An Analysis of the Self-Use fraction of Photovoltaic Electricity in Ireland - and the Effective PV Electricity Price

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ABSTRACT

This paper examines the measured performance of 13 Irish Photovoltaic (PV) systems and calculates the self- use solar fraction, β. It then compares it with the β factor recommended for fuel cost comparisons in the Irish national energy rating software DEAP.
The paper goes on to calculate the effective PV fuel cost based on recorded data and tariffs currently available in the Irish marketplace.
The research, which is funded by the publishers of the national residential building energy rating software ("DEAP"), the Sustainable Energy Authority of Ireland (SEAI) is timely given that the Irish rollout of smart meters is scheduled to finish in 2025.
The findings show that the measured mean β factor of 0.54 (n=13) is significantly higher than that currently proposed for financial analysis (0.3).
Further, the research has identified a significant lacuna in that the officially accredited price comparison websites are incapable of enabling consumers avail of the most suitable smart tariff based on their energy use profiles or to determine if additional savings can be made by changing their energy use profile. This finding is highly relevant as Ireland strives to reduce the dependence on fossil fuels in its residential building stock.

KEYWORDS

PV, Photovoltaic, Financial Analysis, Effective PV Electricity Price, smart tariff, smart meters.

INTRODUCTION

The Irish domestic electricity supply was deregulated in 2005 [1], yet Irish domestic electricity prices remain the 2nd highest in Europe [2]. Of 13 suppliers, Electric Ireland, the company which now supplies domestic electricity following the breakup of the previous semi state ESB, continues to hold a 41% share of the domestic electricity market and ESB's share of the overall supply market fell from 100 per cent in 2005 to 40 per cent in 2025 [3].
While the Irish smart meter rollout is almost complete [4], the adoption of smart meter tariffs remains small, with only 11% smart tariff uptake at May 2024 [5]. The media in Ireland has questioned the value which smart meters are affording in the Irish market [6], with one former energy minister stating that smart meter tariffs are too complicated [7].
In order to facilitate consumers in choosing the correct tariff, the Irish Commission for Regulation of Utilities (CRU) has approved three price comparison websites based on the 2019 CRU19033 Price Comparison Website Accreditation Framework [8]. The sites are bonkers.ie, power-to-switch.ie and switcher.ie, and enable comparison based on annual electricity

consumption figures. They do not however facilitate comparison based on smart meter data, which is freely available to smart meter consumers, and do not incorporate PV generation analysis.
Given that the vast majority of Irish consumers (89%) are using non-smart tariffs [9], the approach taken by this paper has been to carry out a comparison using the CRU approved price comparison website to determine the lowest cost utility provider based on recorded annual kilowatt hour import figures across 13 case study Irish dwellings with PV systems.
One of the key determinants in carrying out a financial assessment of the viability of PV electricity is the amount of PV electricity used within the building itself i.e., the self-use fraction β. The Irish national energy rating software DEAP software which produces the Irish Energy Performance Certificates, which are called Building Energy Ratings (BER). The DEAP software states that a self-use fraction of 0.3 should be used for financial analysis and also states that this value to be reviewed once data becomes available. This paper seeks to provide the required data.

LITERATURE REVIEW

Chen et al. [9] analysed the domestic electricity energy marketplace in Ireland following the introduction of smart meters and smart tariffs. Inter alia the findings of the paper include:

- The analysis of electricity usage from smart meters from 161 domestic consumers in Ireland shows a consistent 60%+ difference between the cheapest and the most expensive tariff options from across all suppliers;
- Out of 65 available tariffs, only 5-6 are consistently among the cheapest across all customers, while more than 20 are never cost-effective for any customer;
- The main finding is that there are market inefficiencies identified in the research as a result of customers not being able to identify their best / cheapest tariffs.

The challenge for consumers in identifying the most appropriate smart tariff is compounded by the fact that while the CRU has approved three price comparison websites as per the Price Comparison Websites Accreditation Framework [8], the sites currently only cater for fixed & and day/night rates and do not facilitate a comparison of smart tariffs or indeed the contribution possible from solar PV (or other renewable sources). This gap in the marketplace is currently being met by a number of energy cost comparison websites e.g. [10] [11] [12] which use smart meter data. However, these sites are not CRU approved in terms of their veracity and accuracy and have not been used here for comparison purposes.
Solar feed in tariffs (FiT) were re-launched in Ireland in 2022 and currently range from 15.89c to 25.00c (in March 2025), see Table 1.

