
 Total investment cost: 3000 \$/kW
 Investment cost in year 15: 400 \$/kW
 Annual maintenance cost: 20 \$/kW
 Discount rate: 4 %
 Annual revenue (total savings): 810 NZD
 Net present value: 1290 NZD

Report an issue:

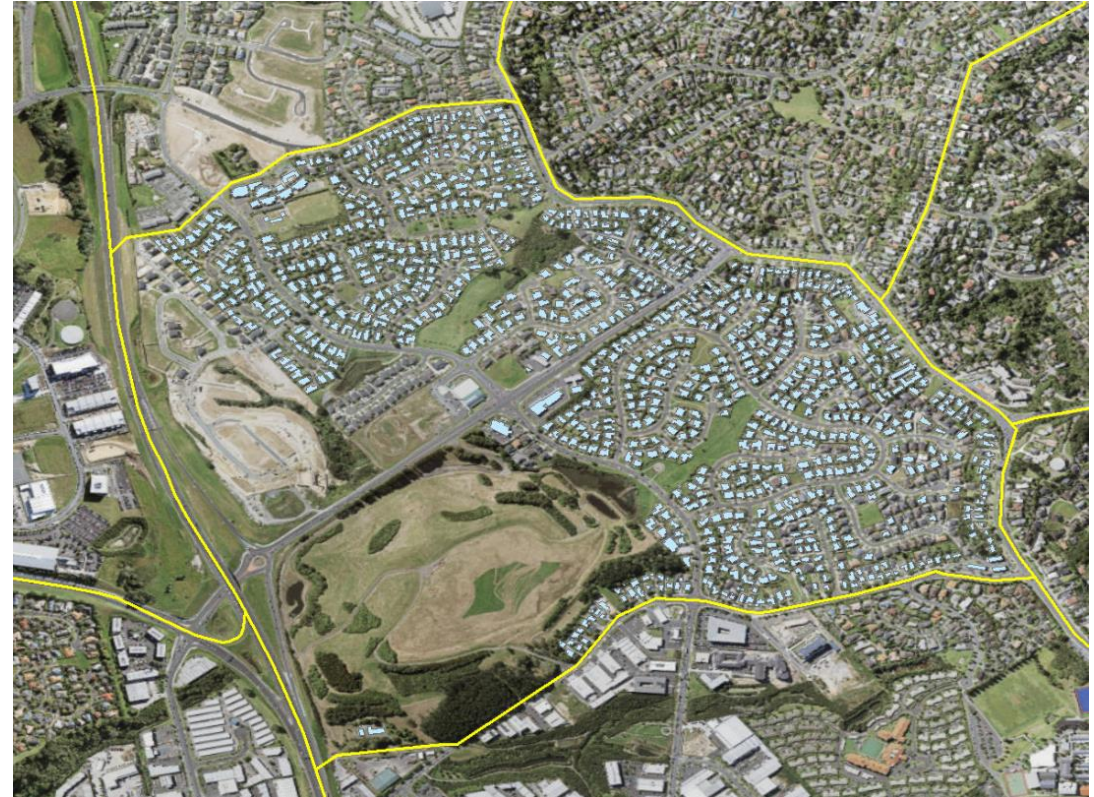
 Submit



Auckland rooftop solar potential: Update

- New approach:
 - Measured solar radiation data as input
 - Results saved at hourly level
 - 12 representative days for a year
- Tested on 1 suburb: Pinehill
 - Roughly 1000 houses
 - 1m2 spatial resolution

