DEPARTMENT OF ENERGY & CLIMATE CHANGE

# Identifying trends in the deployment of domestic solar PV under the Feed-in Tariff scheme

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## 1. Introduction

The Feed-in Tariffs (FiTs) scheme, launched in April 2010, seeks to incentivise the uptake and deployment of small scale renewable technologies. Individual tariff rates are assigned, depending on the technology, size, and eligibility of the installation, and paid to owners of FiT installations (or their nominated recipients) for every unit of electricity generated. A separate export tariff is paid for any electricity exported (or assumed exported) to the national grid, which is a flat rate across all technologies and sizes.

The scheme covers various technology types;

- Solar Photovoltaics (PV) up to 5MW of Total Installed Capacity.
- Anaerobic Digestion up to 5MW of Total Installed Capacity.
- Wind up to 5MW of Total Installed Capacity.
- Hydro up to 5MW of Total Installed Capacity.
- Micro CHP up to 2kW of Total Installed Capacity.

To date, no specific site location information has been release by the scheme's administrator Ofgem. Data is only currently available down to Lower Layer Super Output Area[1] (LSOA), which we have been able to match with data from the Neighbourhood statistics database (maintained by the Office for National Statistics) in order to carry out analysis on those who have partaken in the FiTs scheme. The aim of this analysis is to identify trends in FiTs uptake in order to determine the drivers that cause an individual to take up the scheme.

The data presented in this paper relates to installations confirmed onto the FiTs scheme (i.e. on the Central FiTs Register) between April 2010 and the end of 2011.

## 2. Summary of findings

The evidence from this analysis suggests that domestic PV installations are typically located in the more affluent, higher energy consuming households. This correlates with the additional findings that areas with a high proportion of detached housing, a low proportion of social housing and/or a low proportion of low value housing tend to have a higher amount of PV installations. The analysis also suggests that rural areas (and areas with low gas coverage, which are mostly rural) have a greater density[2] of domestic PV installations than urban areas. Social characteristics, such as age and education also have a part to play.

[1] This is a Census 2001 based geography – for more information, see the 'Data issues' section. LSOAs apply to England and Wales only. Scotland has a separate geographical system in which data zones are roughly equivalent to (though smaller than) LSOAs.
[2] I.e. number of PV installations per 10,000 households.

Areas where the average age is 40 or above have a greater density of PV installations than those with an average age below 40. Areas where educational deprivation is low tend to have higher numbers of PV installations. Of course, there will be some degree of correlation between some or all of these variables. The drivers for uptake of aggregator owned installations, however, differ from those of privately owned installations, with the former typically located in less affluent, lower consuming households. More details are available in Section 6.

## 3. Summary of statistical data used in the analysis

The variables presented in Table 1 have been identified as having the potential to influence FiT uptake and all are available to download at LSOA level from the Neighbourhood Statistics website: http://www.neighbourhood.statistics.gov.uk/dissemination

***Table 1 – Variables of interest***

| ***Variable*** | ***Source – including latest year and coverage*** |
|---|---|
| Average electricity consumption | DECC sub-national energy consumption statistics (2009[3], England and Wales) |
| Average gas consumption | DECC sub-national energy consumption statistics (2009[3], England and Wales) |
| Gas Coverage | Derived from DECC sub-national energy consumption statistics (2009[3], England and Wales) |
| Fuel Poverty – percentage of households in LSOA that are fuel poor | DECC (2009[3], England). |
| Average Age of population | Derived from Census 2001 data (England and Wales) |
| Index of Multiple Deprivation and its various domains | DCLG (2010, England) |
| Dwelling stock by tenure (%) | Derived from Census 2001 data (England and Wales) |
| Dwelling stock by type (%) | Derived from Census 2001 data (England and Wales) |
| Urban/Rural Classification | Derived from Census 2001 data (England and Wales) |
| Council Tax Band | DCLG, (2011, England) |

## 4. Data limitations

LSOAs are a Census 2001 based geography designed to be of consistent size and with fixed boundaries. The minimum population in an LSOA is 1,000 and the average population is 1,500 (or around 500 households). Since the LSOAs are designed to be of roughly equal size to one another, in this analysis we have assumed that the number of households in each are equal. However, this is unlikely to be the case, especially given that these geographies are based on data from 2001 and, in some cases, the number of households is likely to have changed considerably since then.

There are some FIT installations that cannot be matched to an LSOA - of the 147,869[4] FIT installations confirmed on the Central FITs Register (CFR) by the end of 2011,

[3] DECC have now published 2010 data for this series but these were unavailable at the time that this analysis was carried out.
[4] This number was correct at the time of the analysis, however as the Central FiTs Register is continually being updated, this number may have been subsequently revised.

approximately 1.5% (2,126 installations) were affected by this problem. As such, these installations were removed from the analysis.

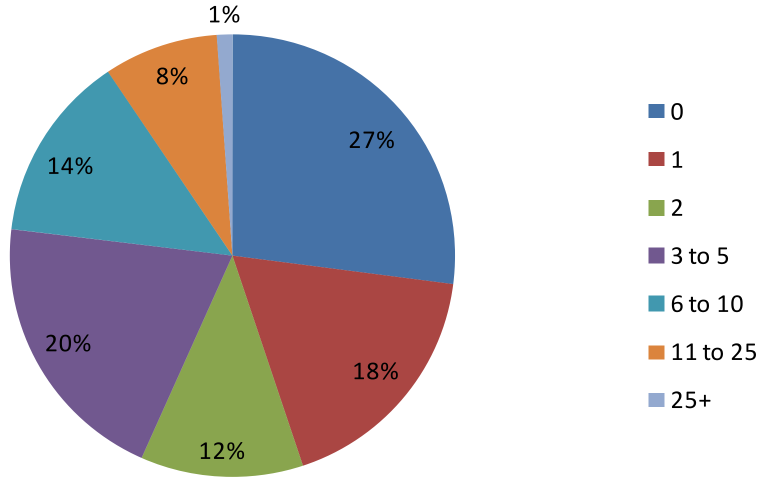
As shown in Table 2, the deployment of the Feed-in Tariff appears to be widespread with just under 70% of LSOAs in Great Britain having at least one installation (of any technology) present. However, only England has been included in the remaining analysis as the IMD variables (as described in Table 1 above) and some of the other variables are available for England only.

***Table 2 – Data on LSOAs and FIT installations in each nation in Great Britain as at end 2011***

| *Country* | *Total number of LSOAs* | *Number of LSOAs with at least one FiT installation present* | *Percentage of LSOAs with at least one FiT installation* | *Total FIT Installations* | *Number of Domestic PV installations* | *Domestic PV as % of total installations* |
|---|---|---|---|---|---|---|
| England | 32,483 | 23,700 | 73.0% | 126,671 | 122,664 | 97% |
| Wales | 1,896 | 1,556 | 82.1% | 9,473 | 9,079 | 96% |
| Scotland | 6,506 | 3,057 | 47.0% | 9,599 | 8,651 | 90% |
| **Total** | **40,885** | **28,313** | **69.3%** | **145,743** | **140,394** | **96%** |

Chart 1 shows the proportion of LSOAs that have a certain number of FiTs installations. For example, at the end of 2011, 73 per cent of LSOAs in England had at least one FiT installation (of any technology type).