Table 1. Feed in Tariffs available in the Irish domestic electricity market in March 2025

Supplier No.	Export Rate per kWh incl VAT {€ c}
1	18.50
2	19.50
3	20.00
4	20.00
5	25.00
6	19.50
7	15.89

The Sustainable Energy Authority of Ireland (SEAI) Solar PV Scheme, offered as part of the domestic retrofit plan, is experiencing strong demand [13], with some industry commentators reporting that solar uptake is driving Ireland's retrofitting scheme progress [14]**.** This finding is consistent with a recent paper which indicated that solar PV is highly cost-effective in an Irish retrofit scenario [15].

However, the literature review has revealed that little has been written about the Irish financial value per solar PV unit in (1) avoiding the import of electricity units from the grid and (2) generating income via the current Feed in Tariff mechanism.

In addition, the national dwelling energy rating software, Dwelling Energy Assessment Procedure (DEAP) [16] states that the PV self-use fraction (also called the β factor) should be used for financial analysis is 0.3. This means that 30% of the PV electricity generated is deemed to be used within the dwelling rather than exported [17], as stated in the DEAP Manual:

"The effective price depends on a factor β, in the range 0.0 to 1.0, and is the proportion of the generated electricity used directly within the dwelling. The value of β depends on the coincidence of electricity generation and electricity demand.

At present the value of β = 0.30 should be used if performing fuel cost calculations: this will be reviewed in future if relevant data becomes available."

The figure of 0.3 is in contrast with a number of other approaches for temperate maritime climates e.g. the UK's national dwelling energy rating software, SAP has a fixed assumption of a self-use factor of 0.5 for buildings without battery storage [18]. McKenna et al recorded a self-use fraction (β) of 45% based on 302 UK households [19], and the U.K.'s Building Research Establishment (BRE) has reported a range from 0.54 without battery storage to 0.95 in the case of 10kWh battery storage [20].

This paper seeks to address the knowledge gap for Irish domestic properties and provide relevant data to determine (1) recorded values of β and (2) the financial value of PV generated electricity units based on recorded data from 13 live Irish installations.

METHOD

While a total database of 50 dwellings has been recruited for analysis, at the time of writing only thirteen dwellings have the required full years data for analysis (Table 2). The dwellings have a variety of technologies deployed (e.g. Electric Vehicles (EV), Heat Pump (HP), batteries, and different heating systems and BERs). See Tables 2 and 3.

The electricity only tariffs were compared using the specified annual consumption figures with the assumptions of new customer, 24-hour tariff, urban location (i.e. ESB Network's "DG1"), direct debit and online billing. As smart meter plans could not be requested, the results were requested for non-smart meter plan results, variable and fixed rates and didn't include any cashback offers available.

The CRU approved price comparison websites were used for 13 selected case study dwellings. Previous analysis determined that there was good agreement between the three CRU approved price comparison websites [15]. Therefore, one of the websites has been used in this analysis. Based on the annual imported electricity units, the same 24-hour tariff was identified.

The energy supplier's website was then used to determine the feed in tariff available for any export PV generated electricity. Data obtained from the customers inverter and smart meter data was used to determine the import and export energy.

Table 2. Description of the 13 case study dwellings
(Note "e" indicates "estimated")

Description						
unique_id	**BER**	**space_heating**	**EV**	**smart_plan**	**PV {kW_p}**	**Bat {kWh}**
D1PK129	A2	heat pump	no	yes	6	5
D1PK234	A3	heat pump	no	yes	6.5	2
D1PK517	A1	heat pump	yes	yes	6.6	10
D2PF784	A1	heat pump	no	yes	4.7e	0
D2PH123	B2	oil boiler	yes	yes	4.2	0
D2PH124	A2	gas boiler	no	no	4	5
D2PH458	C1	electrical storag	yes	no	4.2	0
D2PJ154	B3	Oil Boiler	yes	yes	4.8	5
D2PK567	A3	heat pump	yes	yes	5.8	5
D2PK579	C3	wood/biomass b	yes	no	5.46	5
D3PK687	A1	heat pump	yes	yes	6	0
S2PB222	A3	gas boiler	yes	yes	1.3	5
S2PG176	B3	oil boiler	yes	yes	3.9	0

Table 3. Overview of technologies, heating systems and BERs for case study dwellings

Technologies delpoyed, heating systems & BER			
Technology	Detail	Number	% of total
EV	no	4	31%
	yes	9	69%
Space Heating	HP	6	46%
	Boiler	6	46%
	Direct elec	1	8%
BER	A	8	62%
	B	3	23%
	C	2	15%
Sm Met Pln	n	3	23%
	y	10	77%
Battery	y	8	62%
	n	5	38%

