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The British Feed-in Tariff for small renewable energy systems: Can it be made fairer?

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Executive summary

The British Feed-in Tariff (FiT) scheme, which launched in April 2010, pays £500 million each year to the owners of small scale renewable energy installations for the clean energy their installations produce. This paper looks at the fairness of the FiT scheme by examining how its costs and benefits have been distributed across rich and poor households during the scheme's first three years.

379,000 installations had been registered under the FiT scheme to March 2013. Matching the installations data to socioeconomic data from the 2011 census shows that a disproportionately small number of installations are located in relatively poor areas and a disproportionately large number of installations are located in relatively rich areas. The benefits of the scheme appear to be flowing more to rich households than to poor ones. A key reason for this is that there is no policy mechanism in place to support access to the scheme for poor households.

Even though richer households are benefiting more from the scheme and poorer households less, no provisions are in place to ensure that the cost of the scheme is spread fairly across households. The Government has relinquished responsibility for how the cost of the scheme is distributed to the electricity suppliers. The electricity suppliers are authorised to pass on the cost to consumers through higher electricity bills but the Government provides no guidance or oversight to ensure that the cost is spread fairly. So, while poor households are participating less in the scheme, they are likely bearing a similar financial burden to support the scheme as rich households.

Compared to similar microgeneration promotion schemes in Australia and California, the British scheme differs because it does not have a policy mechanism in place either to ensure that the cost of the scheme is spread fairly, or to counteract forces, such lack of access to financial capital, that tend to shut poor households out of scheme participation.

The analysis in this paper suggests that the poorer half of British households receive (at least) between £14.2 and £26.6 million less per year in FiT payments than they would if FiT-registered installations were distributed equally across income groups. This pattern in the distribution of FiT payments across income groups could persist for the life of the scheme – until 2033 and beyond – unless reforms are made.

The following changes to the scheme are recommended to address fairness issues in the way the scheme is targeted and paid for:

- Ofgem should establish whether the electricity suppliers are passing on the cost of the scheme to electricity customers as a fixed or variable charge and require electricity suppliers to state the cost of the scheme clearly on electricity customers' bills.
- Scheme cost information should be provided alongside information about the proportion of the bill attributable to wholesale electricity costs, transmission and distribution, and other environmental programs, so bill payers can see the *relative* contribution of the FiT scheme to their bill.
- Ofgem should review how the cost of the scheme is being spread across income groups, produce best practice cost-distribution methods, and enforce uptake of this best practice by the electricity suppliers where the electricity suppliers do not implement best practice voluntarily within 1 year.
- Ofgem should set a target for 10 per cent of FiT installations delivered until 2020 to be registered to relatively poor households, and publish progress towards this target annually in the FiT scheme Annual Report.
- To support the 10 per cent target, the Department of Energy and Climate Change should facilitate a public awareness campaign targeted at relatively low income households. This may be complemented by an incentive scheme to induce installer companies registered under the Micro-generation Certification Scheme to target low income households through the marketing methods they are already using.

- Multi-household dwellings like council estates present unique barriers to installation uptake. The Department of Energy and Climate Change and Ofgem should include some number of multi-family dwellings in the 10 per cent target. The Department of Energy and Climate Change and Ofgem should produce guidance on overcoming the installation issues faced by these dwellings and take further action as necessary to fulfil the installation target for these dwellings.

Outline

Tables and Figures

1. Aims of this paper

Under the Feed-in Tariff (FiT) scheme, at least £497 million is being paid each year to owners of small scale renewable energy installations in England, Scotland and Wales. The overall level of annual FiT payments made by electricity suppliers to all installation owners combined will increase in the years to 2020, as more installations are enrolled in the FiT scheme. In the three years from April 2010 to March 2013, 379,531 installations registered under the scheme. The aim of the scheme is to have 750,000 installations registered by 2020. This means that as many new additional installations are intended to be registered in the next seven years as were registered in the three years since the scheme began, in April 2010. This may, therefore, be a good point in time to review who benefits from the scheme and who pays for it.

