

Sources: www.engineersjournal.ie; www.investopedia.com; www.theguardian.com

Solar PV where the sun doesn't shine: Estimating the economic impacts of support schemes for residential PV with detailed net demand profiling

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Research Motivation

Summary of context:

- EU Policy: Difficulty meeting 40% RES-E by 2020 in Ireland and future targets (27% renewables by 2030 for all EU) solely through wind
- Technology: installed PV costs have dropped by half since 2010
- Irish Policy: White Paper & RE Support Scheme consultations on possible solar PV subsidy
- Previously looked at utility-scale solar PV in Ireland

Key Questions:

- What are the consumer economics of residential solar PV in the Irish system?
- What are the impacts of:
  - Subsidies
  - Finance
  - Tariff structure

Overview

We model financial performance from the consumer perspective for residential PV in Ireland under

- 3 levels of annual demand estimates (low, average, and high)
- 3 PV system sizes (3 kWp, 4.5 kWp, and 6 kWp)
- 4 remuneration scenarios (base, net-metering, feed-in tariff, declining feed-in tariff)
- Financing (100% equity, 50% debt, 50% low-interest debt, grant programme)

We use **detailed, hourly generation and consumption data** to calculate how much power is consumed and how much is exported to the grid, then calculate lifetime savings. This approach…

→ gives a **more accurate** result than making blanket assumptions about the proportion of self-consumption

→ allows us to capture conditions specific to Ireland's temporal and seasonal characteristics as a **low-irradiance, winter-peaking market**

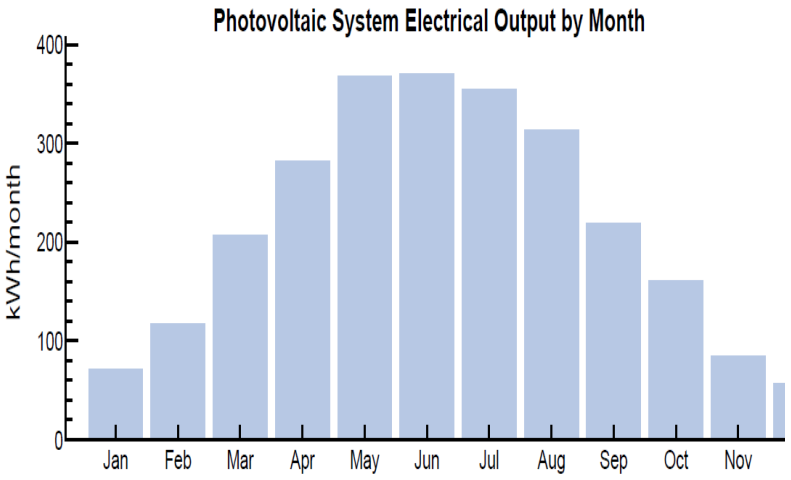
Data: Generation

Hourly generation profile for 3, 4.5, 6 kWp system

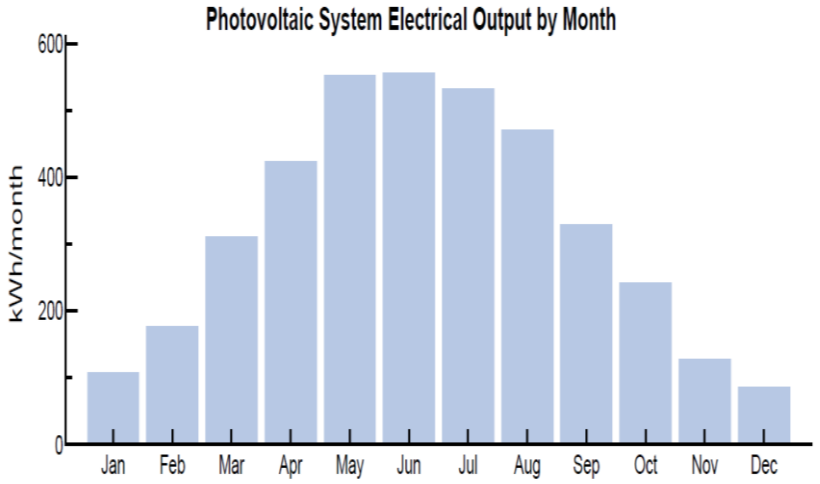
Source: NREL System Advisor Model (SAM)