In conjunction with the import and export tariffs, the total annual value of PV self-use and exported electricity was determined for each dwelling.
This figure was divided by the total number of PV units generated in order to determine the value per generated PV unit, i.e. the effective PV electricity value.
It is noted that once the tariff had been selected based on the CRU approved price comparison websites, fixed charges where not considered in the analysis, as the fixed charges were already committed to. No element of the fixed charges or PV system depreciation were applied to the calculations of the per unit PV electricity price.
In addition to the financial analysis, the self-use fraction β was also determined for each dwelling, and the mean values for all dwellings were calculated (see Table 4).

RESULTS AND DISCUSSION

The data presented in Table 4 is derived from inverter and smart meter data over 2023 and 2024. In instances where monthly data was available for both years, an average was obtained for the months in question. In the small number of cases where smart meter data was unavailable for the month, PV system derived data was used and vice versa.

Recorded β Factors

The β factors range from 27% to 73% with a mean value of 54% (Table 4). This is significantly higher than the 30% β factor proposed in DEAP in respect of performing fuel cost comparisons.

Table 4. Recorded key energy metrics per dwelling

Unique_id	Recorded Energy {kWh}					ß factor {%}
	PV {kWp}	Import	Total PV Gen	Total Export	Self Cons	
D1PK129	6	3,728	5,808	3,162	2,646	46%
D1PK234	6.5	5,466	5,918	2,859	3,059	52%
D1PK517	6.6	5,500	6,399	3,036	3,363	53%
D2PF784	4.7	7,116	3,998	1,869	2,128	53%
D2PH123	4.2	7,192	3,154	1,143	2,010	64%
D2PH124	4	2,588	4,285	1,141	3,145	73%
D2PH458	4.2	1,505	3,263	2,384	878	27%
D2PJ154	4.8	6,228	4,478	1,922	2,556	57%
D2PK567	5.8	12,498	3,386	993	2,393	71%
D2PK579	5.46	12,798	4,525	1,650	2,875	64%
D3PK687	6	7,832	4,582	3,091	1,491	33%
S2PB222	1.3	4,532	948	288	660	70%
S2PG176	3.9	4,743	3,771	2,345	1,426	38%
Mean	**4.9**	**6,287**	**4,193**	**1,991**	**2,202**	**54%**

The reasons for the higher β factor for the specific dwellings depend on a number of factors. It may be associated with the profile of the 13 sample dwellings, which primarily comprise dwellings with battery (n=8), smart meter plans (n=10) and EV ownership (n=9). It may also be a function of the level of engagement of the homeowners, given that they self-selected to participate in PV related research.

A specific reason for higher beta factors among some dwellings can be seen from Figure 1, which shows the dependency of the beta factor on the installed capacity. As can be seen from the trendline, the beta factor ranges from 63% (where the installed capacity is 1.3 $kW_{p)}$ to 49% (where the installed capacity is 6.5 kW_p). So, there is an inverse relationship between the self-use beta factor and the capacity. For example, if there is a small array, nearly all the PV electricity is used in the dwelling, whereas if there is a very large array, the percentage used directly in the dwelling reduces and more is exported. Further research on a larger sample size will be carried out to verify these findings.

The reasons for the variation in recorded beta factors will be the subject of further analysis, as data becomes available from more dwellings.

