EPECentre
ELECTRIC POWER ENGINEERING CENTRE

UC
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Predicting PV Uptake in New Zealand

SEANZ 2016 The Power Shift

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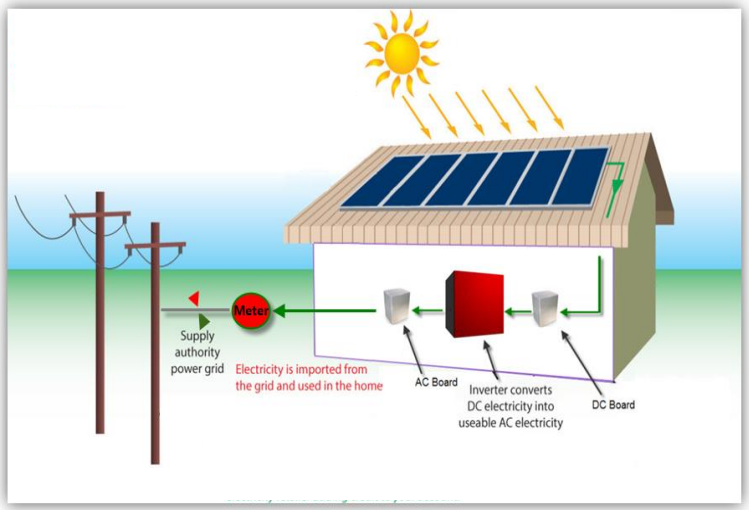
18 November 2016

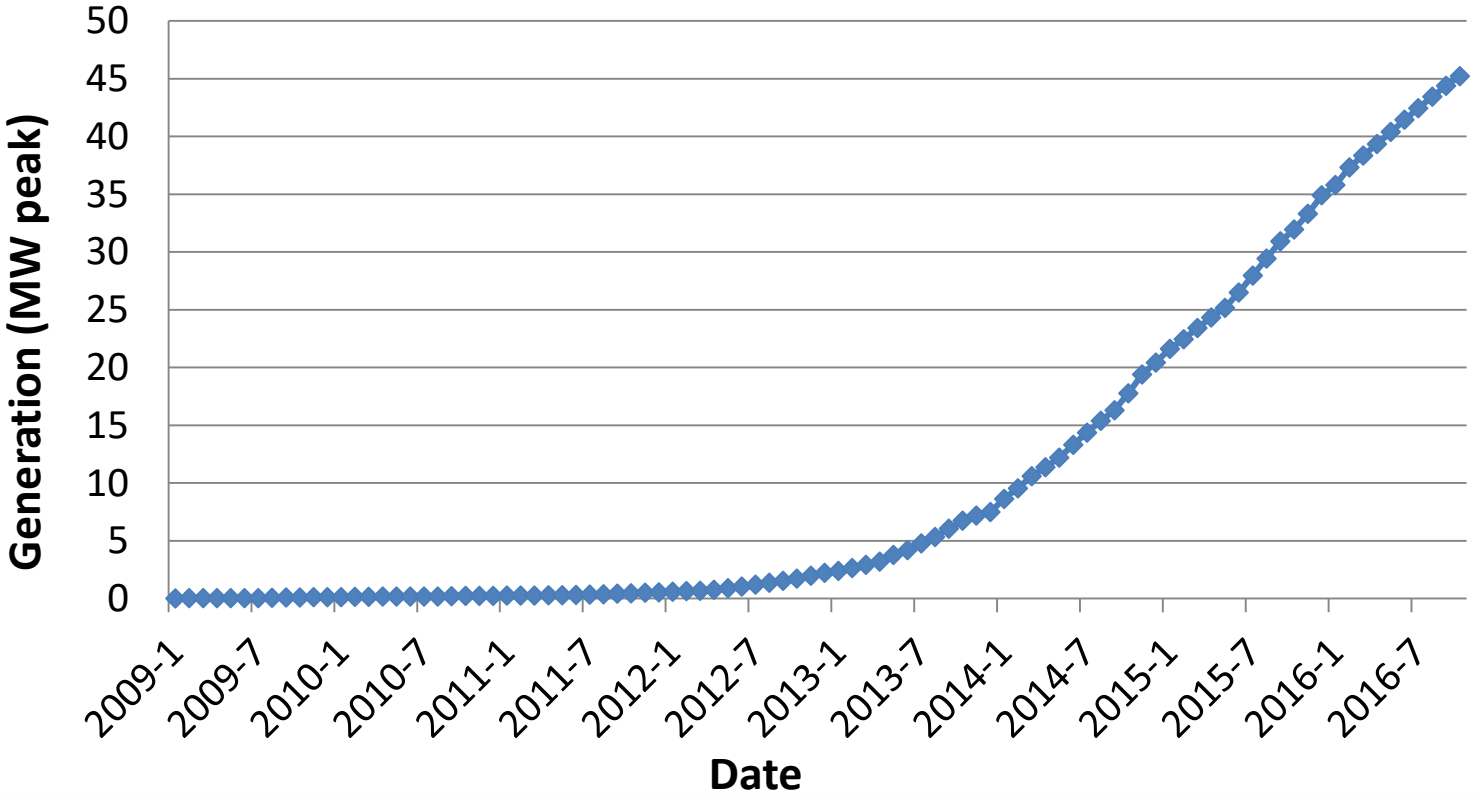
Outline

- Background
- Method of Estimating PV Uptake
- Results
  - Variable system costs
  - Panel azimuthal angle
  - DG user charges