Annual Yield: 865 kWh/kWp

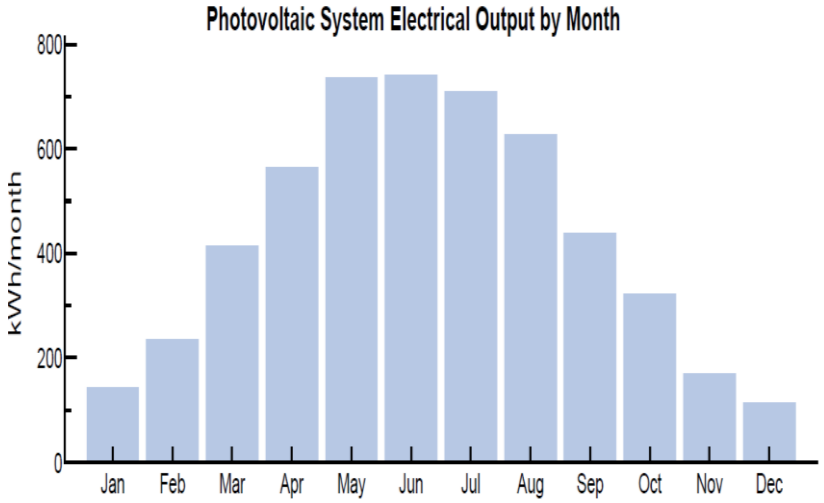
3 kWp
Annual Output 2,594 kWh



4.5 kWp
Annual Output 3,891 kWh



6 kWp
Annual Output 5,188 kWh



Data: Demand

¼ hourly unitised demand profile

Source: ESB standard load profiles (SLPs)

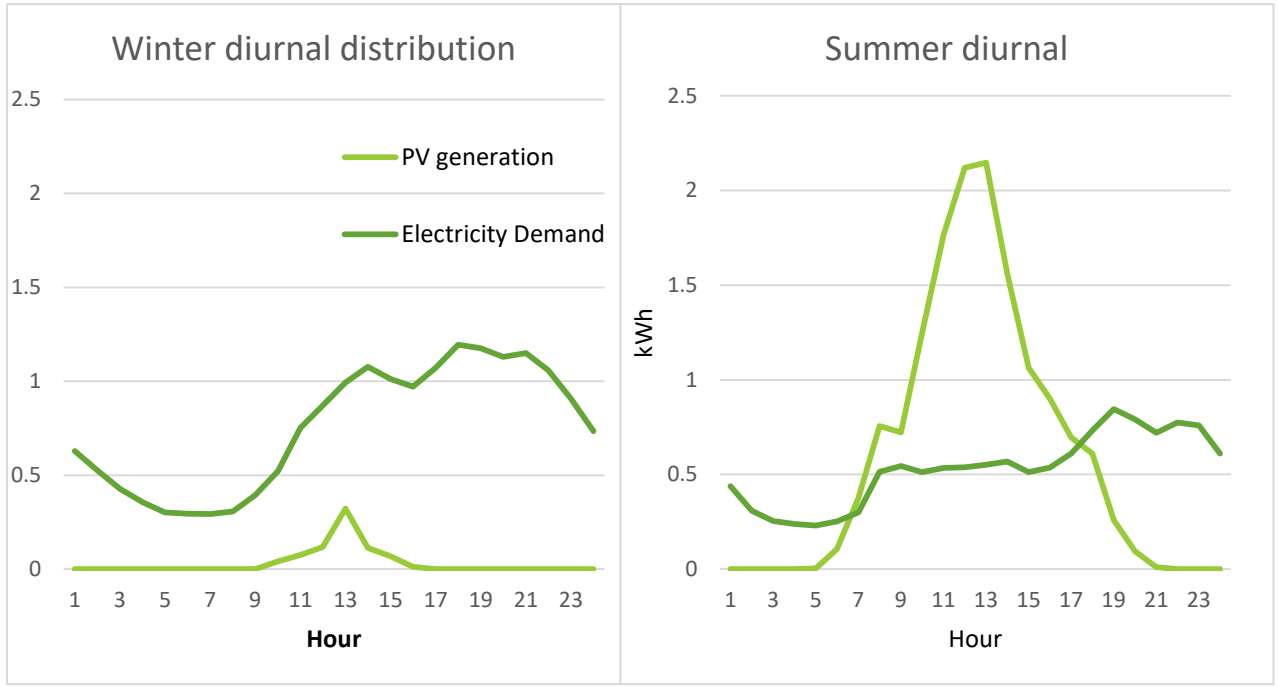
¼ hourly data is summed to provide hourly demand values

