Department of Energy & Climate Change

Annex B: Electricity use in households with solar PV

25th June 2015

URN 15D/148

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Contents

Introduction

This annex details an innovative research project that DECC conducted for the first time this year as part of the main analysis of NEED data. It forms part of the research effort to investigate the impact of renewable microgeneration technologies on households' metered energy use. To this end, a subset of the main NEED sample was selected, consisting of households that installed solar photovoltaic (PV) panels in 2012 ('microgenerator households'). The metered electricity use of this group in the full calendar years before and after the installation (i.e. in 2011 and in 2013) was compared to that of another subset of the main NEED sample: a group of households matched closely to the microgenerator sample on a number of geographical and property attributes but, importantly, without microgeneration installations. Comparison with such a matched group was necessary because microgenerator households tend to have higher-than-average electricity consumption. In 2011, for example, the average (mean) consumption figure was 5,200 kWh, compared to the 4,000 kWh average for England and Wales. This analysis was conducted in the same way as the 'impact of measures' analyses described elsewhere in this publication, with the important difference that it investigated households' electricity consumption, rather than their gas consumption. The results show that households' use of mains electricity fell substantially (by 900 kWh, or 15 per cent) as result of installing solar PV panels.

The Feed-in Tariff scheme

DECC introduced the Feed-in Tariff (FIT) scheme in April 2010 to promote the deployment of a range of small-scale low-carbon electricity generation technologies in Great Britain. The FIT scheme subsidises solar PV, hydro, wind, anaerobic digestion installations below 5 MW, and micro combined heat and power below 2 kW. Microgenerators receive guaranteed payments from electricity suppliers based on the amount of electricity produced, along with export tariffs for electricity not used on-site but fed ('exported') to the grid. Unless the microgenerator installs a second electricity meter specifically for exports, 50 per cent of the electricity generated is deemed to be used on-site, and the other 50 per cent, exported to the grid, and export payments are made accordingly. For more information, visit www.ofgem.gov.uk/environmental-programmes/feed-tariff-fit-scheme.

After the launch of the scheme, the number of installations increased rapidly. As of 31st March 2015, there were 599,200 installations with a total capacity of just over 3.3 GW on the Central Feed-in Tariff Register (CFR). The overwhelming majority (96 per cent) of these installations were domestic, although the aggregate capacity of this group (2 GW) only makes up 60 per cent of the whole because they tend to be small. Information on households that registered for the FIT scheme and installed solar PV panels to generate electricity has now been combined with NEED. The analysis of their energy consumption habits will allow DECC to gain a better understanding of how the FIT scheme is performing against its objectives of increasing public engagement with the transition to a low-carbon economy and fostering behaviour change through bringing renewable electricity generation into communities around the country.

Sample selection

In 2012, 143,400 households installed solar PV panels, successfully applied for feed-in tariffs, and were entered onto the CFR. An AddressBase Unique Property Reference Number (UPRN) could be assigned to 140,670 properties (98 per cent). Of these, 21,930 (16 per cent) had been selected for the NEED sample, and for these, detailed property information was available. Excluding flats (140 or 0.7 per cent), properties for which no valid electricity meter readings were available for any of the years between 2011 and 2013, and properties where electricity consumption between 2011 and 2013 fell by more than 80 per cent or increased by more than 50 per cent (as per the impact of measures methodology), left a pool of 13,250 records.

Table B.1 – Selection criteria for properties in the intervention group

Domestic solar PV installation registered for FITs in 2012	- Record of a domestic-scale (<4 kW) solar PV installation on the CFR - Installation commissioned in 2012.
Valid electricity use figures available	- Property included in the NEED sample; - Electricity use in each year between 2011 and 2013 no less than 100 kWh and no more than 25,000 kWh; - Change in electricity/gas use from 2011 to 2013 no less than -80 per cent and no more than +50 per cent; - Actual electricity/gas meter reading available in each year between 2011 and 2013 (i.e. estimated readings are excluded).
No energy efficiency measures or non-PV microgeneration	- Property has no record of energy efficiency measures (e.g. cavity wall insulation) or other microgeneration technologies (e.g. wind turbine).

In order to be able to investigate the unique contribution of solar PV to changes in energy use, households that installed energy efficiency measures such as cavity wall insulation, solid wall insulation, or double-glazing in or before 2013 were excluded. This is in line with the methodology for the impact of energy efficiency measures analyses. The number of properties with each type of major energy efficiency measure installed is summarised in Table B.2. The most popular energy efficiency measures in this group are cavity wall insulation (5,670 properties) and loft insulation (5,330 properties). The percentages add up to more than 100 because there is overlap between the categories: some properties have more than one energy efficiency measure. For example, 1,140 (nine per cent) of the microgenerator households also have both cavity wall insulation and loft insulation.