***Chart 1 – LSOAs by number of FIT Installations at end of 2011, England***



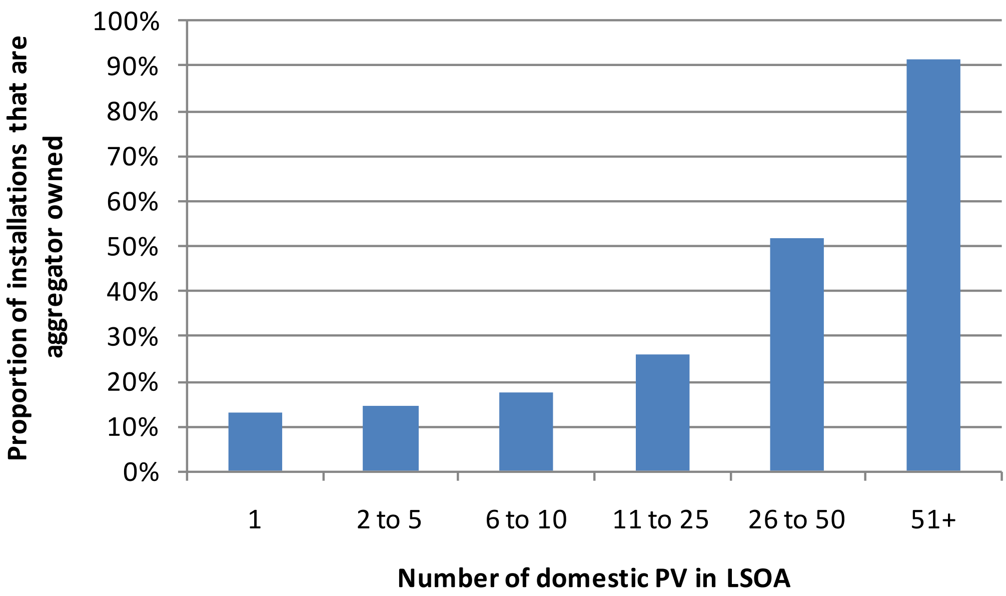

There may be different drivers for installations of different technology type and the size. For example, a commercial PV site of 5MW installed in Cornwall would have been installed for very different reasons from a 6kW wind turbine in the Scottish Highlands. Therefore, the remaining analysis will only focus on domestic PV installations (since these constitute over 95 per cent of installations in the Feed-in Tariff currently as seen in Table 2) in order to minimise any anomalies in the trends.

## 5. Impact of Aggregators

The impact of aggregators (or multi-site owners) within the domestic PV market must be taken into consideration since the drivers for uptake of these are likely to be different to those for privately owned installations. For this analysis we have defined an aggregator to be any single generator that owns 25 or more installations – this is in line with the recent changes to tariff rates for these owners which set the level at 25 or more.

Chart 2 shows that there is a clear trend between the number of PV installations in the LSOA and the proportion of those which are owned by an aggregator. For example, there are around 8,800 LSOAs with only 1 domestic PV installation, of these, only 13 per cent are owned by aggregators (across LSOA boundaries). This is compared to the 47 LSOAs which have over 50 PV installations each (amounting to just over 3,000 installations) where the proportion owned by aggregators is just over 90 per cent.

***Chart 2 – Percentage of domestic PV installations assumed to be owned by aggregators***




Overall, at the end of 2011 in England, 24 per cent of all domestic PV installations are assumed to be owned by aggregators.

Similarly to different technologies and capacity sizes, it is sensible to assume that the drivers behind an individual installing PV and paying the upfront costs are going to be different from an allowing a company to install PV on their roof for free. Therefore, throughout this analysis, we have attempted to cover private owners schemes and aggregator schemes separately where possible.

## 6. Analysis – <u>England Only</u>

*6.1 Energy Consumption*

DECC produce data on the average electricity and gas consumption in every LSOA in England and Wales on an annual basis. At the time of analysis, the most recent data available was for 2009. Using this data, the LSOAs were grouped into 10 equally sized groups (or decile groups) based on their average annual domestic electricity consumption. Group 1 are the 10% of LSOAs with the highest average electricity consumption (approx. 4,800 kWh per annum and above) and group 10 contain the 10% of LSOAs with the lowest average electricity consumption (approx. 3,100 kWh per annum and below).

Chart 3 shows the number of PV installations (at the end of 2011) for each of the 10 groups and indicates that the highest electricity consuming group of LSOAs (group 1) has the most domestic PV installations and group 10 the lowest amount, with declining amounts seen for the groups in between. This would seem to suggest that high electricity consuming households were more likely to install a PV installation than low electricity consuming households. This trend is repeated for those PV installations assumed to be privately owned but we see a different trend for those assumed to be owned by aggregators where groups 7 and 8 (i.e. lower electricity users) have the most installations.

***Chart 3 – Domestic PV Installations by average electricity consumption group***

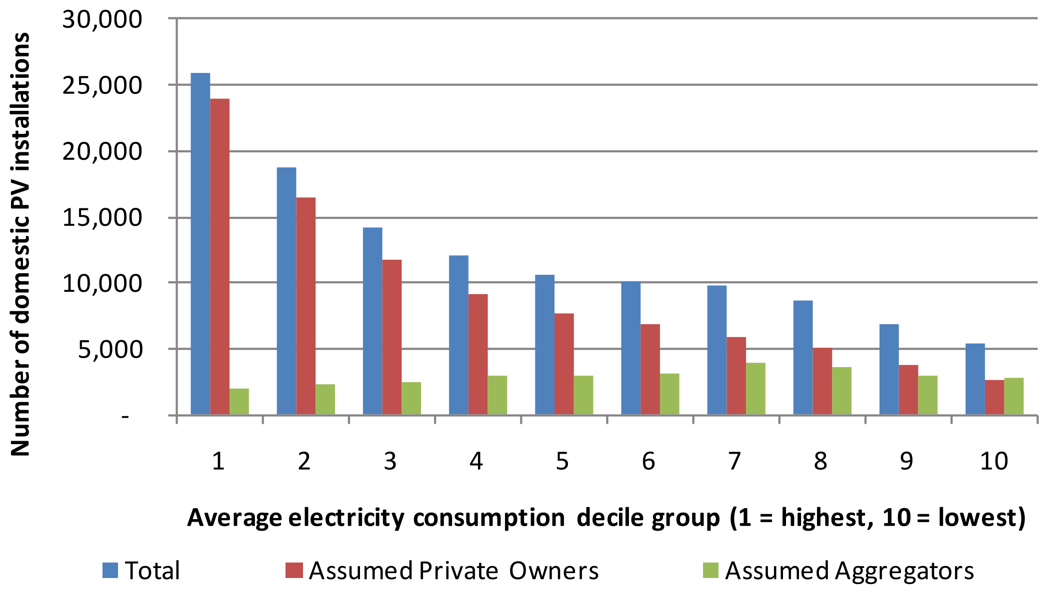
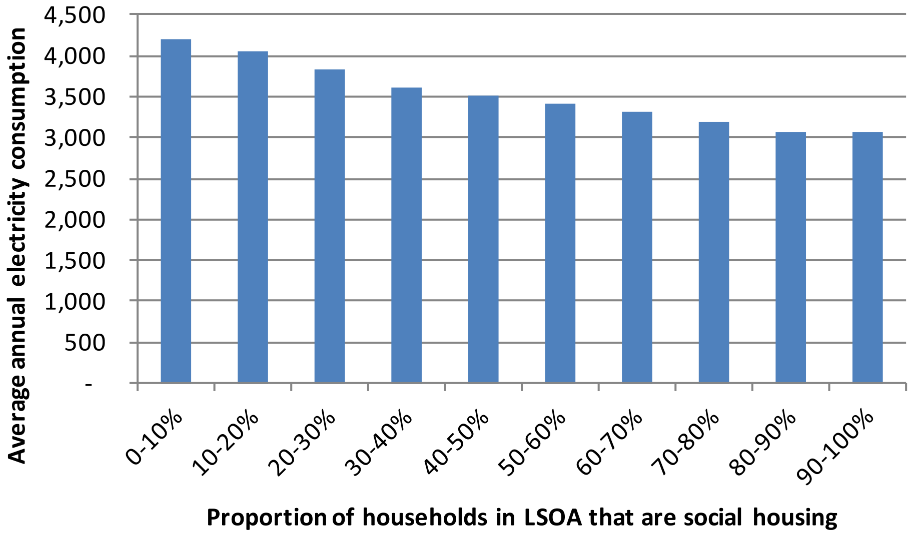



Chart 4 shows that those LSOAs with a high proportion of social housing have a lower average electricity consumption that those LSOAs with a low proportion of social housing. This may help to explain the trend for aggregator owned installations seen in Chart 3 where lower electricity consuming LSOAs tend to have higher amounts of aggregator owned PV installations (also see Section 6.6 on 'Tenure').