3 demand scenarios:

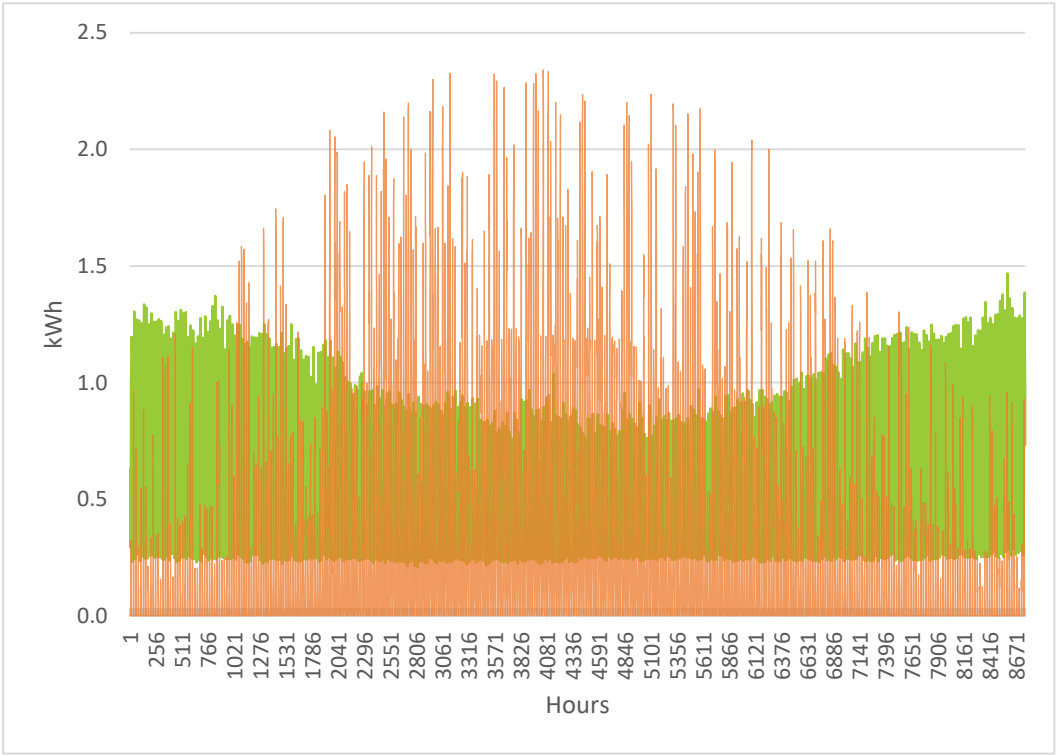
Low Usage	Mid Usage	High Usage
3,100 kWh	5,300 kWh	8,100 kWh

Demand v. Generation

Daily (seasonal contrast)