Table B.2 – Energy efficiency measures installed in microgenerator households

Energy efficiency measure	Number of installations	Of all properties in NEED with solar PV
Cavity wall insulation	5,670	42.8 %
Loft insulation	5,330	40.2 %
Boiler	4,910	37.1 %
Double-glazing	3,660	27.6 %
Solid wall insulation	250	1.8 %
Draughtproofing	220	1.7 %
FIT installation (other than solar PV)	0	0.0 %

After the exclusion of these records, the final sample was created of the 1,900 properties that had solar PV installed and registered for FITs in 2012, but have no other energy efficiency measures installed to date. This constituted the 'intervention group' in the subsequent analysis.

Matched comparison group

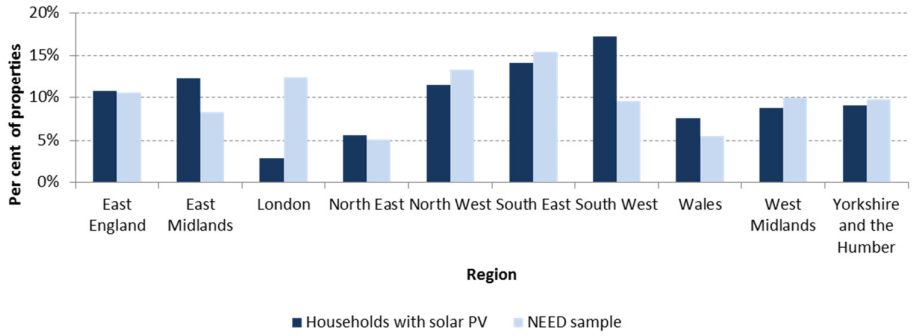
The property characteristics of the sample of FIT households are not representative of the dwelling stock, so a matched comparison group was drawn up from the NEED sample. A stratified random sample of households was created from the NEED sample, which matched the distribution of the FIT sample on the combination of five variables: Government Office Region, year of construction (grouped), property type, number of bedrooms, and electricity consumption band in 2011 (i.e. baseline electricity use). These property characteristics are the same as in the impact of measures analysis, with the exception that electricity usage, rather than gas usage is used for the matching.

Property characteristics of households with solar PV

The sample of microgenerator households is not representative of the dwelling stock in England and Wales. Comparison with the entire NEED sample revealed that, in general, properties with solar PV installations tend to be large, built in the mid-20th century, and have four external walls. In addition, their geographical distribution is uneven, with the South West having the highest proportion of microgenerator households, while London is much underrepresented.

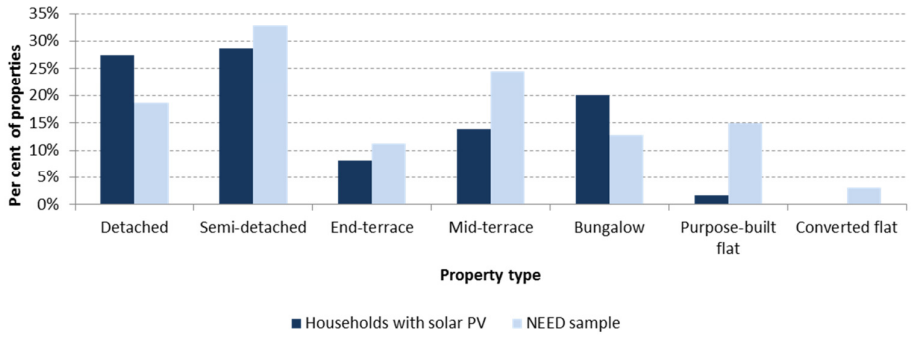
Chart B.1 shows that FIT households are most overrepresented in the South West (10 per cent of all dwellings, but 17 per cent of microgenerator households) and in the East Midlands (eight per cent of all dwellings, but 12 per cent of microgenerator households), but they are underrepresented in the other regions, most notably in London (12 per cent of all dwellings, but only three per cent of households with solar PV). This is probably due to the high proportion of flats and rented properties in the capital.

Chart B.1. – Geographical distribution of FIT households compared to the housing stock



Nearly half of FIT households have four external walls: 28 per cent are detached houses, and 20 per cent are bungalows (see Chart B.2.), although these two categories make up only 19 per cent and 13 per cent of the dwelling stock, respectively. On the other hand, while a quarter (25 per cent) of the dwelling stock is made up of mid-terrace properties, they make up only 14 per cent of microgenerator households. Flats are excluded from this analysis, but virtually none of them have solar PV installations (two per cent), even though they make up 18 per cent of all dwellings.