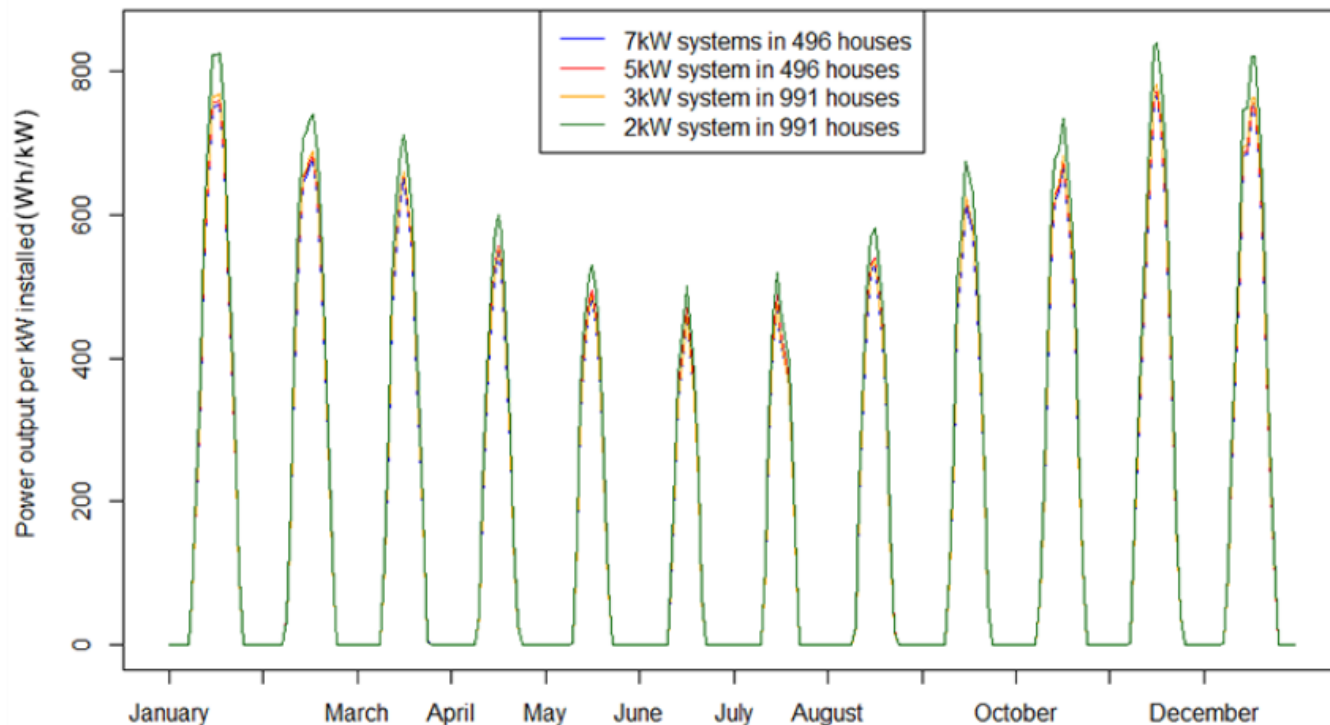
Pinehill, Auckland



Small PV systems on all roofs vs.
larger systems on “best” 50% of all roofs?

Results: PV output

Hourly power output per installed kW at neighborhood level



Size (kW)	kW installed (kW)	Yearly power output per kW installed (kWh/yr/kW)
7	3472	1604
5	2480	1628
3	2973	1625
2	1982	1752

Small PV systems on all roofs vs.
larger systems on “best” 50% of all roofs?

Results: Economic assessment

- Installation of 7 kW solar PV systems in 496 rooftops.
- Installation of 5 kW solar PV systems in 496 rooftops.
- Installation of 3 kW solar PV systems in all 991 rooftops.
- Installation of 2 kW solar PV systems in all 991 rooftops.