***Chart 4 – Average annual electricity consumption by proportion of social housing***




A similar methodology was also applied to the average annual domestic gas consumption statistics[5]. Group 1 are the 10% of LSOAs with the highest average gas consumption (approx. 20,000 kWh per annum and above) and group 10 are the 10% with the lowest average gas consumption (approx. 11,700 kWh per annum and below). Chart 5 shows similar trends to those seen for electricity consumption in Chart 3.

***Chart 5 – Domestic PV Installations by LSOAs average Gas Consumption***

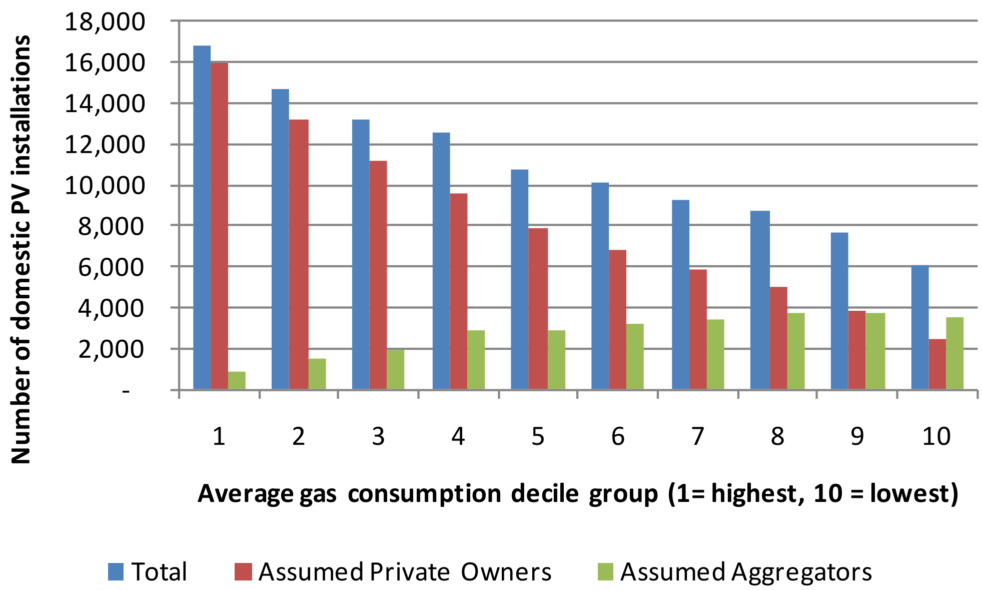
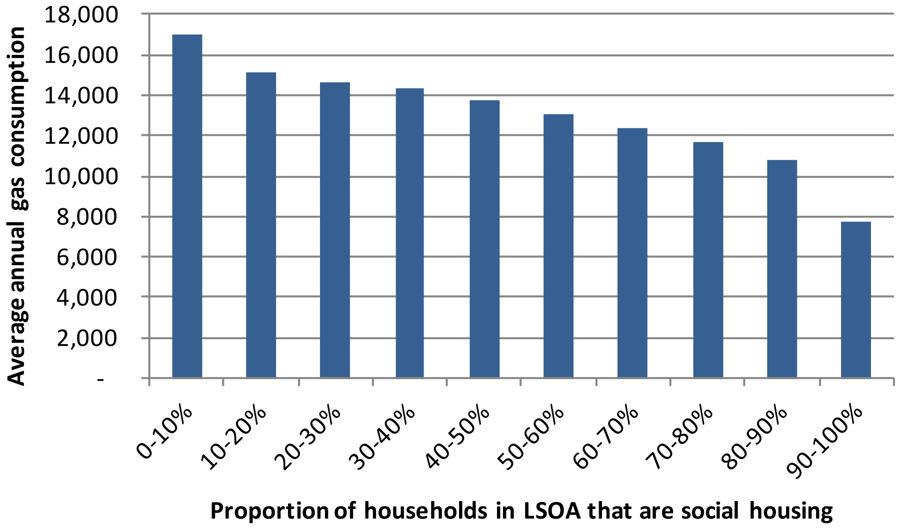



Chart 6 shows that those LSOAs with a high proportion of social housing have a lower average gas consumption than those LSOAs with a low proportion of social housing, which may help to explain the trends in Chart 5.

[5] Those LSOAs that are 100% off the gas grid were not included in the data used to produce Chart 5.

***Chart 6 – Average annual gas consumption by proportion of social housing***

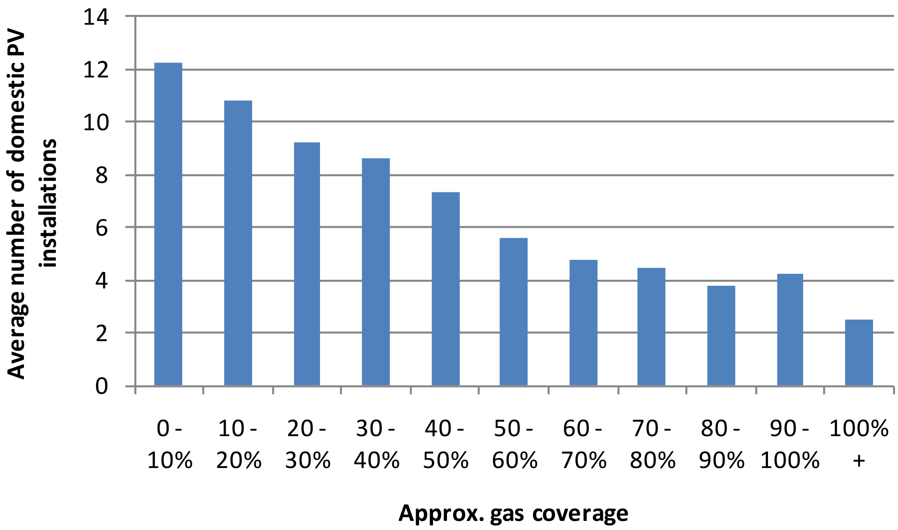



*6.2 Off gas grid areas*

It is possible that a lack of gas coverage could drive uptake of PV installations as this would ease the reliance on other more costly fuels and/or contribute to the electricity needed for heating. Unfortunately, there is currently no data available on gas coverage at the LSOA level. As such, it was necessary to approximate a 'gas coverage' measure for each LSOA. This was calculated by dividing the number of domestic gas meters by the number of households in each LSOA.

Chart 7 shows the average number of PV installations per LSOA by estimated gas coverage. The chart clearly shows a downward trend, i.e. those LSOAs with low gas coverage have the most PV installations per LSOA on average. Areas of low gas coverage include parts of Devon, Cornwall and the East of England.