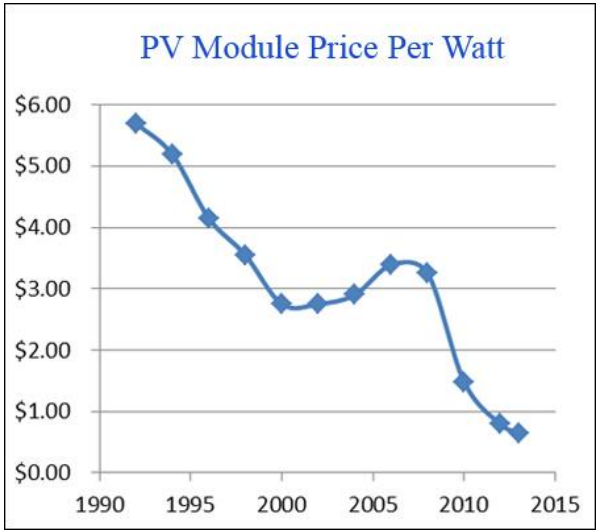
NZ PV Uptake

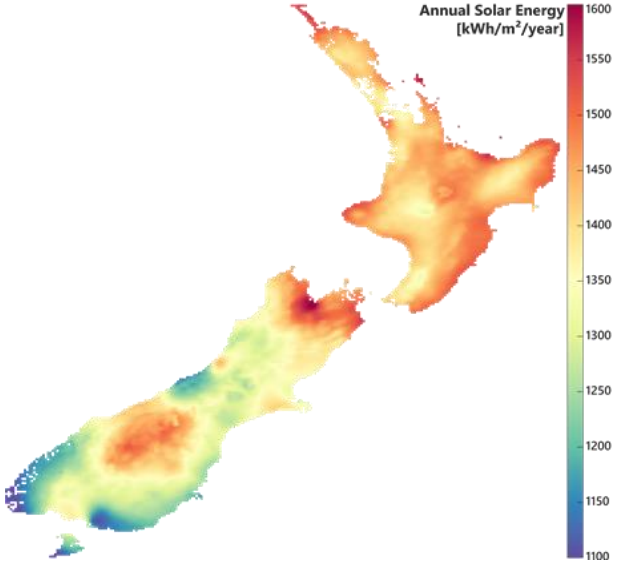
(January 2009 – October 2016)



Factors Affecting PV Uptake

- Economic
- Geographic
- Societal
- Political

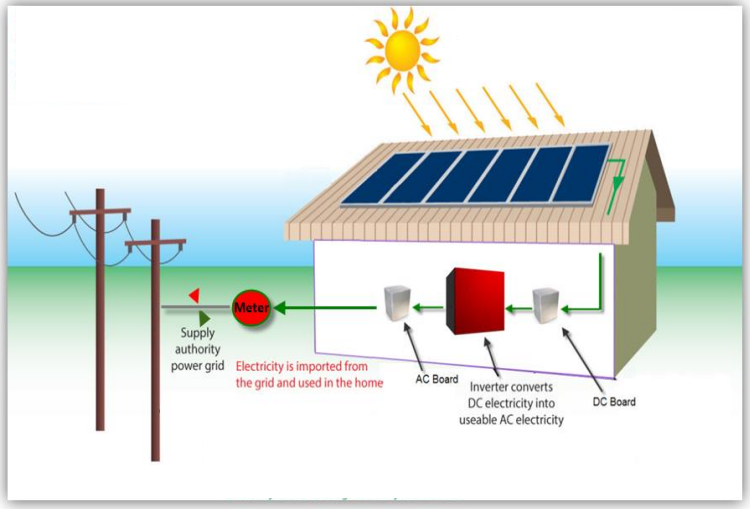




Solar Cell Central
http://solarcellcentral.com/cost_page.html

Outline

- Background to this work
- Method of Estimating PV Uptake
- Results



Uptake Hypothesis:

Households with a positive Net Present Value (NPV) will install PV

$$NPV = \sum_{i=1}^{N} \frac{Revenue_i - Cost_i}{(1+r)^i} - I + \frac{R}{(1+r)^N}$$

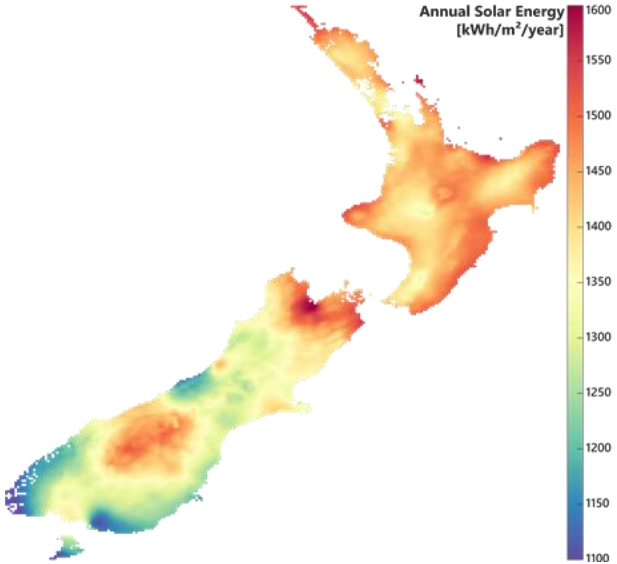
0

where

- *N* = the number of years for the analysis (25 years),
- *r* = the discount rate (6% is assumed)
- *I* = the initial investment
- *R* = the salvage value (0);
- $Revenue_i$ = the revenue for the i^{th} year
- $Cost_i$ = costs for the i^{th} year

Calculating Generation

- Generation per region
  - NIWA's Typified Meteorological Year Irradiance data (hourly)
  - Converted into a 3.5kW reference system taking into account
    - optimal panel tilt of 30° tilt, 0 azimuth (north-facing, also east-west facing)
    - Derating factors such as wiring losses, cell mis-match
    - Balance of system losses of 10% assumed
    - Panel degradation over time 0.8% p.a.
  - Assume same irradiance profile for 25 year analysis period