The analysis in this policy paper looks at how the cost of the FiT scheme is being distributed across rich and poor households in Britain. It looks at whether poor households are benefitting from FiT payments to the same extent as rich households; whether poor and rich households are paying the same amount as a proportion of income to support the scheme; and what changes should be made to the scheme to safeguard against the unintentional transfer of hundreds of millions of pounds from poor to rich households and over the life of the scheme to 2020 and beyond.

This paper provides empirical analysis which supports previous studies suggesting that many poor households are being shut out of the financial benefits of the FiT scheme for the following reasons (Druckman and Jackson 2008; Feng et al., 2010; Metcalf, 2009):

- they are less likely to have access to the financial capital to purchase a renewable energy installation;
- they are more likely to live in rented accommodation that does not permit erecting or owning an installation;
- they are more likely to live in communal housing arrangements that introduce layers of legal and administrative complications to participating in the scheme;

- they may live in urban areas that are unfavourable to erecting installations; and/or
- they are more likely to lack quality information about the scheme itself (in part because they may be less likely to seek it out).

While many poor households are being excluded from the benefits of the scheme, the average poor household is also likely to be paying more for the scheme as a proportion of income than rich households. This is because poor households tend to spend a larger proportion of income on electricity, heating and transport fuel than rich households.

2. Aims and operation of the Feed-in Tariff scheme

In autumn 2008 the then newly-formed UK Department of Energy and Climate Change announced its intention to introduce a feed-in tariff (FiT) scheme to encourage the uptake of small scale renewable and low-carbon energy generation systems. A key policy motivator for the scheme was the EU Directive on Electricity Production from Renewable Energy Sources (2001/77/ED) and later modifications to this Directive. Under the Directive the UK had an initial target to produce at least 10 per cent of its gross electricity consumption by renewable energy sources by 2010. Beyond 2010, the Directive sets a target for the UK to produce at least 15 per cent of its gross electricity consumption by renewable sources by 2020 (DECC, 2011).

Other motivations for the FiT scheme were the renewal of aging electricity generation and distribution infrastructure; the need to stimulate economic growth in an economic downturn by supporting the small but influential domestic renewable energy industry; and a desire to counterbalance the depletion of domestic oil and gas reserves and the greater dependence on energy imports that a decline in domestic production might lead to.

The FiT scheme officially opened for registration to owners of eligible installations in England, Scotland and Wales on April 1st, 2010. The scheme has been and continues

to be aimed at households, community organisations, businesses, farms and other establishments that are able to become small scale energy producers. Qualifying technologies include solar photovoltaic (PV), wind turbines, hydroelectric, anaerobic digestion and micro-combined heat and power (micro CHP). The maximum size of an eligible installation is 5 megawatts in generation capacity (MW). Ofgem has set a target for the FiT scheme to support 750,000 installations by 2020 (DECC, 2010).

The FiT scheme is attractive to owners of small scale renewable energy installations because it creates financial rewards that flow directly to installation owners in proportion to the amount of clean energy they produce. The FiT scheme creates an obligation for electricity suppliers to make these payments to installation owners in line with a tariff schedule set out by the Ofgem, the regulator. The level of payment varies by the type of technology, the size of the installation and the type of owner (domestic, community, commercial, industrial). Almost all installations registered with the scheme to date are connected to the grid. FiT payments are index-linked and therefore inflation-proof, guaranteed by the government for 20 years, and paid regularly to the installation owner by the electricity supplier via bank transfer or cheque. The expected return on investment for a typical 3.5 kW photovoltaic (PV) system costing £10,000 was 8 per cent per year or higher in the early stages of the program (DECC, 2009). At the time of writing, an installation owner can expect around 5 per cent per year according to the Energy Saving Trust.

The owner of a FiT-registered installation can benefit from two streams of payments from their electricity supplier. Under the 'generation tariff', the electricity supplier pays the installation owner for each kilowatt-hour (kWh) of electricity the installation owner generates, regardless of what is done with the electricity. Separately, under the 'export tariff' the electricity supplier pays the installation owner for each kWh of electricity the installation owner exports to the grid in excess of what they consume. Installation owners can therefore benefit from both tariffs and many do. Given that the generation tariff is considerably larger than the export tariff per kWh, the FiT incentive structure rewards installation owners more highly for using the energy they produce on site than exporting it. This means that the FiT scheme resembles

something closer to a 'production' tariff than a 'feed-in' (export) tariff (Mendonca, 2011; Ofgem, 2011; Ofgem, 2012).