***Chart 7 – Average number of domestic PV installations per LSOA by gas coverage***

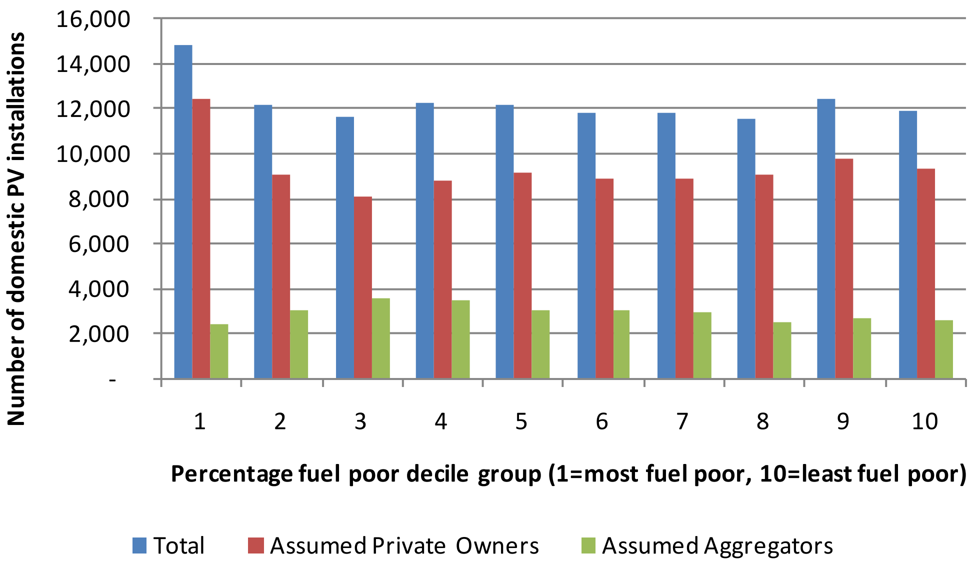


*6.3 Fuel Poverty*

DECC produce statistics on the proportion of households in an LSOA that are fuel poor. This data was used to split the LSOAs into 10 equal groups (deciles) such that group 1 contains the 10% most fuel poor LSOAs and group 10 contains the 10% least fuel poor LSOAs. Chart 8 suggests that overall take up of PV installations is relatively consistent across the groups with the exception of the most fuel poor group which seems to have had a higher take up. Fuel poverty could be a result of many different factors, this includes income poverty but also factors such as energy inefficient housing, high energy use and use of higher cost fuels for heating (e.g. this is often the case for off gas grid households). As such, it is difficult to assess the reasons for the higher take up in group 1 and so further investigation may be required.

The trend for privately owned PV installations is similar in that group 1 have the highest take up, however the trend for aggregator installations does not follow the same pattern with groups 3 and 4 having the highest take up.

***Chart 8 – Number of domestic PV installations by fuel poverty decile group***

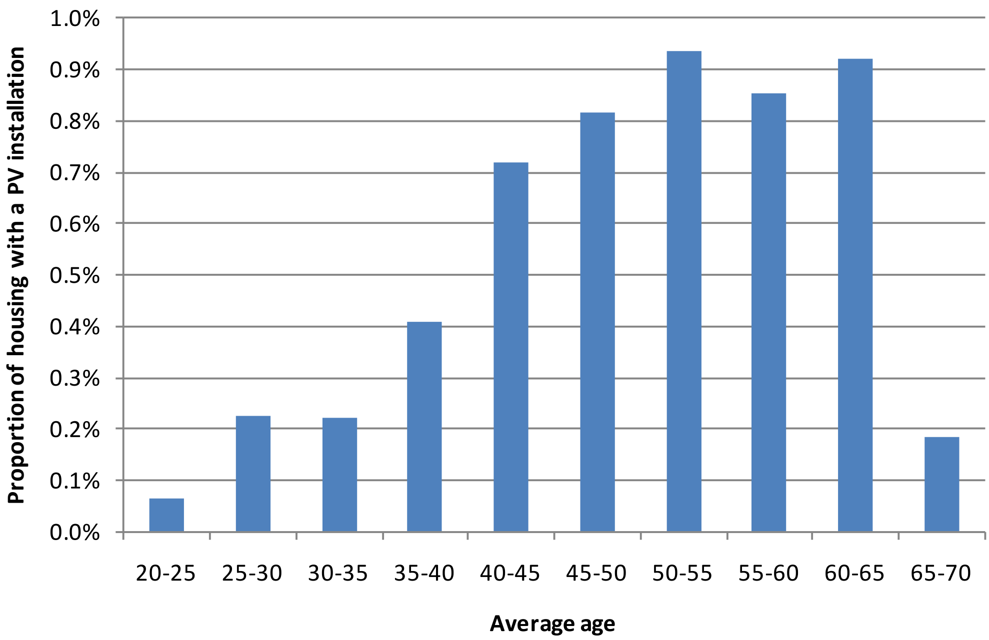



*6.4 Average Age of population*

The average age of the population was calculated for each LSOA using Census 2001 data[6]. Chart 9 shows the proportion of properties with a PV installation for each of the different average age groups. There is a clear trend that the greater the average age of the LSOA, the higher the proportion of households with a PV installation. The exception is the oldest average age group (65 – 70 , i.e. those more likely to be pensioners), where the proportion is substantially lower than the previous group (60 – 65).

[6] The data contains the number of people at every age (e.g. number of 1 year olds, 2 year olds, etc.) and so a simple weighted average was used to calculate the average age.

*Chart 9 – Proportion of housing with a PV installation by Average Age*




*6.5 Index of Multiple Deprivation*

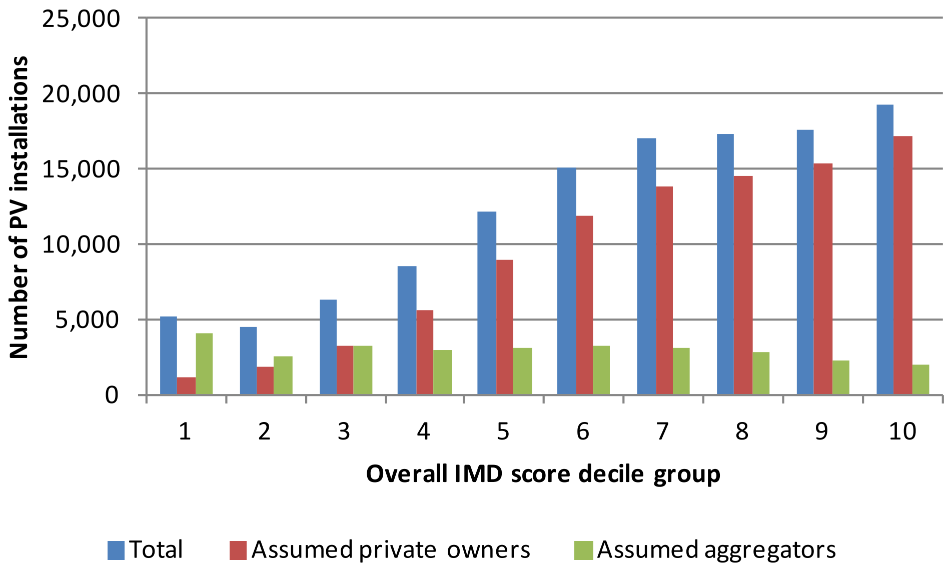
Published by the Department for Communities and Local Government (DCLG), the Index of Multiple Deprivation (IMD) is a Lower layer Super Output Area (LSOA) level measure of deprivation. It is made up of seven domain indices that reflect the broad range of deprivation that people can experience, including:

- income deprivation
- employment deprivation
- health deprivation and disability
- education, skills and training deprivation
- barriers to housing and services
- living environment deprivation, and
- crime

In all of the IMD measures, a score between 1 and 100 is given to each LSOA, where 1 represents the highest level of deprivation for that domain. For this analysis, the LSOAs were ranked according to their score and ten equal groups (decile groups) were created from these rankings such that LSOAs in group 1 were the most deprived for the particular domain and those in group 10 were the least deprived. The following charts are based on these groupings.