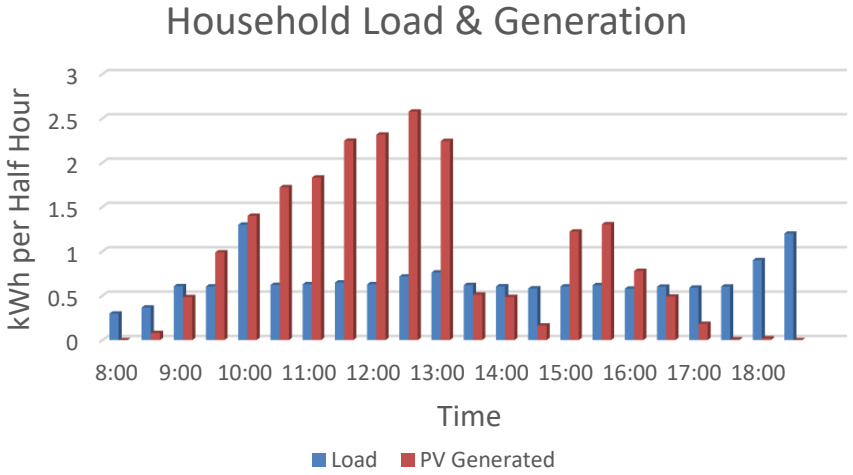
Ref: Santos-Martin, D. Lemon, S. (2015). SoL – A PV generation model for grid integration analysis in distribution networks, Solar Energy 120 (2015) 549–564.

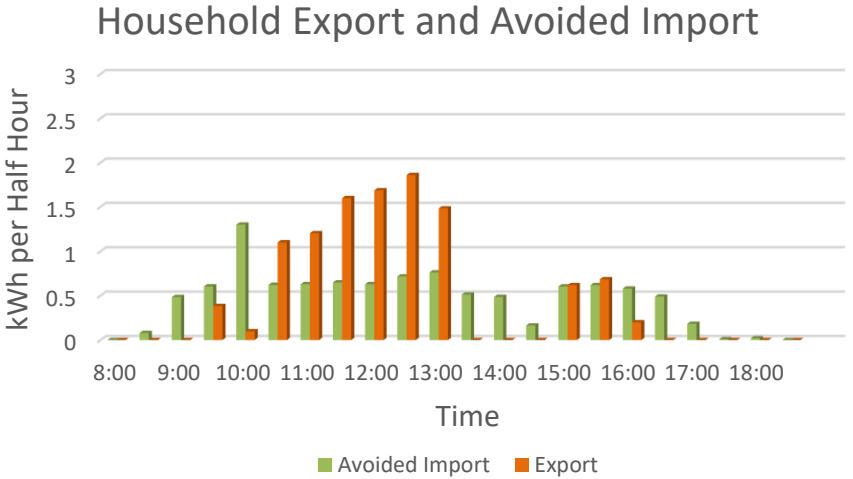
Load Profile Acquisition

- Over 18 000 load profiles obtained anonymously from energy retailers
- Households categorised as low or high users/flat or night rate tariff
- Load profiles for 15 out of 16 regions
- Half-hourly load data for a full year
- Assume static load profiles over 25 year analysis period

Region	Number of Load Profiles	Percentage of Occupied Dwellings Sampled
Northland	548	0.91%
Auckland	4085	0.86%
Waikato	2535	1.66%
Bay of Plenty	549	0.53%
Gisborne	0	0.00%
Hawke's Bay	565	0.97%
Taranaki	647	1.49%
Manawatu-Whanganui	583	0.66%
Wellington	3557	2.00%
Nelson	44	0.23%
Tasman	15	0.08%
Marlborough	230	1.26%
Canterbury	2212	1.06%
West Coast	140	1.01%
Otago	2796	3.45%
Southland	16	0.04%

Calculating Revenue Per Household





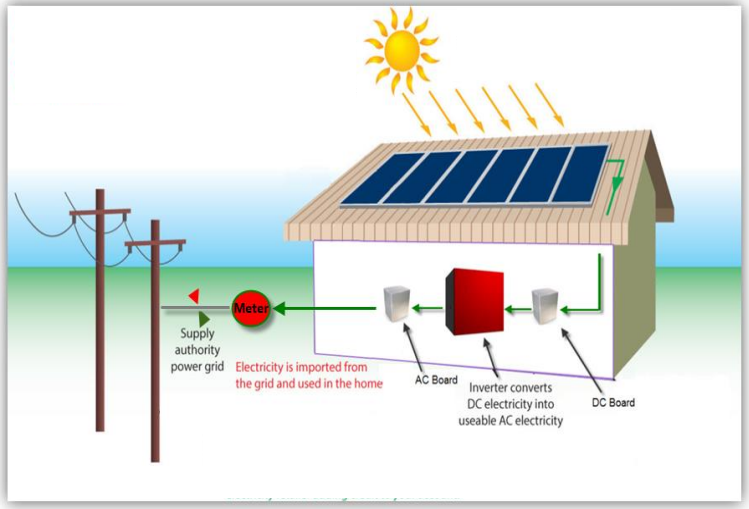
- Load < Generation
  - Revenue = Export + Avoided cost of electricity
- Load ≥ Generation
  - Revenue = Avoided cost of electricity

Grid Buy-back Rate: 8c/kWh
Electricity Rates: Genesis Energy's website (regional)
Annual Price Adjustment:
Retail 1.5%, Export 0.5% p.a.