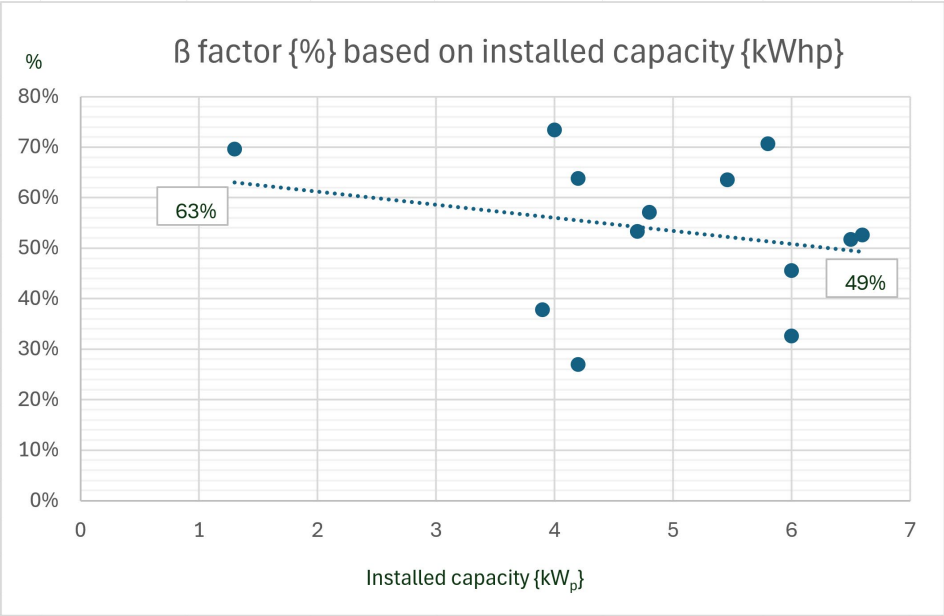

Figure 1. Relationship of self-use beta factor with installed capacity

As previously discussed, the β values obtained from the literature review indicate higher values for the UK e.g. 0.45 [19], 0.5 [18] and that the impact of specific technologies can increases further (e.g. to 0.83 and 0.96) with on-site battery storage [20].
Based on the findings from the measured dwellings and the literature review, it appears that the currently assumed self use rate β of 0.3 should be revised upwards when carrying out fuel cost calculations. The specific factor is to be determined and is the subject of further study.

Effective fuel price for PV electricity

Using the recorded imported energy figures in Table 4, the most cost-effective tariff was determined using a CRU approved price comparison websites, and the value of the PV electricity was determined using the procedure previously outlined for the 13 case study dwellings (Figure 2). It was found that supplier 3 offered the lowest overall costs, taking into consideration both the cost of electricity purchased and the value of the PV Feed in Tariffs.
In order to understand the impact of PV FiT, Table 5 gives the import and export rates for three suppliers (obtained from their websites) – those with the highest and lowest export rates and those for supplier 3 (the supplier with the most attractive overall proposition). Based on supplier 3 the PV value ranged from €58 sold & €156 avoided (a total of €214) to €794 sold & €607 avoided (a total of €1,401). The average value of PV was €520 avoided & €398 sold (total €918), see Figure 2.

Table 5. 24-hour import and export rates for 3 case study supplier' more s tariffs at time of writing

Supplier	Export Rate per kWh incl VAT {€ c}	Import Rate per kWh incl VAT {€ c}
3	20.00	23.61
5	25.00	31.33
7	15.89	28.74

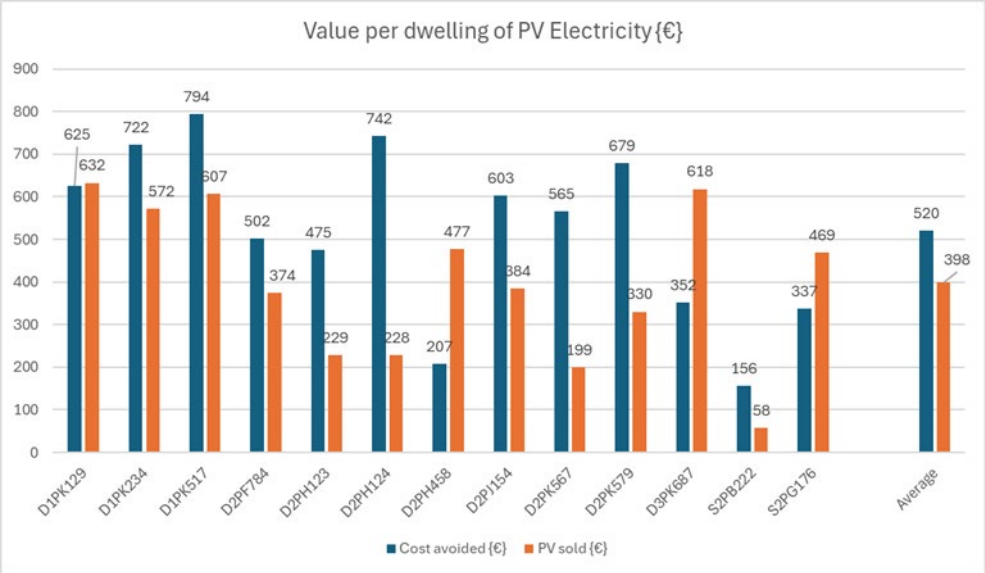

Figure 2. Total annual value per dwelling for self-use and exported PV electricity (Supplier 3)

The per unit PV value ranged from 20.97c to 22.65c, with an average of 21.94c (Figure 2). This corresponds with range of +4.4% /- 2.8%.