Annual



Calculations – net demand

Annual Net Demand and Self-Consumption for First Year

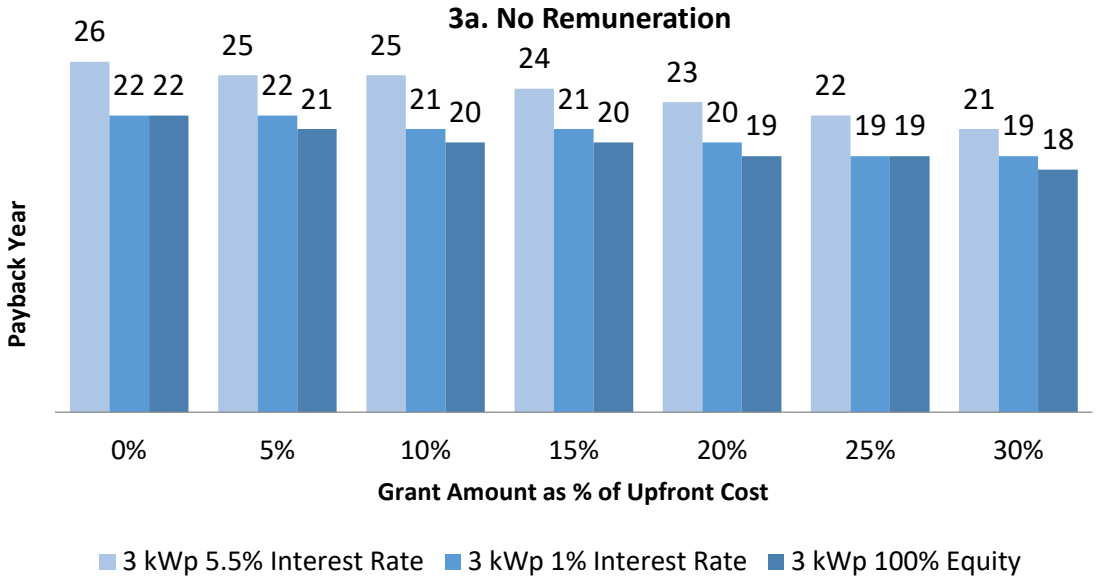
System Size (kWp)	3	3	3	4.5	4.5	4.5	6	6	6
Demand Size	Low	Mid	High	Low	Mid	High	Low	Mid	High
$Demand_{no\ PV}$ (kWh)	3,100	5,300	8,100	3,100	5,300	8,100	3,100	5,300	8,100
Generation (kWh)	2,594	2,594	2,594	3,891	3,891	3,891	5,188	5,188	5,188
$Demand_{w/PV}$ (kWh)	1,950	3,635	6,001	1,848	3,399	5,574	1,791	3,261	5,309
Self-Consumption	**44%**	**64%**	**81%**	**32%**	**49%**	**65%**	**25%**	**39%**	**54%**