Chart 10 is based upon the overall IMD score (which is comprised of the domains listed above) and shows the total number of domestic PV installations in each decile group, the number of those assumed to be privately owned and the number assumed to be aggregator owned. Chart 10 clearly shows an increasing trend for overall installations and for privately owned installations, i.e. the less deprived the group of LSOAs (according to the IMD score), the more installations they have. However, the opposite appears to be true for aggregator owned installations, with more installations appearing in the most deprived groups than the least deprived groups.

***Chart 10 – Number of domestic PV Installations by IMD Score decile group***




The following charts look in more detail at some of the domains of the IMD in order to establish the drivers of the trends seen in Chart 10.

Chart 11 shows the number of domestic PV installations by decile group for the income deprivation domain, which is essentially based on the proportion of people in families who receive a form of income support[7]. The trend seen in this chart is very similar to the overall IMD score, i.e. the least deprived LSOAs have more domestic PV installations than the most deprived LSOAs, with the exception of the aggregator owned installations where the opposite appears to be true.

[7] These include Job Seeker's Allowance, Income Support, Pension Credit, etc.

***Chart 11 – Number of domestic PV Installations by Income Score decile group***

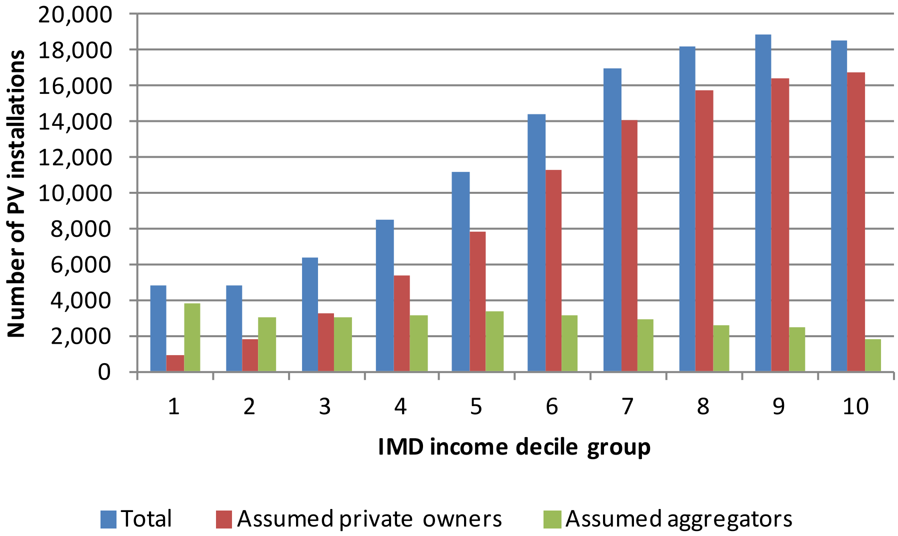
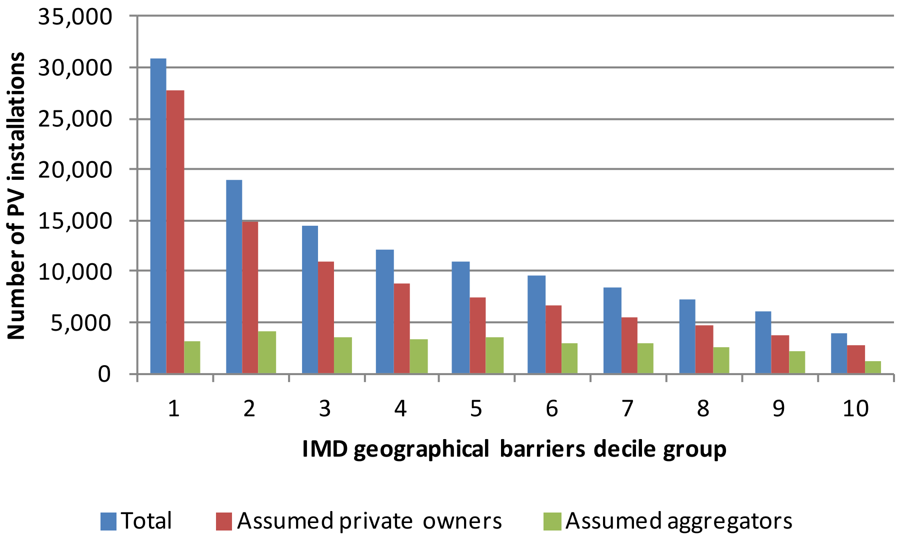


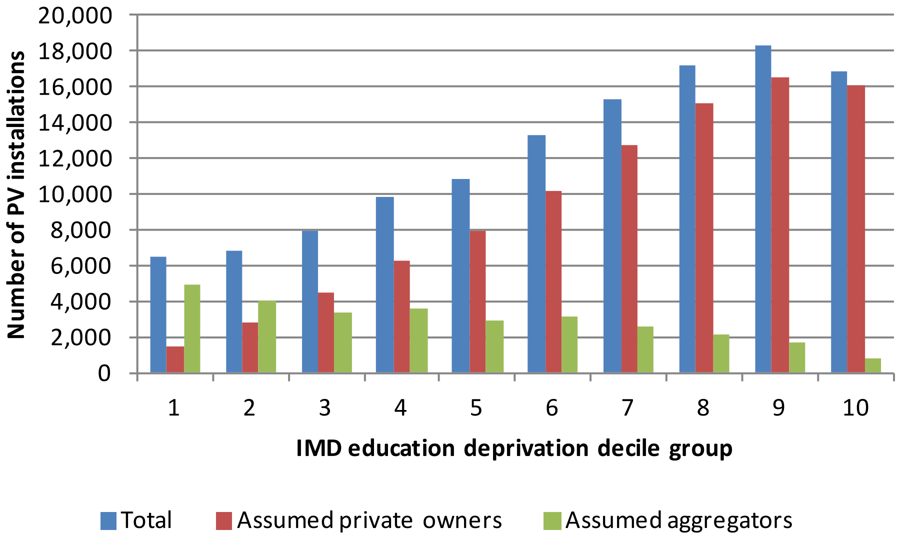

Chart 12 is based on the Geographical Barriers sub-domain of the 'Barriers to Housing and Services' domain. The Geographical Barriers sub-domain is essentially a measure of rurality as the score is calculated based on the road distances to the nearest GP surgery, food shop, primary school and post office. In this context, group 1 can be thought of as the 10% most rural LSOAs and group 10 as the 10% least rural LSOAs. The chart shows that, for installations overall, the more rural the group, the more PV installations there are (this is likely to be correlated with off gas grid areas). The same pattern is seen in the privately owned installations but the trend is less clear for the aggregator owned installations.

***Chart 12 – Number of domestic PV installations by Geographical Barriers decile group***



Another domain of the IMD is the Education, Skills and Training domain which measures the attainment of qualifications by children and young people and the lack of qualifications in the resident working age adult population. Chart 13 shows that those LSOAs where education deprivation is the highest (i.e. group 1), have the lowest number of overall PV installations. The number of installations increases as the deprivation lessens, with the exception of group 10. For the aggregator owned installations, the opposite trend is seen, i.e. those with the highest deprivation have the highest number of installations.