3. Uptake of the Feed-in Tariff scheme

Ofgem publishes data quarterly about the size, technology type, tariff rate, location, and owner type of all installations registered under the Feed-in Tariff (FiT) scheme (Ofgem, 2013a). This data shows the extent of scheme uptake to date, as well as patterns of uptake across installations with different features. The analysis in this and subsequent sections considers installations registered in the three years from the start of the scheme on April 1st, 2010 to March 31st, 2013.

According to the Ofgem data, a total of 379,531 installations were registered with the scheme in its first three years of existence. That is one installation for every 50 households in England and Wales. Total generation capacity of all installations combined is approximately 1,792 MW. Total generation capacity is equivalent to about three average-sized coal-fired power plants. This means that small-scale FiT-registered installations now account for around 2 per cent of all UK generating capacity.[1] Tables 1 to 3 show how the installations vary by technology, type and size.

Table 1: Installations by technology type

	Number of installations	Installed capacity (kW)	Mean installation size (kW)
Anaerobic digestion	48	38,183	795.5
Hydroelectric	364	35,167	96.6
Micro CHP	441	450	1.0
Photovoltaic	374,031	1,585,484	4.2
Wind	4,647	133,154	28.7
All	379,531	1,792,438	4.72

[1] Total plant generating capacity in the UK in 2012 was approximately 89,000 MW meaning that FiT-registered installations now account for approximately 2.01 per cent of all UK generating capacity.

Table 2: Installations by type of owner

	Number of installations	%	Average installation size (kW)
Community	1,855	0.49	9.71
Domestic	366,465	96.56	3.23
Commercial	10,565	2.78	14.39
Industrial	646	0.17	20.97
All	379,531	100	3.53

Table 3: Installations by size

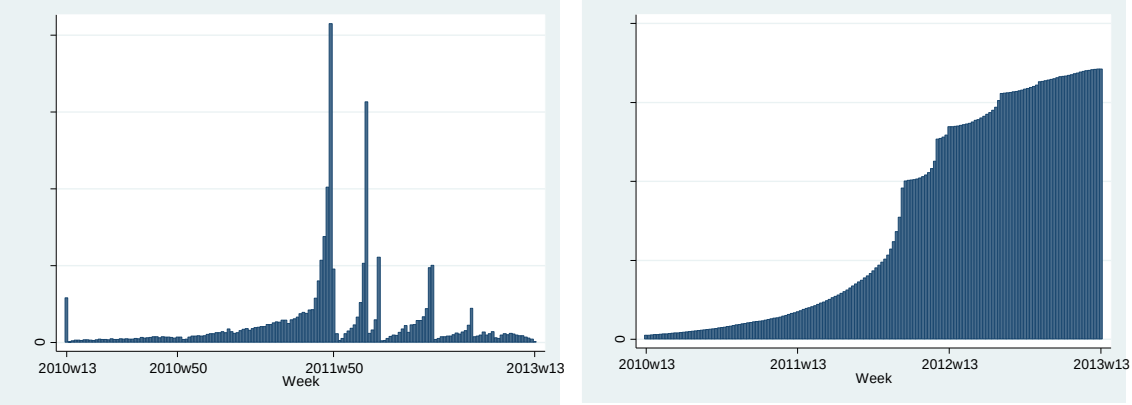
Size (kW)	Number of installations
< 2kW	78,608
>2 kW and <5 kW	282,703
>5 kW and <20	11,957
>20 kW and <50 kW	5,066
>50 kW	1,197
All	379,531

Tables 1 to 3 highlight that FiT scheme uptake to date has been dominated by small-scale, domestic solar PV installations. Solar PV accounts for 374,031 from a total of 379,531 installations and the majority of installed capacity. Domestic installations as opposed to community, commercial, or industrial installations account for the majority of installations by type of owner (366,465 out of 379,531). Most installations are relatively small: 361,311 have an installed capacity of less than 5 kW. This means that the bulk of FiT payments are flowing to installation owners at domestic premises, and not to commercial, industrial or community owners.