Initial Investment & Costs

- Initial Investment, varied 1 – 4.5 $/Wp

- Costs
  - Operation & Maintenance $20/kW/p.a.
  - Inverter Replacement (after 15 years), 0.5 $/Wp



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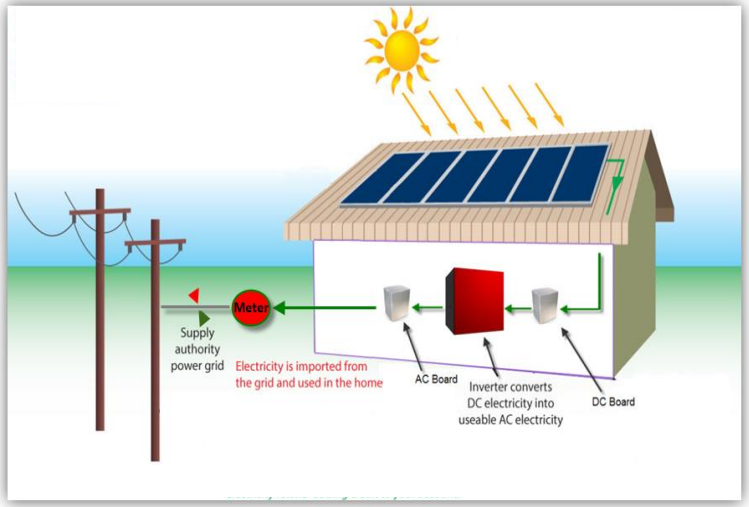
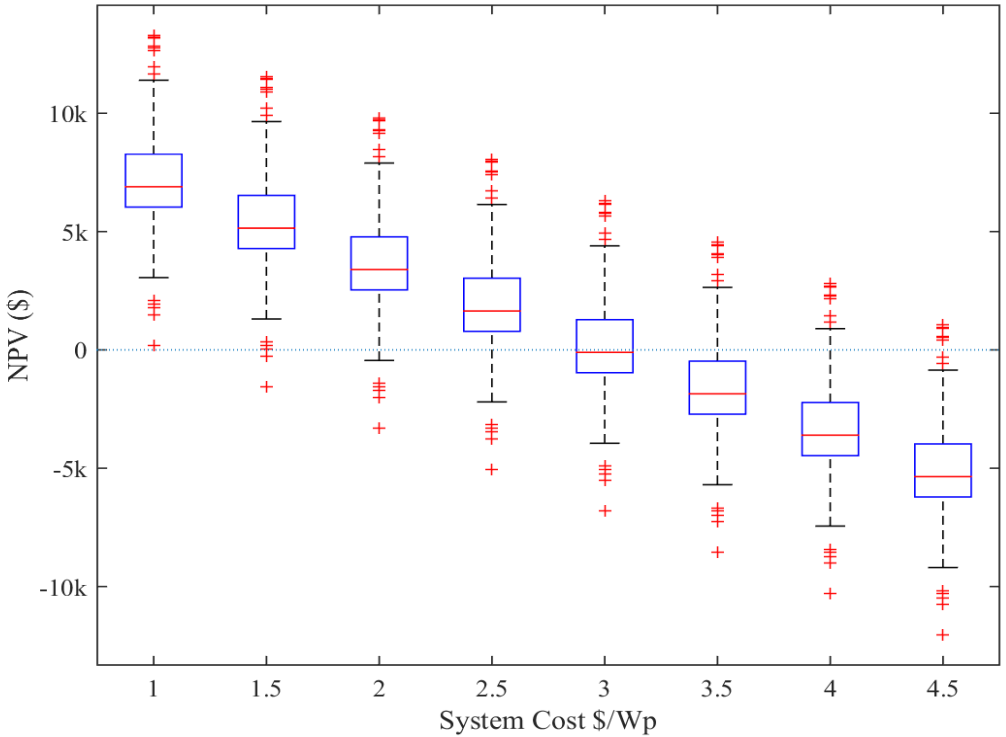
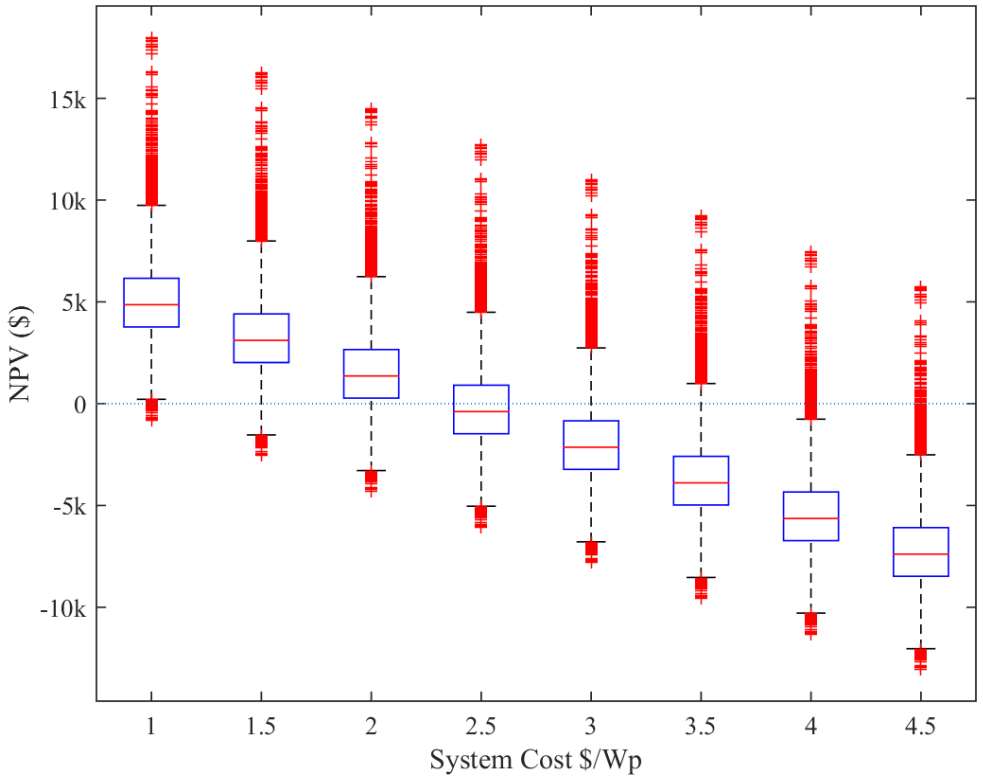