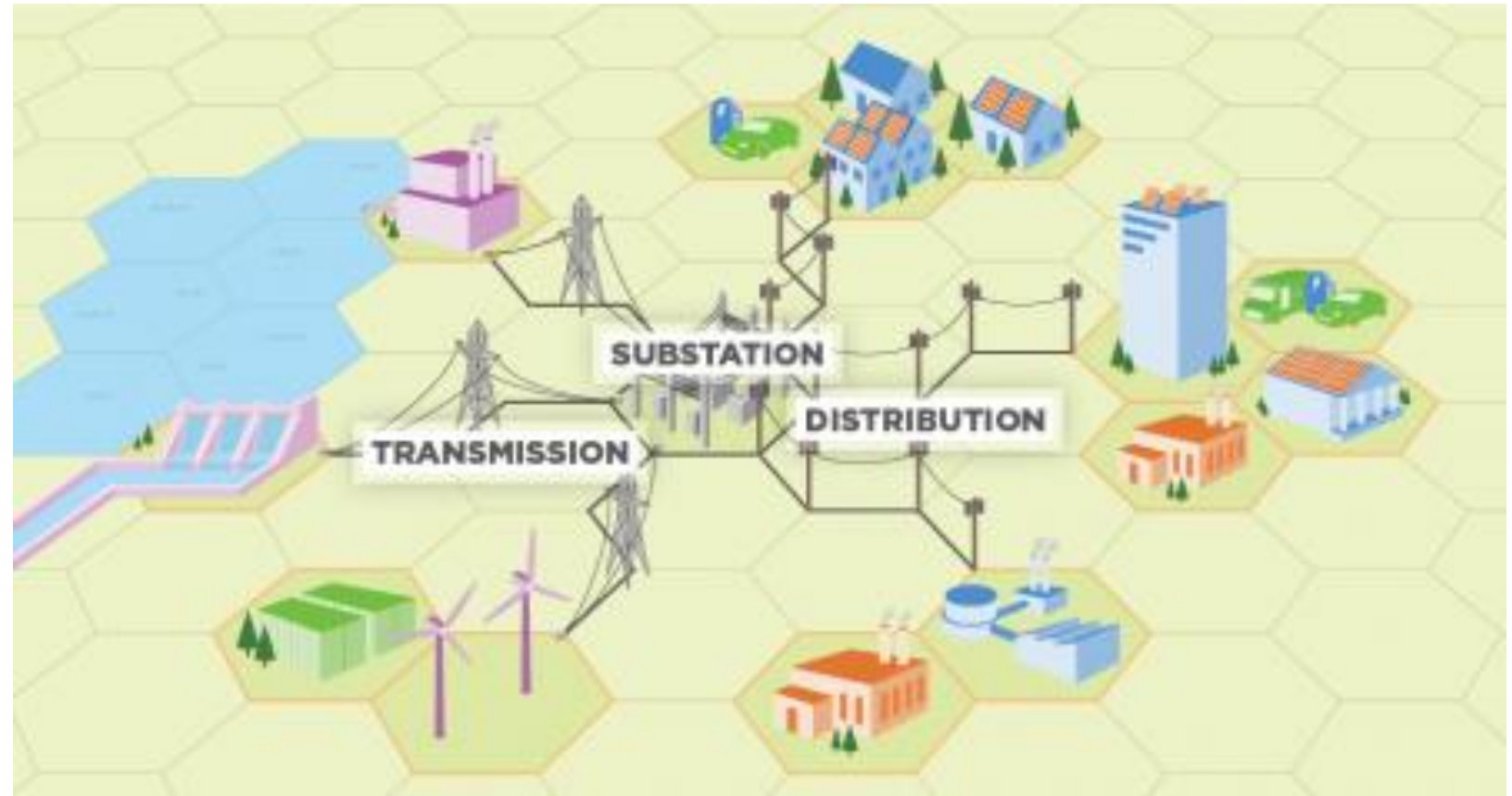
System size (kW)	Cost (NZD)	Total cost Pinehill (NZD)	Total yearly power output (kWy)	Total yearly power output per NZD invested (kWy/NZD)
7	21000	10,416,000	5,567,533	0.535
5	15000	7,440,000	4,036,929	0.543
3	9000	8,919,000	4,830,080	0.542
2	7000	6,937,000	3,471,958	0.500

Solar and grids: Challenges in island energy systems

Many island states have high renewable energy targets, 100%: e.g. Cook Islands, Samoa, Tuvalu, Vanuatu.

Projects focused on isolated solar/wind/battery systems – omitting (economic) impacts on grid.

Where should the new tech go?



Source: www.epa.gov

Solar and grids: Economic assessment

Asset	Economic valuation parameters
Diesel generators	Capacity Remaining economic life Salvage value
Transmission	Remaining economic life of asset Salvage value Annual OPEX Expected costs of upgrade Weighted cost of capital
Distribution	Salvage value Partial retirement Upgrade costs

	Samoa	Tonga	Cook Islands
Domestic solar + battery	NPV \$438 Payback 21.1 years	NPV -\$592 NA	NPV \$17,139 Payback 9.3 years
Commercial solar + battery	NPV \$102,660 Payback 7.9 years	NPV \$14,907 Payback 10.5 years	NPV \$157,699 Payback 4.4 years
Commercial solar without battery	NPV \$81,885 Payback 3.7 years	NPV \$13,850 Payback 5 years	NPV \$115,403 Payback 2.3 years

Source: adapted from Caldecott et al., 2013

Grids are costly to build and maintain.
Solar + battery project costs vary significantly by location.

We need to understand how to transition to a resilient, low-carbon energy system at lowest system cost.

Next steps



- Develop economic assessment model for exploring optimal deployment path for solar/distributed generation.
- Test for one island, produce a model that can be applied to other islands.
- Introduce stochasticity for uncertainty in fuel/carbon price, technology costs, climate change impacts.

Take-home messages

- Time resolution matters: residential solar economics
- Size matters: larger systems of fewer roofs may be the most economic way forward
- Islands: Local energy system has big impact on solar economics
- Systems perspective needed to plan for a secure, economic transition to a low-carbon energy system