The weekly rate of new FiT registrations has oscillated over time (see Figure 1). This has mainly been driven by the timing and manner of the changes that were made to the level and structure of the tariff (for details see Ofgem, 2011; and Ofgem, 2012). The tariff structure was designed at the outset with a gradual reduction in mind.[2] In practice the reductions were implemented more rapidly than expected and implemented in a way that caused installation owners to rush to register systems before the changes took effect. The spikes in weekly installations in the left panel in Figure 1 correspond with the last week that a new FiT installation would qualify for a particular tariff rate, before a new lower tariff rate took effect.

[2] The logic behind a gradual reduction to the level of the tariff was to support renewable energy deployment with larger payments while installation costs were high and the microgeneration installation industry was less developed. As the industry matured and the cost of an installation came down, the applied logic was that the tariff payment would be reduced since not as much support would be needed for uptake to occur.

Figure 1: FiT registrations per week and cumulative registrations per week



Note: spikes in the weekly rate of new FiT installation registrations in the left panel reflect installation owners rushing to register their installation with the scheme ahead of a scheduled reduction in the tariff rate (payable for at least 20 years). In the right panel: it is intended that cumulative installations will rise to 750,000 by 2020.

Well before the registration spikes it had become clear, in the second quarter of 2011 or earlier, that the rate of scheme uptake was more rapid than expected. This was being driven in part by a faster than expected fall in the upfront cost of installations, particularly solar PV. Policymakers at HM Treasury, the Department of Business Innovation and Skills and Ofgem became concerned that scheme oversubscription would have large, long-term, unanticipated, and unaffordable financial implications. They therefore moved to attenuate the rate of uptake by revising the tariff structure.[3]

The prospect of lower tariff rates, unforeseen by microgeneration system installers and would-be installation owners, led to rush-to-register behavior and large registration spikes. Rush-to-register behavior threatened to destabilise the FiT scheme at several points during its first three years of operation and forced politicians and policy-makers to exercise their 'fast track' authority to bring the scheme under control. Hasty downward adjustments to the tariff structure in 2011 and 2012 eroded market participants' confidence in the stability of the policy framework. This lack of

[3] Deeper and more frequent changes were made to the generation tariff than the export tariff. The generation tariff for a typical small-scale 4 kW solar PV installation started out in the first year of the scheme at between 36.1p and 41.3p per kWh produced, depending on the specific installation type. The tariff rate declined over the years of the scheme to between 9p and 21p per kWh. The exact rate varies by program period, installation size and other factors. The export tariff at the time of writing (August 2013) is 4.64p per kWh.

confidence stoked the rush-to-register behavior that led to the oversubscription problem, and provoked policy-makers to make further changes to the scheme, in a damaging negative feedback cycle. By 2012 a more predictable tariff reductions schedule had been implemented and the rate of uptake had reached a stable equilibrium.

It is unclear how the period of policy instability impacted on installation registration by rich and poor households, or whether registration across household income groups was more equitable when the policy environment was stable. However, there is anecdotal evidence from a similar microgeneration promotion scheme in Australia, where similar registration spikes and instability occurred. There, installation uptake across household income groups was considerably less equitable during rush-to-register periods (Macintosh and Wilkinson, 2010). Further discussion of the Australian scheme is provided below.

4. Distributional impact

It is important to appreciate the distributional impact of the FiT scheme in a complete and balanced way. To do this one needs to consider both the distribution of the benefits of the scheme (uptake), as well as the distribution of the cost of the scheme (who ultimately foots the bill for FiT payments), across rich and poor households.