***Chart 13 – Number of domestic PV installations by Education deprivation decile group***



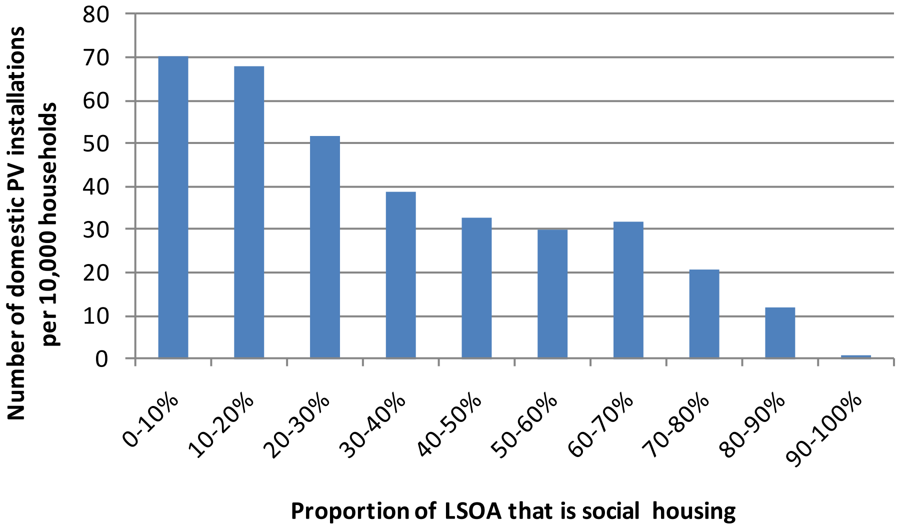

The charts relating to the other domains of the IMD are presented in Annex A.

### *6.6 Tenure*

Chart 14 shows the number of domestic PV installations per 10,000 households[8] in LSOAs grouped according to their proportion of social housing. Those LSOAs with a low proportion of social housing (i.e. those in the 0-10% group) have the highest number of installations per 10,000 households and a downward trend is evident such that those LSOAs with a high proportion of social housing have the lowest number of installations per 10,000 households.

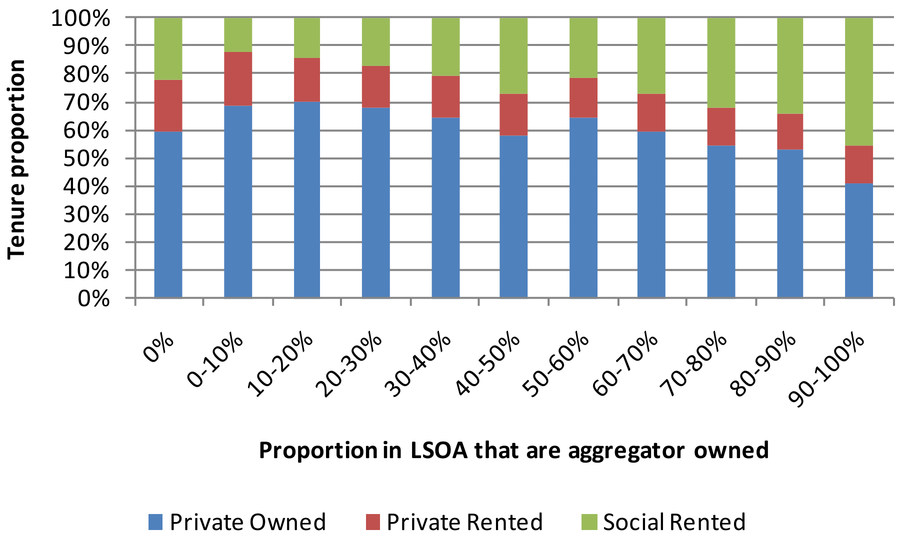
[8] As the groups of LSOAs presented in this chart are not equal in size, we have to use the number of installations per 10,000 households (rather than the total number of installations) in order to ensure the different groups can be compared fairly.

***Chart 14 – Number of domestic PV installations per 10,000 households by social housing coverage***




However, as demonstrated in the previous sections, the trends for aggregator owned installations and those for privately owned installations often differ. Less deprived LSOAs tend to have the most privately owned PV installations while the more deprived LSOAs tend to have the most aggregator owned PV installations. For each LSOA with at least one domestic PV installation, the proportion of the installations that are aggregator owned was calculated. The LSOAs were then grouped according to this proportion and Chart 15 shows the tenure composition for each group. The chart shows that those LSOAs where the vast majority of PV installations (70% or more) are aggregator owned tend to have a higher proportion of social housing than those where the majority of installations are privately owned.

***Chart 15 – Tenure composition by proportion of aggregator owned installations***



*6.7 Dwelling type*

Chart 16 shows the number of domestic PV installations per 10,000 households in LSOAs grouped according to the proportion of detached houses. The trend shows that those LSOAs with a high proportion of detached houses have a higher number of installations per 10,000 households than those LSOAs with a low proportion of detached houses. However, it is interesting to note that the proportion levels off for LSOAs with more than 60% detached houses.

***Chart 16 – Number of domestic PV installations per 10,000 households by detached house coverage***

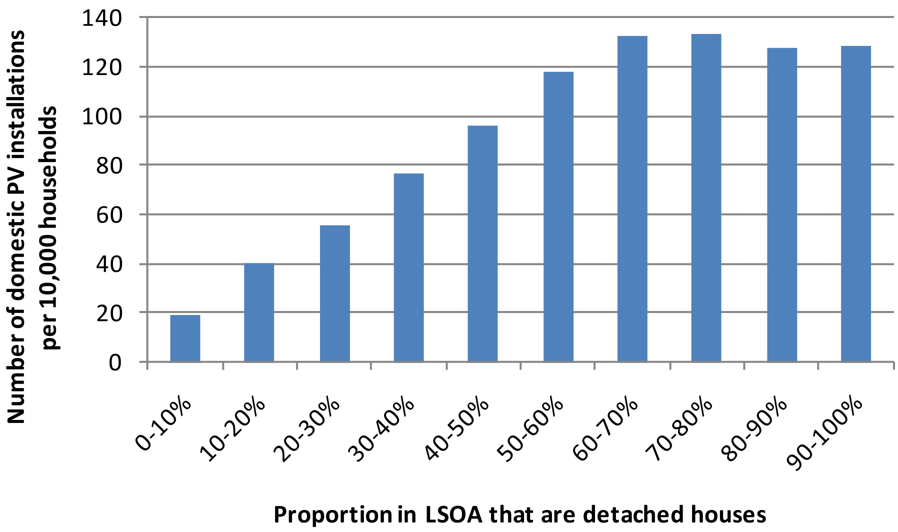
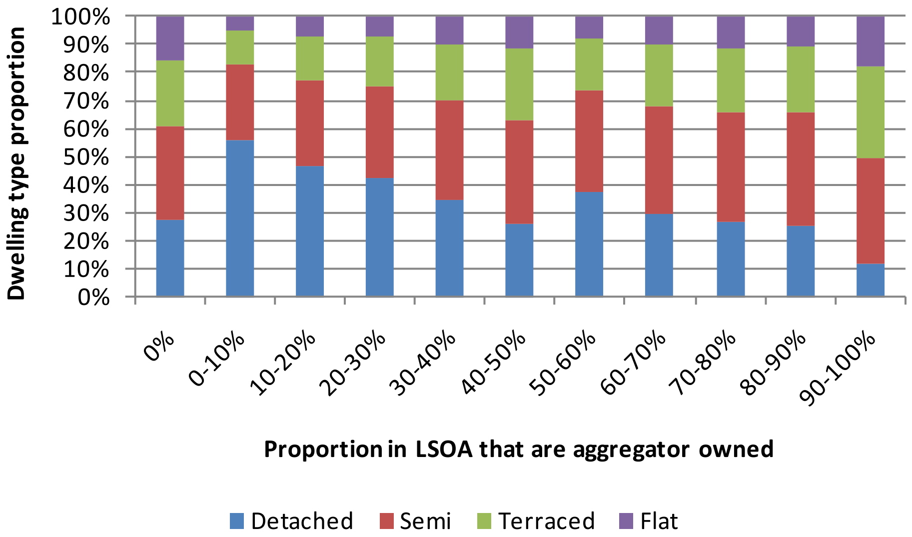



Chart 17 shows the dwelling type composition of those LSOAs grouped according to the proportion of installations that are aggregator owned (i.e. similar to Chart 15). The chart shows that those LSOAs where the proportion of aggregated owned installations is high tend to have a low proportion of detached housing.

