Feed-in tariff design for domestic scale grid-connected PV systems using high resolution household electricity demand data

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Background

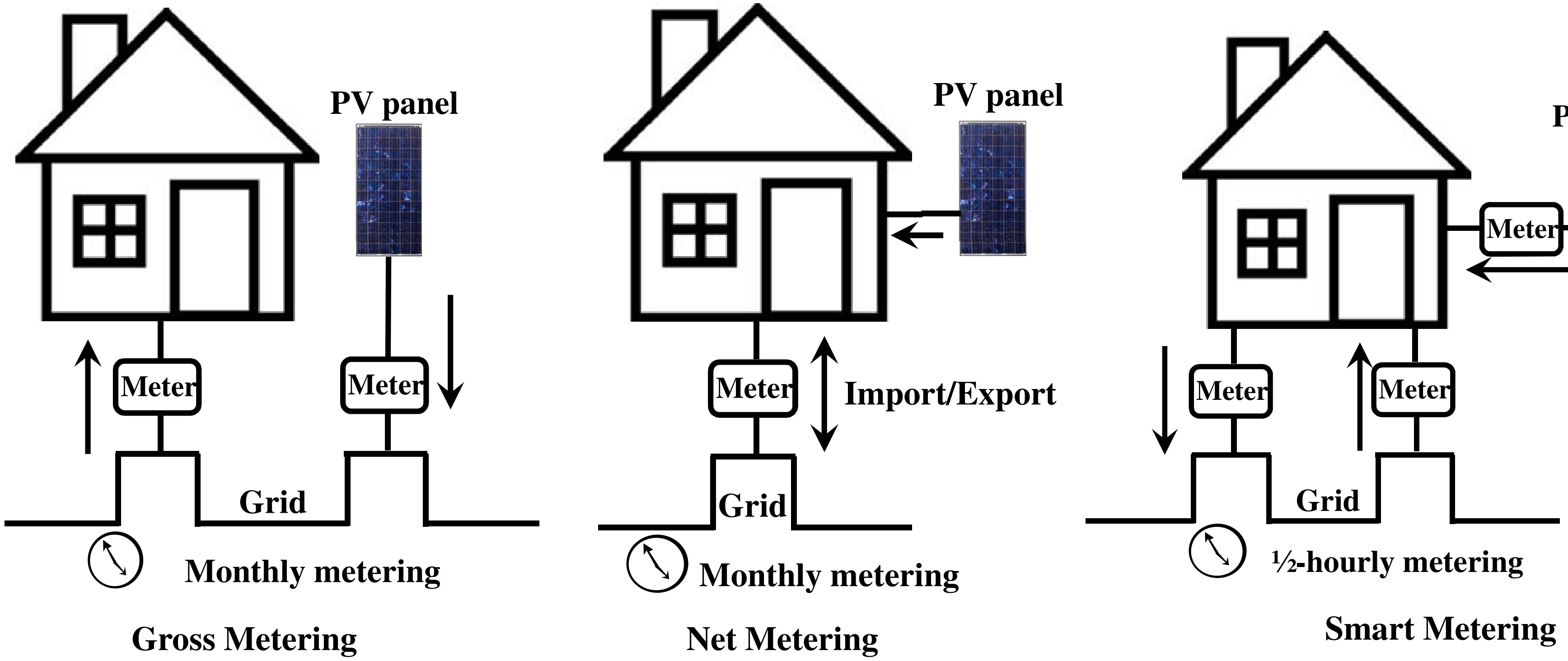
- Why support embedded generation
- Investors interested in favourable ROI
- Most domestic scale RETs not yet economically viable
- Support therefore required

Background

- Feed-in tariffs (FITs) have proved to be successful in promoting PV
- A FIT is an explicit monetary reward for producing electricity using renewable energy technologies at a rate per kWh
- Efficient design of FITs important to encourage uptake

Background contd.

- Three types of domestic scale PV metering configurations



Background contd.

- Domestic-scale PV systems (0-4 kW_p) have been targeted separately to larger commercial systems
- For smart metering, FITs have been designed considering 50% on-site consumption
- New data on household electricity demand (≤ 1 hr) now available
- This data can be combined with PV electricity output from dynamic models

Justifications and Objective

- Extra electricity cost from FIT is born by consumers
- It is important to efficiently design FITs
- Objective is to present a new methodology for efficient FIT design for domestic scale PV systems using high resolution household electricity demand data

Design Methodology

Collect large sample of high resolution household electricity demand data ($\leq$ 1hr)

Model instantaneous energy output from A range of commercially available domestic scale PV systems ($\leq$ 1hr)

Match instantaneous electricity demand and generation to determine the quantity of electricity generated by each PV system that is used on-site by each household