a. Who benefits from the scheme

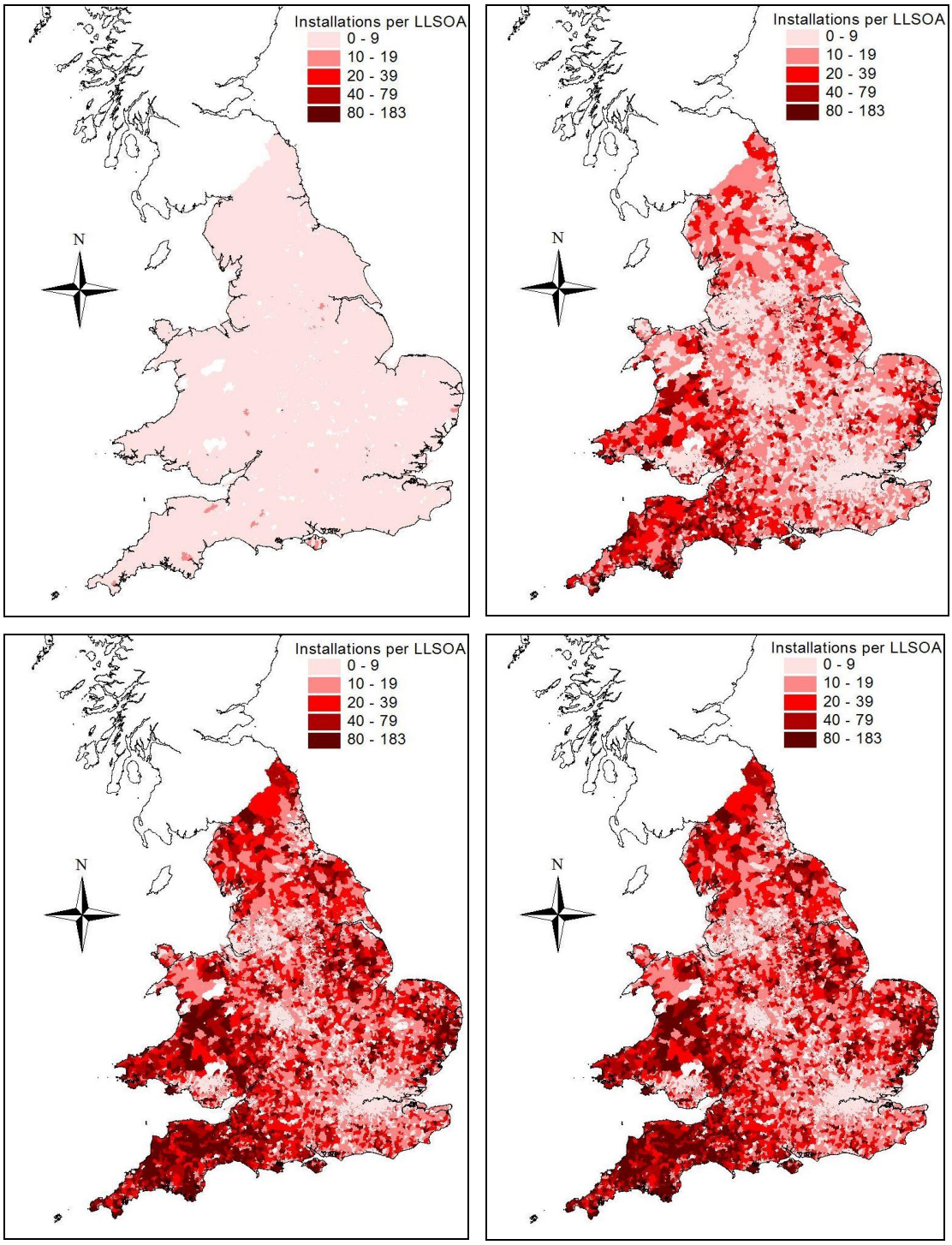
In order to get a picture of which types of households are registering installations with the FiT scheme, the Ofgem installation data was matched to 2011 census data for England and Wales. The FiT installation data on its own does not contain any information about the socio-economic characteristics of the installation owner. Census data on the other hand provides detailed information about the socio-economic characteristics of the households residing in small geographic areas called Lower-

layer Statistical Output Areas (LSOAs).[4] Although matching the installations to LSOAs still does not make it possible to observe the socio-economic characteristics of the installation owners themselves, it does make it possible to observe the *aggregate characteristics of all of the households* in the LSOA where each installation is located. This tells us how FiT installations are distributed across relatively rich and poor areas.

Figure 2 shows the number of FiT installations across all LSOAs in England and Wales. The number of FiT installations is cumulative and given for four time periods. Moving clockwise these are: April 2010, April 2011, April 2012, and March 2013. Each map gives the cumulative number of installations in each area that had been installed by the end of that month.