Chart B.2. Relative frequency of property types among FIT households and in the NEED sample



The majority (60 per cent) of domestic solar PV panels are installed on properties built between 1945 and 1982, which make up 42 per cent of all dwellings (see Chart B.3). In order to receive FITs at the higher rate, a household must have an Energy Performance Certificate[1] (EPC) rating of at least D. This might partly explain why FIT households are underrepresented among very old buildings (21 per cent of properties built before 1944, which comprise 38 per cent of the dwelling stock). Very young properties (built after 1999) are also under-represented, but because of changing building regulations that require newly built properties to have renewable electricity generation installed, the proportion of very new properties with solar PV is likely to increase in the future.

Chart B.3. – Distribution of building age among FIT households compared to the housing stock

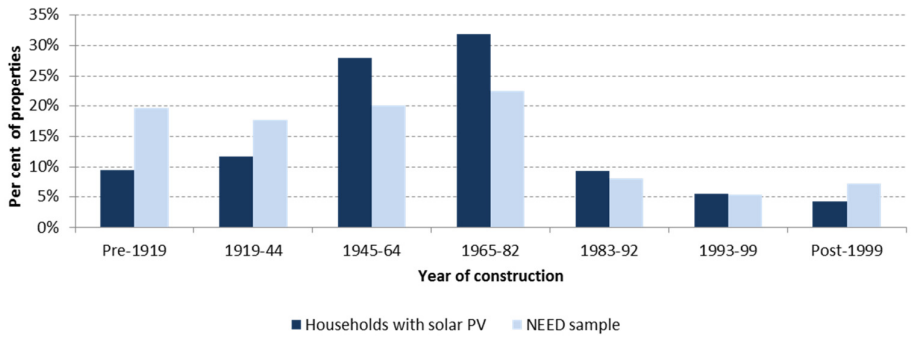
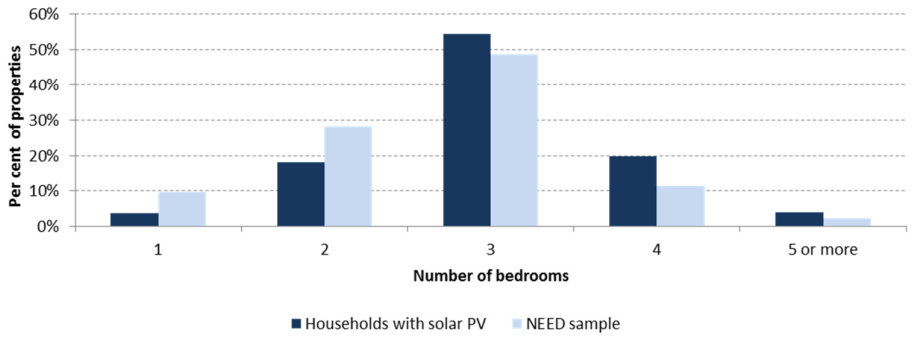


Chart B.4 shows that one-bedroom properties are unlikely to have solar PV installations: they comprise only four per cent of the microgenerator sample despite making up 10 per cent of the dwelling stock. Two-bedroom properties are also underrepresented: 18 per cent of homes with solar PV, 28 per cent of all dwellings. Larger buildings (i.e. with three or more bedrooms) are overrepresented in the microgenerator sample, especially those with four or more bedrooms, which make up 13 per cent of the dwelling stock but nearly a quarter (24 per cent) of households with solar PV. This finding is consistent with the fact that flats (which are more likely to have one or two bedrooms than the other property types) are much underrepresented among microgenerator households.

[1] More information on EPCs is available at the Department for Communities and Local Government's website at https://www.epcregister.com/.

Chart B.4. – Distribution of number of bedrooms among FIT households compared to the housing stock



Overall, these results reveal that households with solar PV are typically large, detached properties, built between 30 and 70 years ago. Properties of this description tend to have higher energy consumption, and also a larger roof area, which might make the installation of solar PV economically more viable. In addition, microgenerator households are most common in the South of England and in the Midlands, where weather conditions are the most suitable for exploiting solar power.

Metered electricity use in microgenerator households

Throughout this analysis, reference is made to the metered electricity use of the households. This means electricity consumed from the grid, and does not include the electricity generated by the solar panels that is used on-site. The distinction is important because drops in metered electricity use cannot unambiguously be attributed to lower energy consumption, but will be the result, at least in part, of using electricity supplied by the solar panels, rather than from the mains.

In addition, this analysis does not cover gas consumption because this is not expected to be significantly affected in microgenerator households. Solar PV panels can be used to heat water, and thus complement natural gas, but DECC does not hold information on the prevalence of this practice because the focus of the FIT scheme is electricity generation.