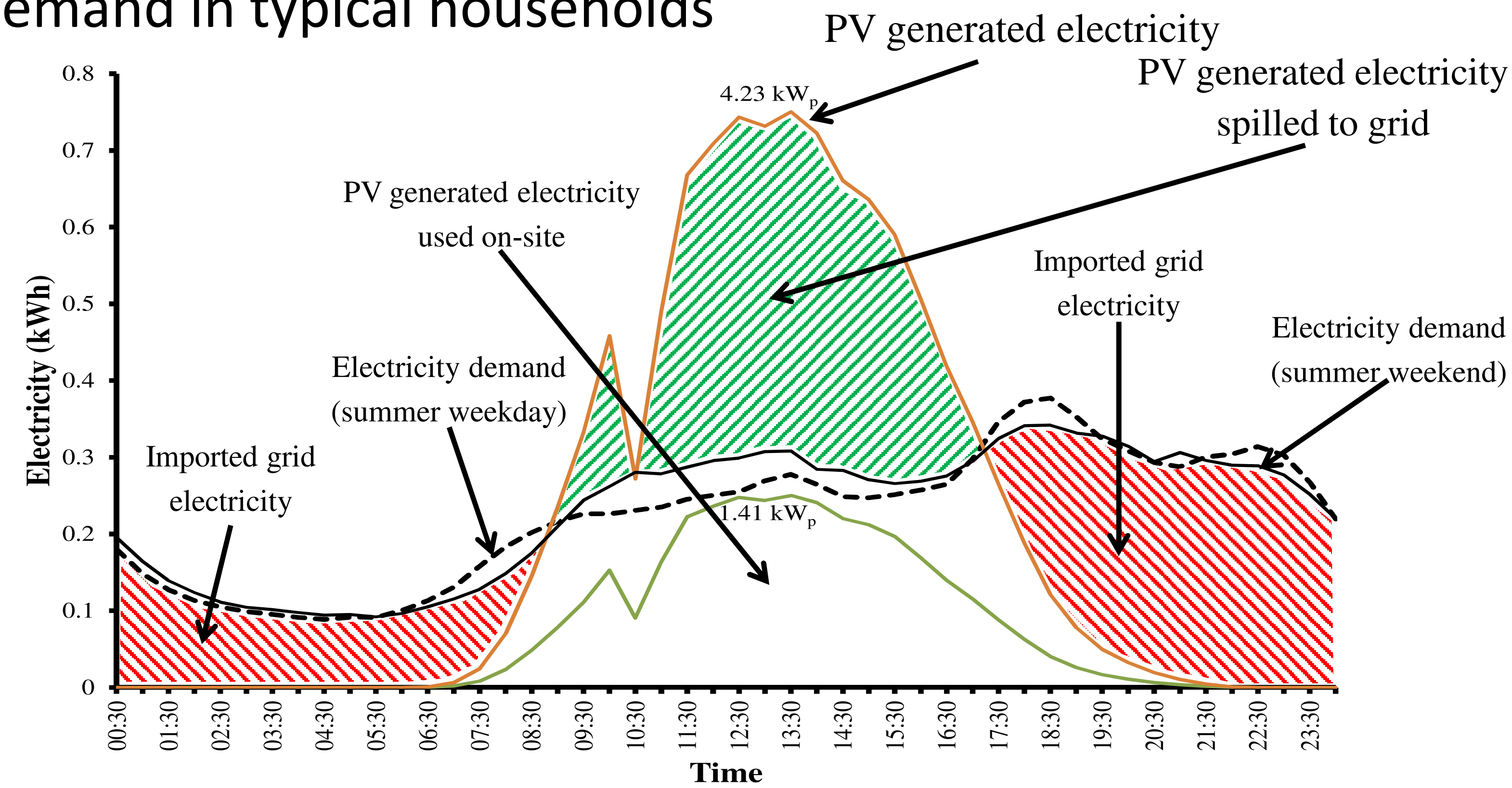
Use current and projected electricity import tariffs and electricity export prices to determine annual streams of cash flows and present value of revenue (R_t) for each household demand data and PV system size

Compute the NPV for the PV systems combined with each household electricity demand data

Select FIT that satisfies design objectives (say 8% IRR and percentage on-site electricity consumption $\geq$ 50%)

Analysis

- Electricity output from PV systems does not match domestic demand in typical households



Sample daily household electricity demand (Electricity Ireland) and electricity generation by different PV systems