[4] The LSOA is a statistical geography used by the Office of National Statistics in the administration of the 2011 census and for other purposes. There are 34,090 LSOAs in England and Wales combined. Installations in Scotland were excluded from the match for census data compatibility reasons. In 2011 the average population of an LSOA in England and Wales was 1,614. The average number of households was 672. See ONS (2012) '2011 Census, Population and Household Estimates for Small Areas in England and Wales' for information about statistical geographies.

Figure 2: Cumulative FiT installations by LSOA in spring 2010, 2011, 2012 and 2013



Note: the distribution of FiT-registered microgeneration installations across the 34,090 LSOAs in England and Wales. The number of installations in each LSOA is cumulative across maps. Only PV installations less than 50 kW are mapped.

Figure 2 shows that a relatively small number of FiT installations have located in urban areas (such as greater London) and a relatively high number have located in rural and peripheral areas. Especially large numbers are located in south-west England, Wales and the East of England. [5] This pattern is almost the exact opposite of the spatial distribution of many indicators of economic prosperity in Britain, where wealth tends to concentrate in, and immediately around, urban areas and diminish in rural, peripheral ones (Martin, 1988; Massey, 1996). This implies that the FiT scheme may be unexpectedly and unintentionally helping to re-distribute wealth away from the economic core towards the economic periphery.

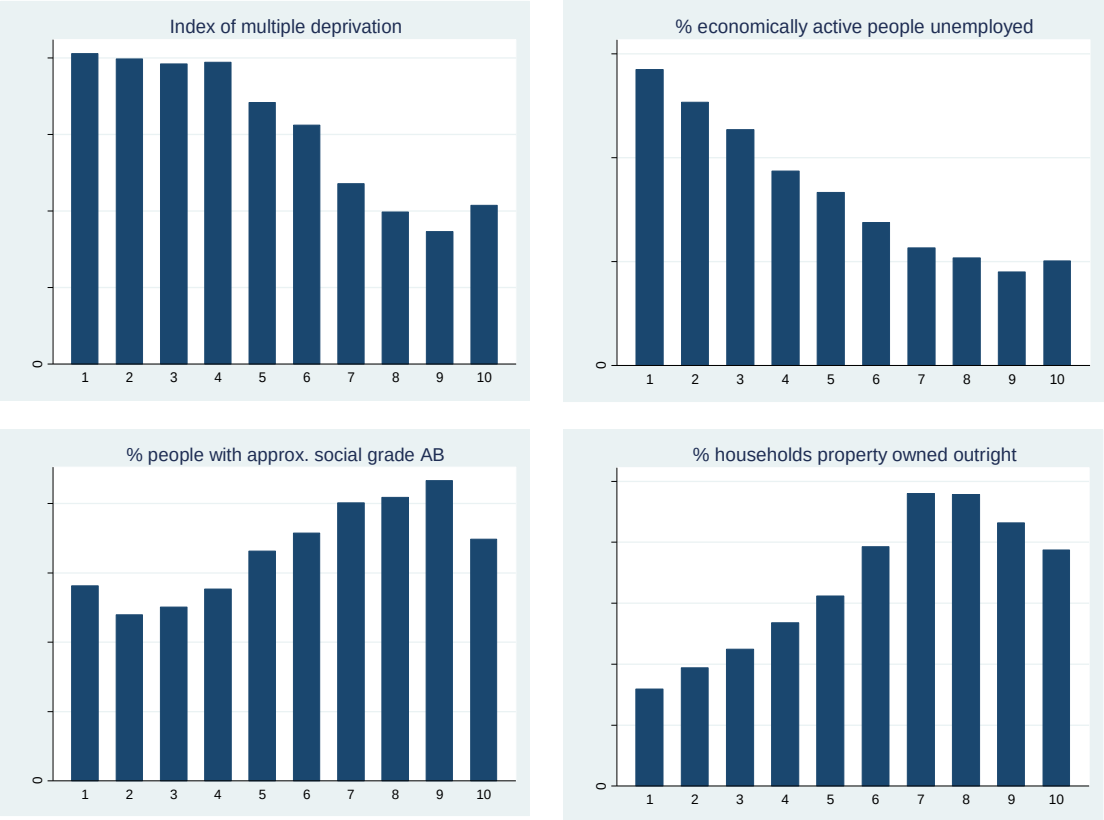
This does not necessarily mean that the FiT scheme is redistributing wealth from rich to poor households. Almost every indicator of economic prosperity in the 2011 census tells the opposite story. Figure 3 uses four indicators of economic prosperity from the census to see how FiT installations are distributed across relatively rich and poor areas. The four prosperity indicators are:

- the index of multiple deprivation (higher is worse-off)
- the per cent of economically active people unemployed (higher is worse-off)
- the per cent of people with approximate social grade AB where AB indicates people employed in managerial posts (higher is better-off)
- the per cent of households where the property is owned outright (higher is better-off).