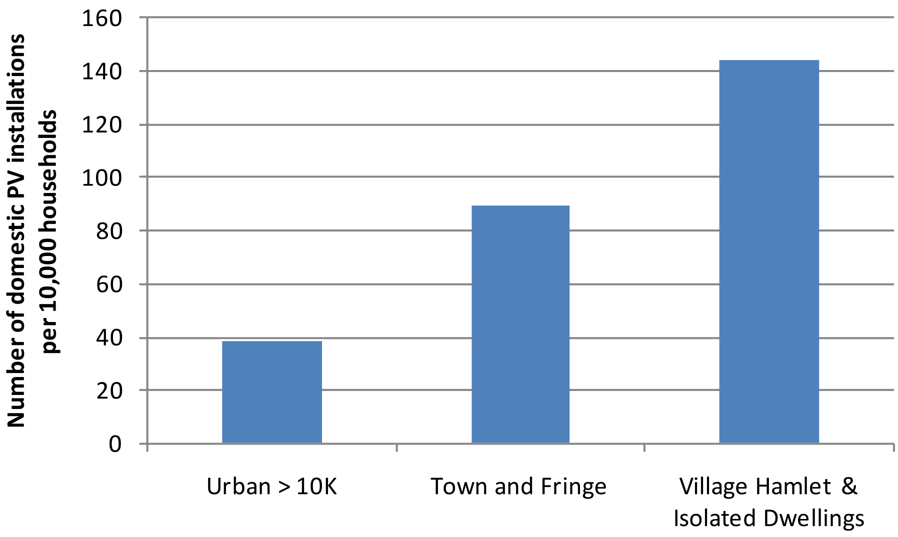
***Chart 17 – Dwelling type composition by proportion of aggregator owned installations***



*6.8 Urban/Rural Classification*

Chart 18 shows the number of domestic PV installations per 10,000 households for LSOAs grouped into three settlement types (as defined by the ONS). The LSOAs in the 'Village, Hamlet & Isolated Dwellings' group have more installations per 10,000 households than those in the urban group. This supports the findings seen in Chart 12 (i.e. the IMD geographical barriers sub-domain) and Chart 7 (i.e. the gas coverage as households off the gas grid are often located in rural areas).

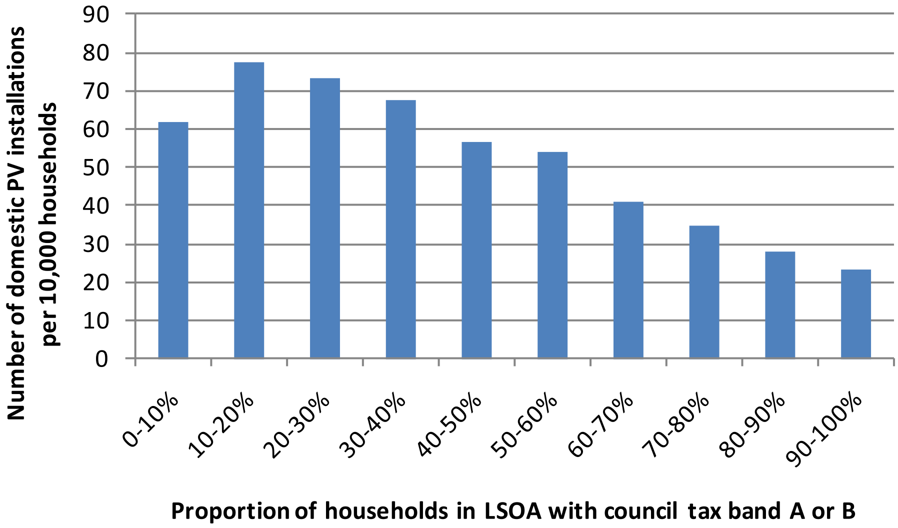
***Chart 18 – Number of domestic PV installations per 10,000 households by settlement type***




*6.9 Council Tax Band*

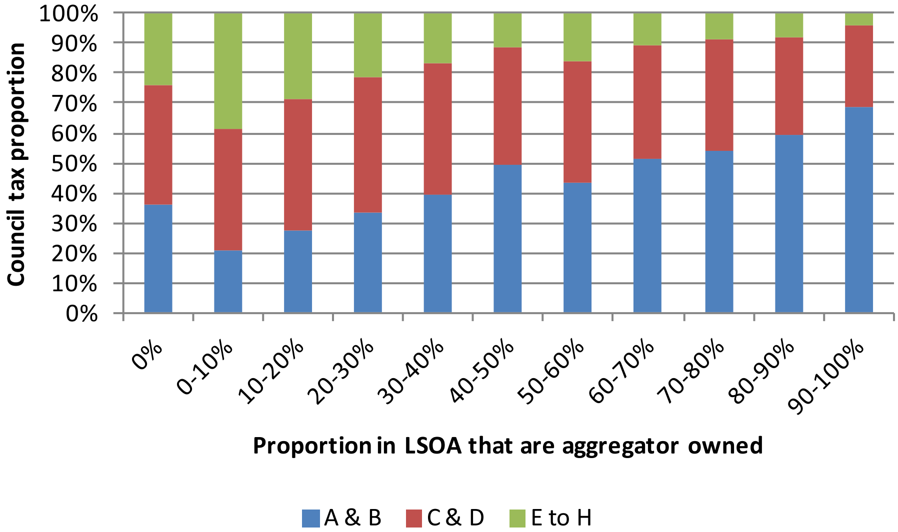
Chart 19 shows the number of domestic PV installations per 10,000 households in LSOAs grouped according to their proportion of council tax band A and B properties (i.e. the lower value homes). The general trend shows that those LSOAs with a high proportion of A and B band properties have a lower number of installations per 10,000 households than those LSOAs with a low proportion of band A and B properties.

***Chart 19 – Number of domestic PV installations per 10,000 households by council tax band A and B coverage***




Again, it is interesting to explore the difference between privately owned and aggregator owned installations. Chart 20 shows the council tax band make up of those LSOAs grouped according to the proportion of installations that are aggregator owned. Those LSOAs where the proportion of aggregator owned installations is high (70% or more) have the highest proportion of A and B band properties.

***Chart 20 – Council tax band composition by proportion of aggregator owned installations***



## 7. Conclusions

There appears to be several driving factors influencing the take up of domestic PV under the FiTs scheme. For example, level of energy consumption as those groups of LSOAs with higher average gas and electricity usage have higher amounts of PV installations. Socio-economic factors are also appear to be influential. The analysis on the average age of LSOAs has indicated that the higher the average age, the higher the proportion of households that have a PV installation (with the exception of the group of LSOAs with average age 65 or over). As shown from analysis on the income deprivation domain of the IMD, those groups of LSOAs which are less deprived have more privately owned, but less aggregator owned, domestic PV installations than the more deprived groups of LSOAs. This is also the case in terms of education deprivation. The trends are less clear for fuel poverty, however this is likely to be because fuel poverty can result from many different factors (as discussed in Section 6.3).

Location was also found to have an influence on PV take up as the number of domestic PV installations per 10,000 households was higher in rural LSOAs than in urban LSOAs. This was supported by analysis on the Geographical Barriers sub-domain of the IMD. Perhaps linked to this is gas coverage as off gas grid households are often located in rural areas[9]. The analysis showed that those LSOAs with low gas coverage had a higher average number of installations that those with high gas coverage.