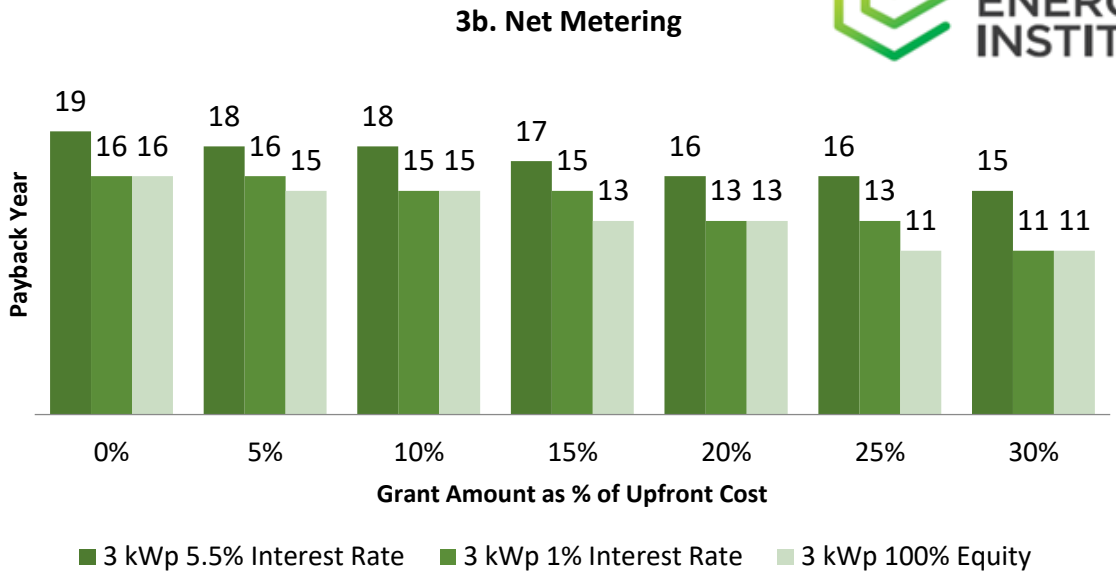
Costs & Assumptions

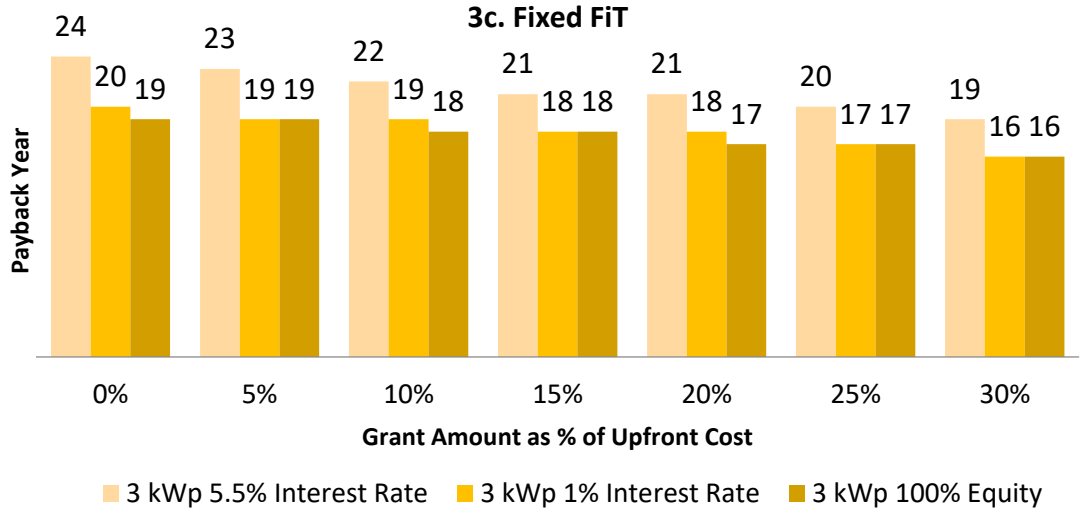
Assumptions	Value	Source
Installed Cost per kWp	€1,744	Survey of Irish PV Installers
Annual Rate of Usage Increase (%)	0.00%	Dennehy and Howley (2013)
Degradation Rate	0.70%	Bazilian et al (2013)
O&M/Insurance	€ 50.00	Li et al (2011) and Georgitsioti et al (2013)
Inverter Replacement Cost	€1,475	Industry quotations
VAT (%)	13.50%	Department of Revenue
Discount Rate	0.55%	Survey of commercially available savings deposit rates
Retail Price Annual Increase (%)	4.00%	Historical EU Average, EU Commission (2014)
Retail Rate (€/kWh)	€0.133	Howley and Holland (2016)
1st Year PSO Levy (€/year)	€60.09	Commission for Energy Regulation (2015)
Standing Charge (€/year)	€132.16	Survey of published supplier pricing