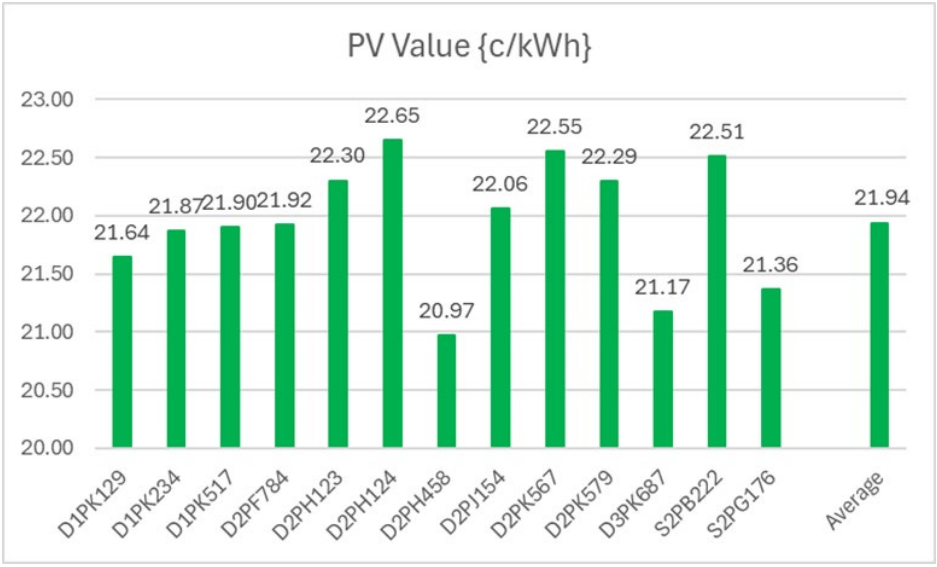

Figure 3. Value of PV electricity per unit generated for supplier 3

The relatively small range is a result of the small range of the export and import rates for supplier 3 (Table 5).

Range of PV values across three suppliers

As can be seen from Table 5, significantly higher and lower export rates than those of supplier 3 are available in the marketplace, and a sensitivity analysis has been carried out to establish the potential range of effective PV price per unit based on the lowest and highest export rates available in the marketplace. The import rate per kilowatt hour was determined for the additional two suppliers (supplier 5 and 7), and the corresponding range per kWh PV value was determined for the market as a whole (see Figure 3), and their individual supplier (Figure 4).

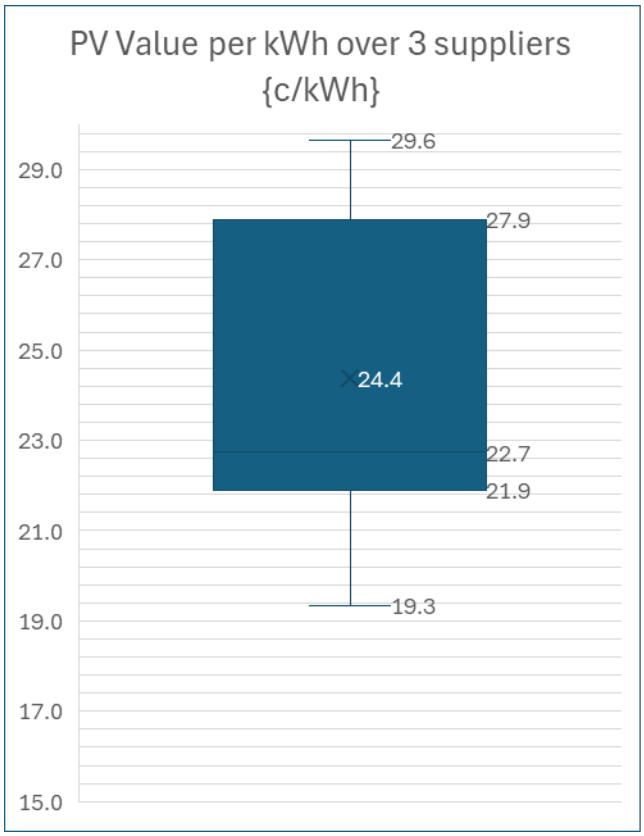

Figure 4. Box plot of value per unit of PV for 3 supplier's tariffs and 13 case study dwellings

Figure 4 shows that while the variation of PV Value / kWh is small for lowest cost supplier, there is significant market variation across a sample of 3 suppliers, with a minimum value of 19.3c, a maximum of 29.6c and a mean of 24.4c (+ 21%/-22%).
It is noted that while supplier 5 and supplier 7 tariffs can result in higher effective fuel prices for the PV electricity, see Figure 5, overall, the lowest electricity costs are offered by supplier 3, see Figure 5.