Net Present Value Results - Marlborough



Marlborough's 0 NPV point: 2.96 $/Wp

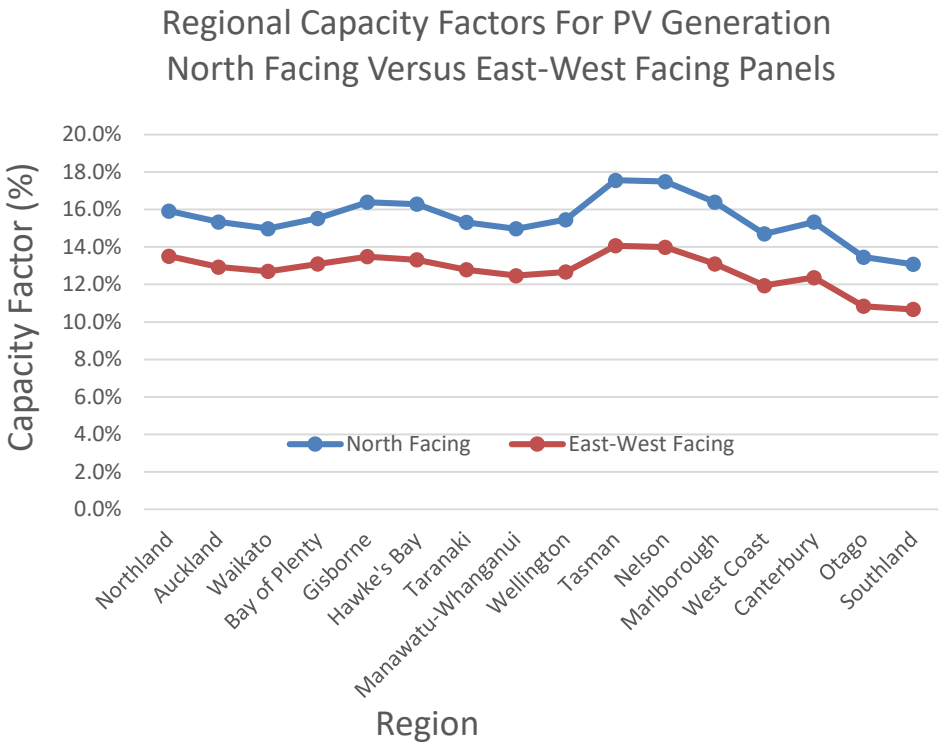
Net Present Value Results N.Z.

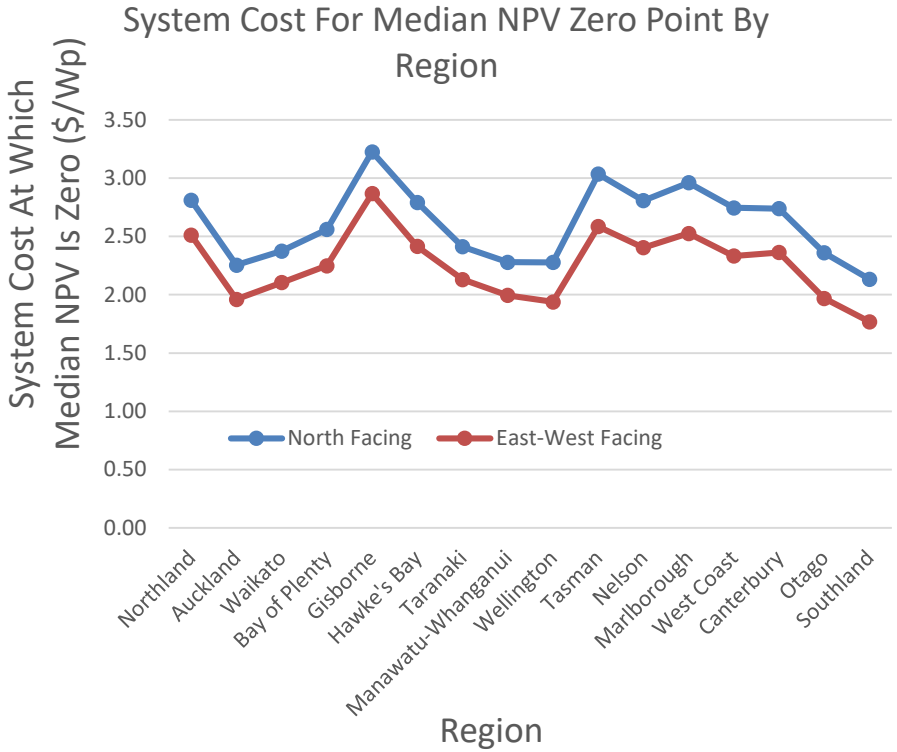


Over all regions in
New Zealand
0 NPV point: 2.4 $/Wp

Region	PV Capacity Factor (%)	PV System Cost at which median NPV is zero ($/Wp)
Northland	15.9	2.81
Auckland	15.3	2.25
Waikato	15.0	2.38
Bay of Plenty	15.5	2.56
Gisborne	16.4	3.23
Hawke's Bay	16.3	2.79
Taranaki	15.3	2.41
Manawatu-Whanganui	15.0	2.28
Wellington	15.5	2.28
Nelson	17.6	3.04
Tasman	17.5	2.81
Marlborough	16.4	2.96
Canterbury	14.7	2.75
West Coast	15.3	2.74
Otago	13.5	2.36
Southland	13.1	2.13