The characteristics of the dwelling also appear to have an effect on the take up of PV. For example, there was higher number of PV per 10,000 households in the groups of LSOAs with low proportions of social housing. That said, those LSOAs where the majority of installations are aggregator owned had a higher proportion of social housing than those LSOAs where the majority were privately owned. In those groups of LSOAs with a high proportion of detached housing, there was a higher number of installations per 10,000 households than LSOAs with a low proportion of detached housing (with the opposite being true for aggregator owned installations). Complementing this, those LSOAs with a higher proportion of council tax band A and B properties, i.e. the lower value properties, generally had a lower number of installations per 10,000 households than those with a low proportion of band A & B properties. However, LSOAs with a high proportion of aggregator owned installations tend to have a higher proportion of properties in bands A and B.

Overall, there appears to be several factors contributing to household take up of solar PV under the FiTs scheme and that these drivers for those households installing privately owned solar panels compared to those taking advantage of the schemes offered by aggregators.

[9] Although many are also flats located in urban areas.

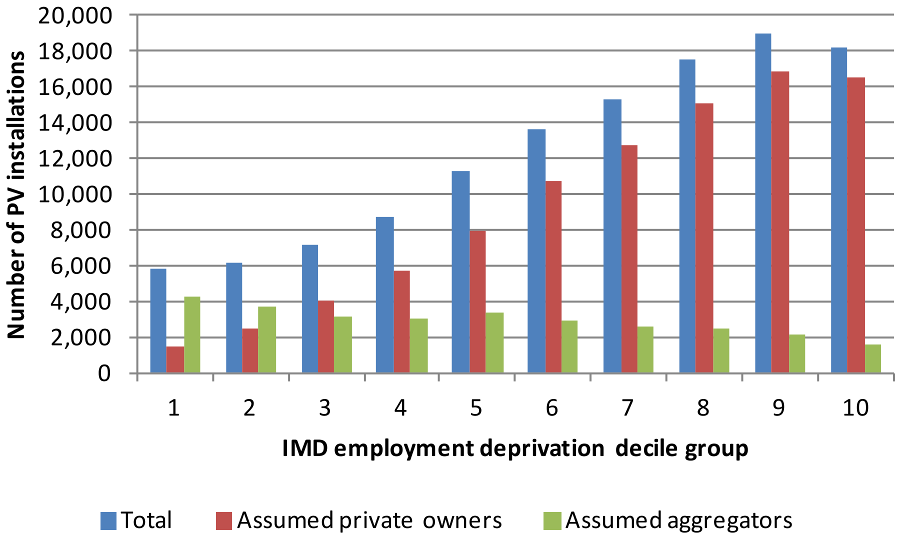
## 8. Next steps

All of this analysis has been carried out at the LSOA level which has provided some valuable insights into the drivers of domestic PV take up under the Feed-in Tariff scheme. However, more detailed and accurate analysis will be possible if we are able to match individual installation level information to the National Energy Efficiency Database (NEED). This will enable DECC to potentially address the question of how a FITs installation changes energy consumption from the grid, i.e. before vs. after. This analysis would also refine the work on whether high/low gas and electricity consumers were installing FITs technologies. NEED contains data from various sources at a household level and therefore will allow detailed profiling of FITs recipients. For example, it would also be possible to investigate whether FITs recipient households had energy efficiency measures before, or if they acquired any after, installation, as well as any changes in energy consumption. It would also be possible to profile early adopters separately from later adopters.

For more information on NEED see the DECC website at:
http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/en_effic_stats/need/need.aspx

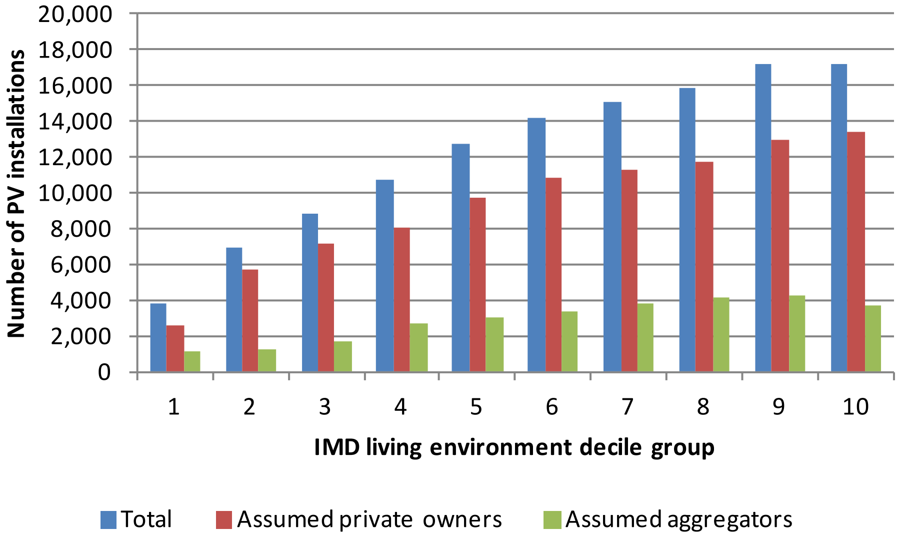
## Annex A

***Chart A1 – Number of domestic PV installations by Employment deprivation Score***



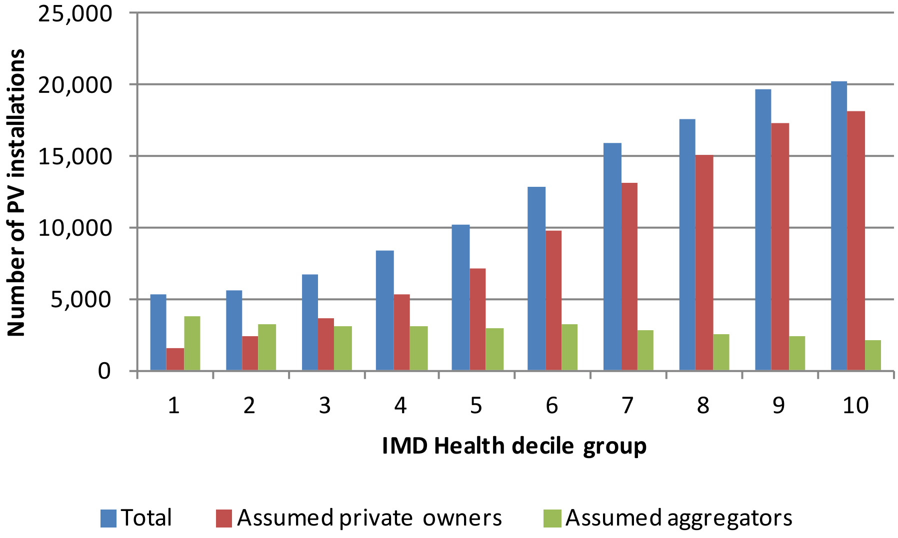

This domain measures employment deprivation conceptualised as involuntary exclusion of the working age population from the world of work. The employment deprived are defined as those who would like to work but are unable to do so through unemployment, sickness or disability. Worklessness is regarded as a deprivation in its own right and not simply a driver for low income.

***Chart A2 – Number of domestic PV installations by Living Environment Score decile group***




This domain measures the quality of individuals' immediate surroundings both within and outside the home. The score is made up of two sub-domains: the 'indoors' living environment, which measures the quality of housing, and the 'outdoors' living environment which contains measures relating to air quality and road traffic accidents.

*__Chart A3 – Number of domestic PV installations by Health deprivation decile group__*




This domain measures premature death and the impairment of quality of life by poor health (both physical and mental health). Ill health is an important aspect of deprivation that limits an individual's ability to participate fully in society.

URN 12D/247