Analysis

$$NPV = R_t - C_t$$

NPV = net present value

C_t = PV system life cycle cost

R_t = total revenue

$$R_t = \sum_{n=1}^{n=N} \left(\alpha_n AI + \beta TG + \gamma_n EX \right)$$

Percentage of total generated electricity used on-site

Total electricity generated

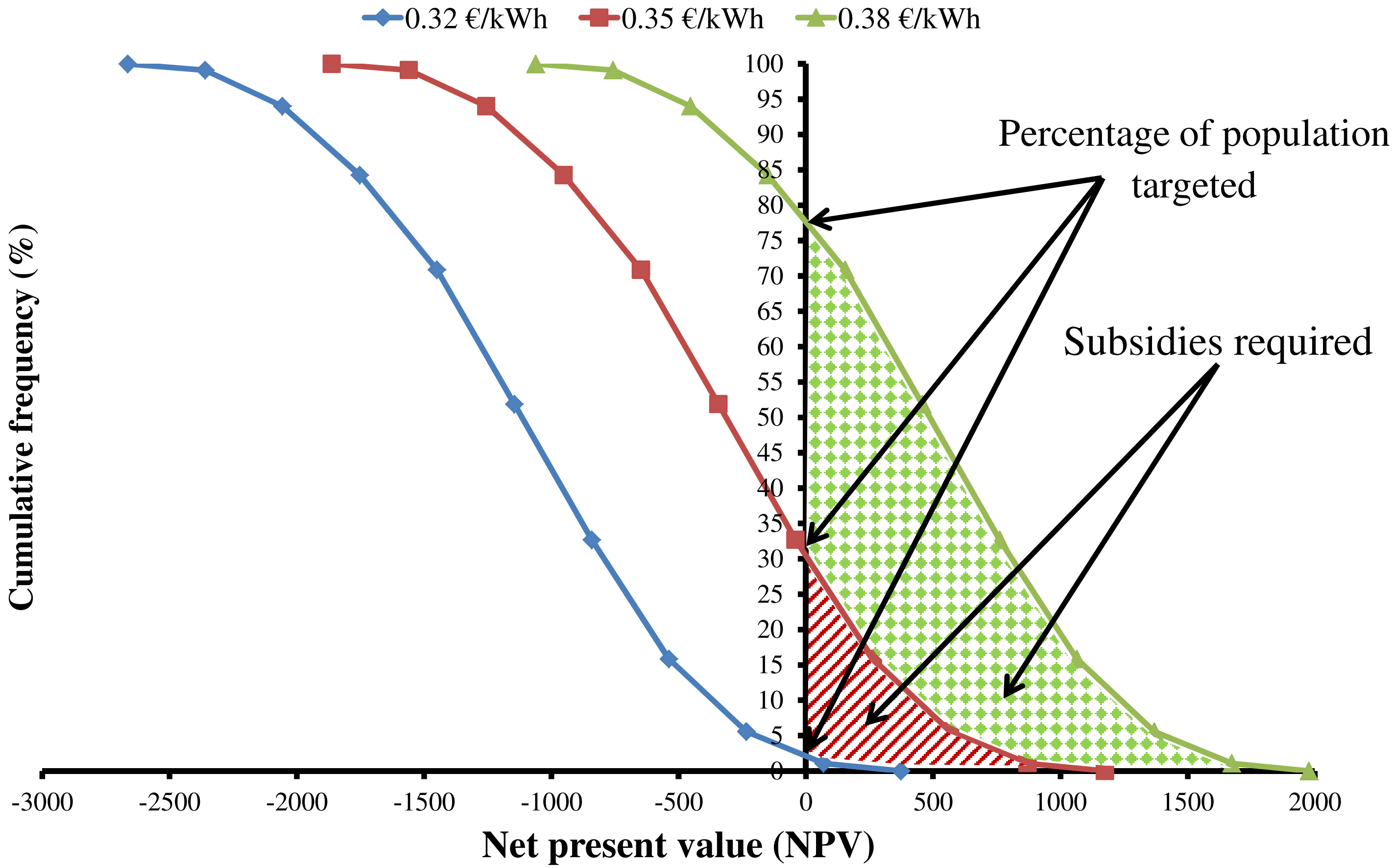
Percentage of total generated electricity exported

Electricity import tariff

Feed-in tariff

Electricity export tariff

Results & Discussions



Cumulative frequency of NPVs for different FITs for the 2.82 kW_p PV system

Results & Discussions contd.

Required FITs, NPV ranges and percentage of sample population with at least 50% on-site electricity consumption for different PV system capacities

PV system capacity (kW_p)	Required FITs (€/kWh)	NPV ranges (€)	Percentage of sample (%)	FITs (€/kWh)	NPV ranges (€)
0.47	0.54	17-351	94.7	0.38	-695 to -361
1.41	0.45	77-986	67.1	0.38	-859 to 51
1.72	0.38	94-1,096	56.6	0.38	94 to 1,096
2.82	0.35	52-1,175	26.7	0.38	854 to 1,977
4.23	0.37	4-1,011	7.2	0.38	405 to 1,411

Economic viability guaranteed by NPVs ≥ 0

Conclusions

- Single FITs not suitable for range of domestic scale PV systems.

- It is possible to design FITs for individual dwellings based on smart metering data for typical years.

- FITs can also be designed for user groups with different electricity consumption patterns and total quantities.

- FITs can be introduced in a phased manner to minimise over-payments or hold nominal values steady and allow technological learning to bring a greater percentage of households into the positive NPV range.

Questions/Suggestions?

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