Effect of Panel Angle North Facing Versus East-West





Assumed Installed Capacity for NZ

For each region:

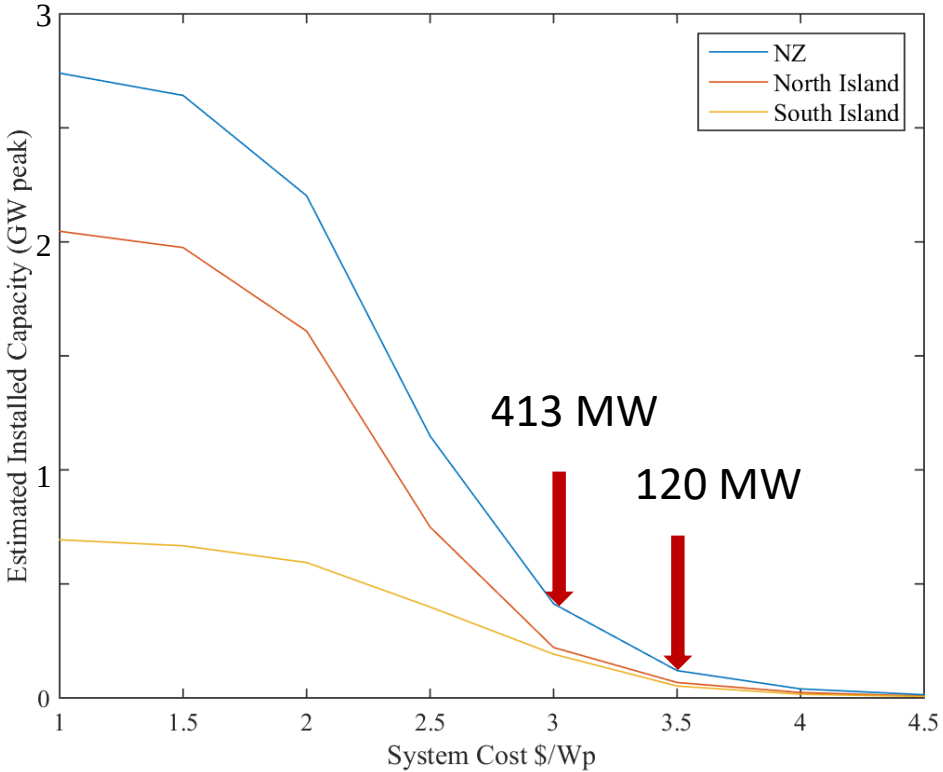
- Assume same % of households in sample have positive NPV over all the occupied dwellings