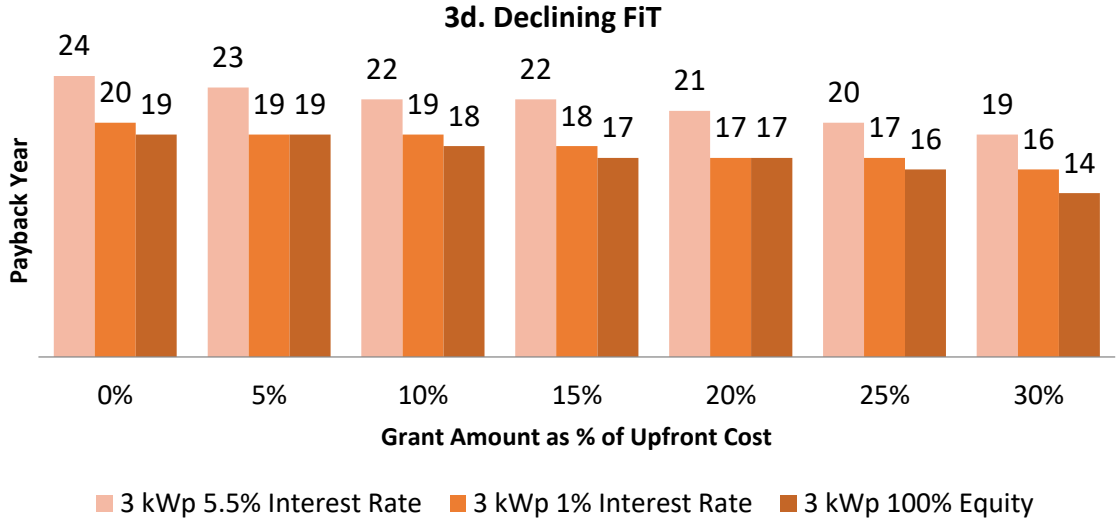
Results – Remuneration Policies

	System size	3 kWp	3kWp	3 kWp	4.5 kWp	4.5 kWp	4.5 kWp	6 kWp	6 kWp	6 kWp
	Demand	Low	**Mid**	High	Low	Mid	High	Low	Mid	High
Base Case	**NPV**	(€1,381)	**€1,398**	€3,626	(€3,374)	€212	€3,576	(€5,635)	(€1,556)	€2,569
	Payback Year	>25	**22**	18	>25	24	20	>25	>25	21
Net Metering	**NPV**	€5,783	**€5,783**	€5,783	€10,000	€10,000	€10,000	€14,217	€14,217	€14,217
	Payback Year	16	**16**	16	14	14	14	14	14	14
Feed-in Tariff - fixed	**NPV**	€576	**€2,606**	€4,228	€267	€2,890	€5,346	(€239)	€2,746	€5,761
	Payback Year	23	**19**	17	24	20	18	25	21	18
Feed-in Tariff - declining	**NPV**	€208	**€2,404**	€4,147	(€447)	€2,396	€5,052	(€1,320)	€1,921	€5,188
	Payback Year	24	**19**	17	25	20	17	>25	21	18


3a. No Remuneration
Payback Year
26 22 22
25 22 21
25 21 20
24 21 20
23 20 19
22 19 19
21 19 18
0%
5%
10%
15%
20%
25%
30%
Grant Amount as % of Upfront Cost
3 kWp 5.5% Interest Rate
3 kWp 1% Interest Rate
3 kWp 100% Equity