Table B.3 shows the annual electricity usage figures of the microgenerator and comparison groups, before and after solar PV was installed in the former group, i.e. in 2011 and in 2013.

Table B.3 – Annual electricity usage (unweighted) in the years before and after installing solar PV in the microgenerator group

		Annual electricity consumption (kWh)	
		2011	2013
Households with solar PV	Mean	5,200	4,300
	Median	4,300	3,500
Comparison group	Mean	5,200	4,700
	Median	4,300	3,900
All properties (England and Wales)	Mean	4,200	4,000
	Median	3,400	3,300

In 2011, the national average (mean) of a household's electricity consumption was 4,200 kWh (median: 3,400 kWh). In the same period, FIT households used, on average, 5,200 kWh (median: 4,300 kWh), similar to those in the matched comparison group (mean: 5,200 kWh, median: 4,300 kWh). In other words, FIT households used nearly 24 per cent more electricity than the national average. This is to be expected because, as detailed above, FIT households tend to be large, with four external walls, leading to a generally higher consumption profile.

Table B.4 shows the observed average (mean) and typical (median) weighted electricity savings in the microgenerator sample and in the comparison group. While electricity use decreased in both groups, there was a significant difference in scale. From 2011 to 2013, the comparison group used, on average, 500 kWh or six per cent less electricity; this figure was 900 kWh (15 per cent) in households with solar PV.

The figures in Table B.4 are weighted in order to mitigate the impact of a biased housing stock in the intervention group. During the weighting process, the intervention and comparison groups are broken down along all possible combinations of five weighting variables: region, property age, property type, number of bedrooms, and baseline electricity consumption. Savings are then calculated separately for each group, e.g. for three-bedroom detached houses in the South East, built between 1919 and 1944, which used between 2,500 kWh and 5,000 kWh of electricity in 2011. These saving figures are then aggregated by multiplying each with the inverse of the proportion of the number of records in that particular group to the whole sample. In this way, a weighted average is calculated, providing an estimate of what the energy saving would be if the intervention group were, in fact, representative of the composition of the entire dwelling stock[2].

Table B.4 – Summary of observed electricity savings (weighted) in households with solar PV and in the comparison group

		Percentage saving	Saving (kWh)
Households with solar PV	Mean	-15.0 %	-900
	Median	-16.0 %	-600
Comparison group	Mean	-6.0 %	-500
	Median	-5.0 %	-200

[2] Further details of the weighting procedure are available in the NEED methodology note at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/359351/domestic_need_methodology.pdf.

Summary and next steps

The results of this analysis show that use of mains electricity dropped considerably in households that installed solar PV panels. This is probably the result of a combination of factors. On the one hand, households are using the electricity generated by the solar panels, meaning they have lower demand for metered electricity from the mains. On the other hand, becoming a microgenerator of electricity may bring with it increased energy awareness and a change in consumption behaviours. There is some evidence that both of these factors play an important part.

For example, earlier work by DECC found that microgenerator households were much more likely to have energy efficiency measures (such as wall insulation or double-glazing) installed, suggesting an increased level of energy awareness[3]. DECC plans to develop this analysis further to gain a better understanding of the interaction between installing microgeneration technologies and energy efficiency measures. The high prevalence of energy efficiency measures in microgenerator households was evident in this analysis, as well: a large proportion (86 per cent) of all households with solar PV installations also had energy efficiency measures, most frequently cavity wall and loft insulation.

Another strand of research effort will focus on obtaining on-site usage figures from microgenerators, which would allow DECC to refine the analysis described here. At the moment, the overwhelming majority of households receive deemed export payments, i.e. a flat rate calculated on the basis of the assumption that 50 per cent of the electricity generated is used on-site. This is because for small-scale installations, which domestic technologies typically are, it is not financially viable to install an export meter. This means, however, that DECC does not have accurate figures for the amount of electricity generated that is used on-site. As a result, it is currently impossible to calculate the total electricity use of a microgenerator household, so our understanding of the impact of solar PV installation on consumer behaviour in terms of energy use and energy efficiency is imperfect.

DECC will explore the possibility of including solar PV installations registered for Feed-in Tariffs in the 'impact of measures' analysis presented in the annual domestic NEED publication in future years.

DECC welcomes feedback on the procedure and results of this analysis, and readers are invited to contribute their suggestions on how to develop this research project further, in addition to the planned work outlined above. DECC is also keen to learn about related investigations and research into the impact of microgeneration on energy-related consumer behaviours and attitudes.

[3] The results of this analysis are available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/404641/energy_usage_in_households_with_solar_pv.pdf.

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