- Each household with NPV > 0 has 3.5kW DG installed

BUT

- Home ownership 64.8%
- Separate dwellings 81.1%

→ 52.5% households available for PV

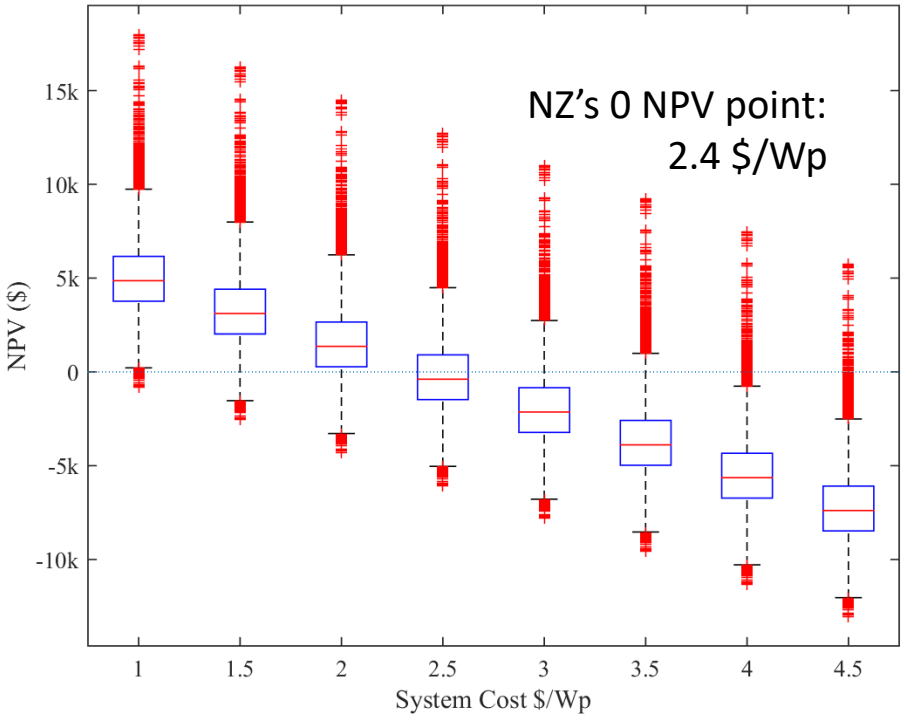


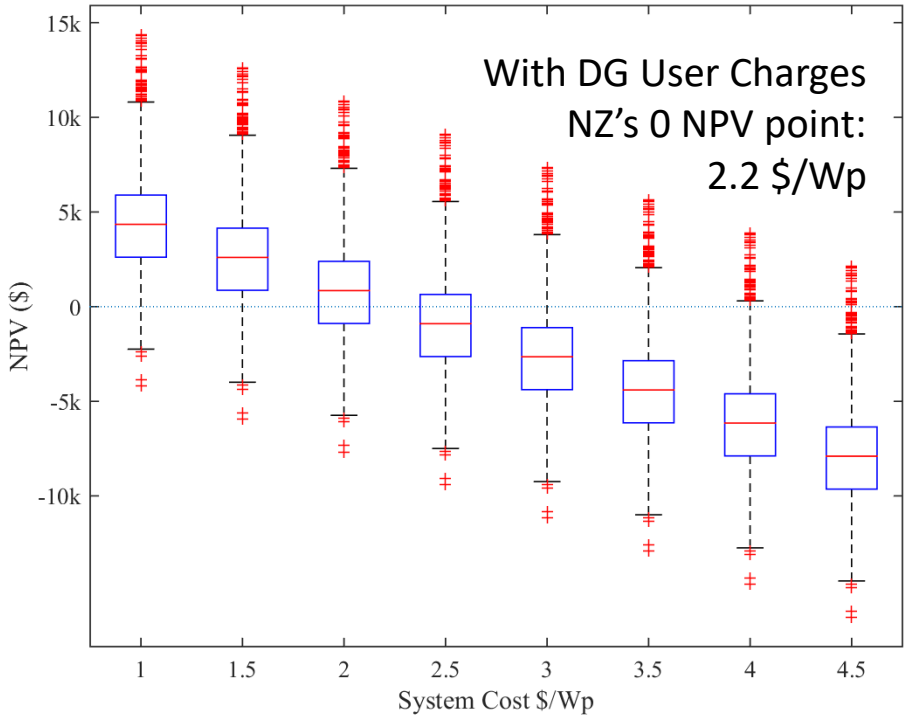
The Effect of DG Charges

- Unison introduced new DG charges 1 April 2016
  - Designed to more fairly reflect the costs incurred by users due to DG often not reducing peak demand

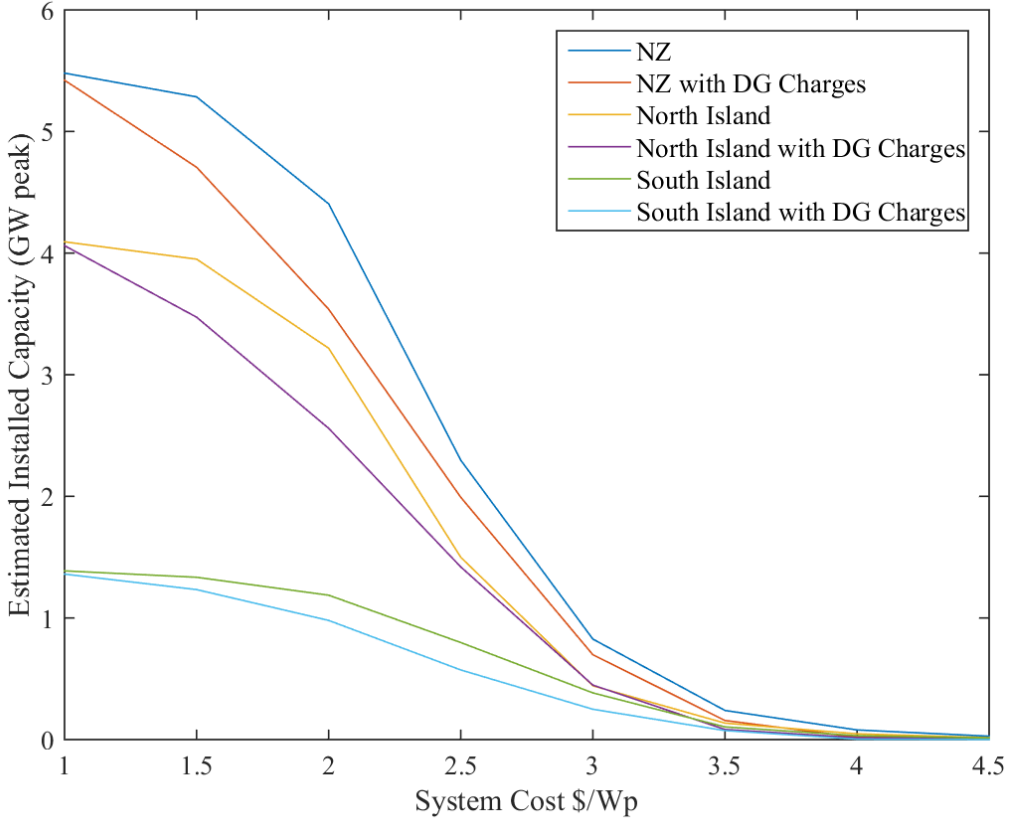
	Fixed Daily Charge	Variable Charge (per unit)
Low User (< 8kWh)	No change	Increase (3c – 6.3c)
High User (>= 8kWh)	Increase (65.5c)	No change

Effect of DG User Charges on NPV





Effect of DG User Charges on PV Uptake



Modelling Assumptions

- That sample load profiles obtained are representative of NZ load profiles.
- Household electricity consumptions remain fixed
  - Doesn't take into account pro-active prosumers altering consumption
  - Ignores the effect new appliance technology may have on electricity consumption patterns
- Electricity pricing structure fixed
- All generated power in the 30 min metering period is available for self consumption (artificial battery effect)
- Cultural and social factors also strongly affect PV uptake but are not considered here.

Conclusions

- PV is financially viable for approximately half NZ households @ 2.4 $/Wp.
- Large regional differences in economic viability.
- Analysis suggests we are potentially on the cusp of large PV uptake of PV in NZ.

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Co-funders

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Research Lead

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Research Partners

University of Otago Te Whare Wānanga o Otāgo New Zealand

Centre for Sustainability Kā Rakahau o Te Ao Tūroa

Thank you to the supporters of the GREEN Grid programme.