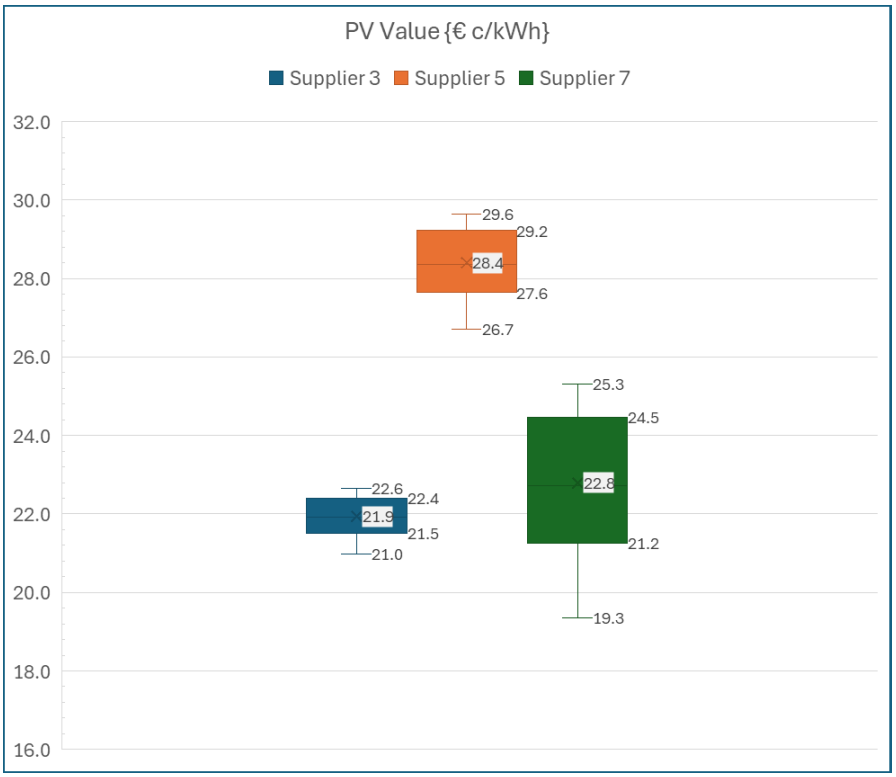

Figure 5. Box plots of case study dwellings for 3 suppliers FiT and import tariffs

CONCLUSION

The key findings from this analysis include:

- A recorded mean self-use factor of 0.54 which is significantly above the 0.3 proposed for fuel cost calculations in the national energy rating software DEAP.
- An inability of consumers to select the most appropriate tariff for their usage profile based on the tools approved by the state body charged with this task, the CRU.
- In addition, CRU do not enable consumers to decide how best to adjust their energy use profile to reduce their overall costs.

Further analysis is needed to

1. Validate the measured self-use factors across a larger sample size of case study dwellings.
2. Identify the key drivers which should be considered when deciding on the approach to fuel cost comparison employed in DEAP.
3. Perform analysis of the effective PV electricity price based on smart meter based tools available to consumers in the marketplace (pending CRU smart meter based comparison engines).

ACKNOWLEDGMENTS

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LIST OF ABBREVIATIONS

Abbreviations	
BER	Building Energy Rating, the Energy Performance Certificate for Irish dwellings
BRE	Building Research Establishment
CRU	Commission for Regulation of Utilities
DEAP	Dwelling Energy Assessment Procedure – the software used to produce energy ratings for Irish dwellings
DG1	The group of electricity customer classified as urban domestic customers by ESB networks
ESB	Electricity Supply Board
EV	Electric Vehicle
FiT	Feed in Tariffs, the amount of money paid by utilities to customers per kilowatt hour of PV electricity exported to the grid
HP	Heat Pump
kWh	Kilo Watt Hour
n	The number of items in the sample size
PV	Photo Voltaic I.e. the electricity produced from solar energy
SAP	Standardised Assessment Procedure – the software used to produce energy ratings for UK dwellings
SEAI	Sustainable Energy Authority of Ireland
β factor	Beta - the ratio of the PV electricity consumed in the dwelling to the total PV electricity produced

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