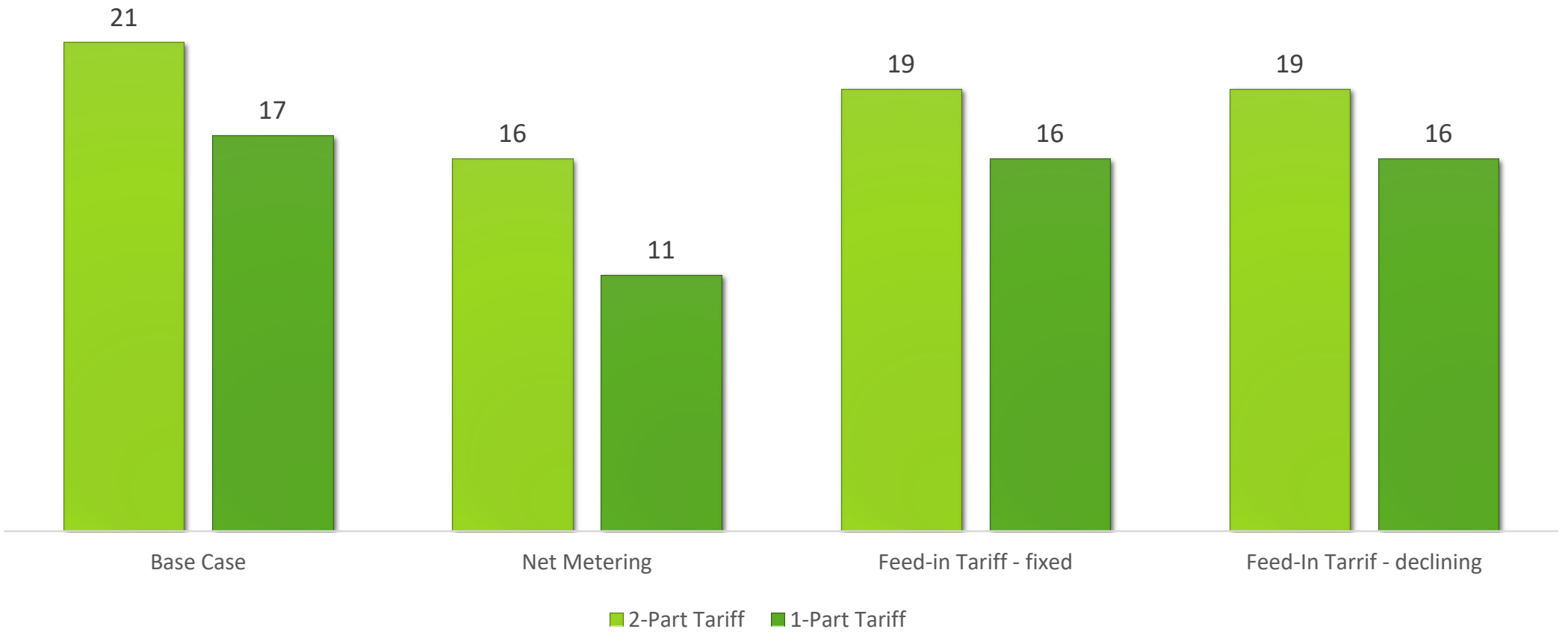

3b. Net Metering
Payback Year
19 16 16
18 16 15
18 15 15
17 15 13
16 13 13
16 13 11
15 11 11
0%
5%
10%
15%
20%
25%
30%
Grant Amount as % of Upfront Cost
3 kWp 5.5% Interest Rate
3 kWp 1% Interest Rate
3 kWp 100% Equity


3c. Fixed FiT
Payback Year
24 20 19
23 19 19
22 19 18
21 18 18
21 18 17
20 17 17
19 16 16
0%
5%
10%
15%
20%
25%
30%
Grant Amount as % of Upfront Cost
3 kWp 5.5% Interest Rate
3 kWp 1% Interest Rate
3 kWp 100% Equity


3d. Declining FiT
Payback Year
24 20 19
23 19 19
22 19 18
22 18 17
21 17 17
20 17 16
19 16 14
0%
5%
10%
15%
20%
25%
30%
Grant Amount as % of Upfront Cost
3 kWp 5.5% Interest Rate
3 kWp 1% Interest Rate
3 kWp 100% Equity

Results: Effect of FiT rate amount

Results: 1-part vs. 2-part tariff structure



Key Findings

In the **base case** (i.e. no remuneration, grant, or financing), 3 kWp and 4.5 kWp systems with average demand have **positive NPV/IRR, but long (20+ year) payback**

Between the base case, net-metering, and FiT scenarios, **net-metering provided the best payback**, at 16 years for a 3 kWp system

Literature and industry input suggests required payback is 10 years or less – the shortest payback period that we measure for a 3 kWp system is **11 years** with **net metering and a 30% upfront grant**

Key Findings

Tariff Structure is critical: 1-part tariff (energy-only) reduces payback estimate by 3-5 years compared with 2-part tariff (fixed + volumetric)

Rate Increases boost returns to customers; slow or flat movement in the volumetric retail rate reduces financial performance

Grant funding considerably improves IRR and NPV, but offers relatively small benefits re: accelerating the payback period (1-2 year improvement in payback per 5% increment of grant amount added)

Grants may be more advantageous in an Irish policy context than in countries with higher solar resources, where the value of future cash flows from remuneration schemes is higher

Full paper:

La Monaca, S., Ryan, L., 2017. Solar PV where the sun doesn't shine: Estimating the economic impacts of support schemes for residential PV with detailed net demand profiling. Energy Policy, 108:731-741.

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