Distributed Generation Guideline

Developed by the EPECentre, under the GREEN Grid project (MIBE funded) in consultation with industry partners

Mission:

- Reduce PV application processing time and cost for EDBs
- Make PV application easier for the customer
- Avoid additional network costs in the future

Status

- Consultation draft published by Electricity Engineers' Association in May 2016

- Consultation feedback discussed at Network Analysis Group meeting held on 13th October 2016, Guideline is now being updated.

DG Connection Process:

1 Application	2 Assessment	3 Approval
Customer applies to connect DG to an LV network (They specify the max export power of the system)	EDB assesses the application based on the hosting capacity of the LV network.	 **Automatic Approval** Application is auto-assessed and approved. **Conditional Approval** Application is auto-assessed and approved subject to the volt-var response mode of the inverter being enabled. **Manual Assessment** Application requires further manual assessment before approval.

Example:

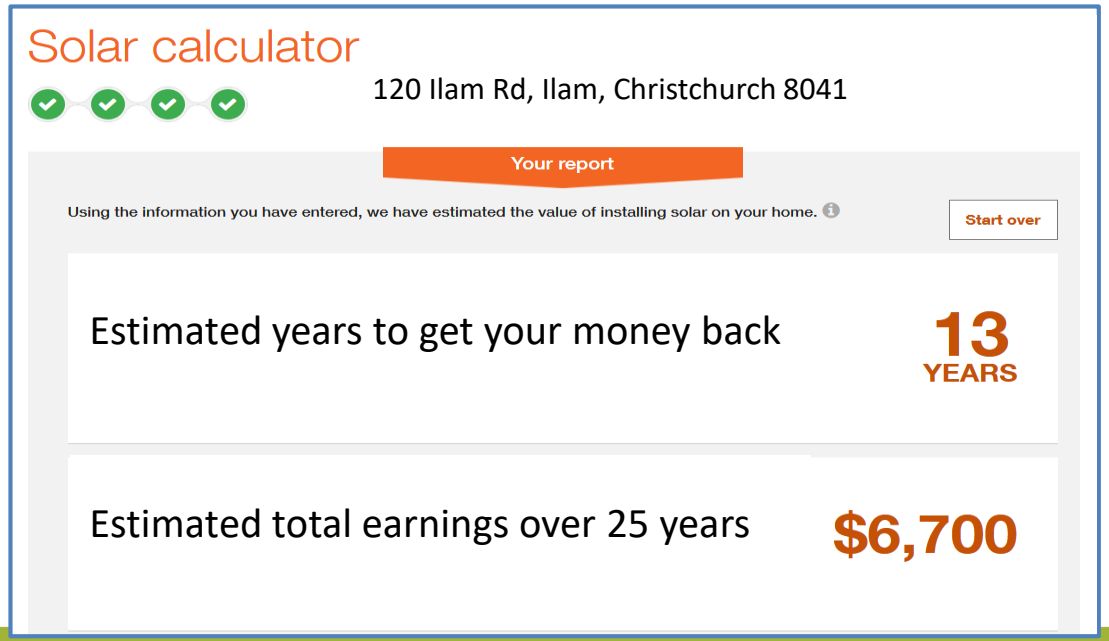
Customer DG Application	LV Network Hosting Capacity Outputs	
Max real export power [kW]	Connection threshold H_1 [kW] (upper limit for no mitigation)	Connection threshold H_2 [kW] (upper limit with mitigation)
4.5	2.7	7.2

Does Roof-top Solar Work For You?

Solar Calculator

https://www.energywise.govt.nz/tools/solar-calculator/

Developed by the EPECentre in partnership with EECA



	North Facing Panel		East-West Facing Panel	
Region	Capacity Factor	System Cost at which median NPV is zero ($/Wp)	Capacity Factor	System Cost at which median NPV is zero ($/Wp)
Northland	0.159	2.81	0.135	2.51
Auckland	0.153	2.25	0.129	1.96
Waikato	0.150	2.38	0.127	2.10
Bay of Plenty	0.155	2.56	0.131	2.25
Gisborne	0.164	3.23	0.135	2.87
Hawke's Bay	0.163	2.79	0.133	2.41
Taranaki	0.153	2.41	0.128	2.13
Manawatu-Whanganui	0.150	2.28	0.125	1.99
Wellington	0.155	2.28	0.127	1.94
Nelson	0.176	3.04	0.141	2.58
Tasman	0.175	2.81	0.140	2.40
Marlborough	0.164	2.96	0.131	2.53
Canterbury	0.147	2.75	0.119	2.33
West Coast	0.153	2.74	0.124	2.36
Otago	0.135	2.36	0.108	1.97
Southland	0.131	2.13	0.107	1.77

Effect of DG User Charges on PV Uptake

Region	Capacity Factor (%)	System Cost at which median NPV is zero ($/Wp)	Change in median zero NPV with DG User Charges ($/Wp)
Northland	15.9	2.81	-0.11
Auckland	15.3	2.25	-0.16
Waikato	15.0	2.38	-0.09
Bay of Plenty	15.5	2.56	-0.18
Gisborne	16.4	3.23	-0.13
Hawke's Bay	16.3	2.79	-0.13
Taranaki	15.3	2.41	-0.04
Manawatu-Whanganui	15.0	2.28	-0.08
Wellington	15.5	2.28	-0.19
Nelson	17.6	3.04	-0.03
Tasman	17.5	2.81	-0.28
Marlborough	16.4	2.96	-0.29
Canterbury	14.7	2.75	-0.32
West Coast	15.3	2.74	-0.27
Otago	13.5	2.36	-0.36
Southland	13.1	2.13	-0.24