The 34,090 LSOAs are divided into tenths (deciles) for each indicator. For example, the graph for the index of multiple deprivation shows that about 40,000 FiT installations are located in the 10 per cent of geographic areas with the lowest level of deprivation. About 21,000 installations are located in the 10 per cent of geographic areas with the highest level of deprivation.

[5] This pattern is closely associated with the regional distribution of measured annual solar radiation in the UK. This implies that the distribution of installations across regions is being significantly influenced by the technology type, given that the majority of installations under the FiT scheme to date have been solar PV.

Figure 3: Installations across the socio-economic groups, for four prosperity indicators



Note: all of the LSOAs in England and Wales are divided into tenths (deciles) according to their score for each indicator. Bars represent the total number of FiT installations in each socio-economic stratum. Installations are restricted to solar PV smaller than 50 kW.

Figure 3 shows that a disproportionately small number of FiT installations are located in relatively poor areas of England and Wales. The difference in installation numbers between the poorest and richest areas is pronounced. For the index of multiple deprivation there are 50 per cent fewer installations in the poorest group of LSOAs than there are in the richest group. In terms of unemployment the same pattern is apparent: areas with the high levels of unemployment have fewer installations. For example there are 60 per cent fewer installations in the LSOAs with the highest unemployment than there are in the areas with the lowest unemployment.

The bottom two panels show the flip side of the pattern: that a disproportionately *large* number of installations are located in relatively *rich* areas. About 20 per cent more installations are located in the areas with the highest per cent of people in social

grade AB than in the areas with the lowest per cent of people in that grade.[6] Similarly there are nearly 60 per cent more installations in the areas where the most households own their property outright, than there are in the areas where least number of households own their own property.[7]

In the bottom two panels the relationship between installation uptake and relative prosperity is not completely straightforward. There are fewer installations in the tenth decile of LSOAs (best-off) than there are in the ninth. This may be because the very richest areas are located in or immediately around urban centres which seem to discourage installation uptake for other reasons.

Uptake of the FiT scheme has so far been heavily skewed away from areas in England and Wales where households are relatively poor. This is not the same thing as saying that FiT installation owners tend to be better off, or that rich households are more likely to benefit from FiT payments than poor households, or that rich households are benefitting from a disproportionate share of total FiT payments. However, this analysis points strongly toward these conclusions.

b. Who pays for the scheme

If rich households are benefitting from the FiT scheme more than poor households, but rich households are also paying more as a proportion of income to support the FiT scheme, then the argument could be made that rich households somehow 'deserve' a larger proportion of the total flow of FiT payments than poor households. However, analysis shows that this argument is not true.

The regulatory framework that established the FiT scheme enables each electricity supplier to pass on the cost of making FiT payments to all electricity customers in its

[6] The 2011 census uses a social grade scale where AB denotes higher and C1, C2 and DE denote lower social status.

[7] The pattern in Figure 3 persists when installations are not restricted to PV installations less than 50 kW in size, when uptake of the FiT scheme is measured in installed capacity rather than installations, and when other indicators of economic prosperity are used.

service area. This means that the FiT scheme is paid for by electricity customers through their electricity bills and not by the Government with funds raised through general taxation. An attractive feature of this funding method, from the point of view of the Government, is that the scheme is effectively 'off book'. This funding method also means that the electricity suppliers and not the Government decide how the cost of the scheme is distributed.[8]

Table 4 shows the total cost of the FiT scheme borne by electricity customers in Britain. Total FiT payments made by all electricity suppliers together are shown to have increased from £10.5 million in the first year of the scheme to £497.2 million in the third year. Installation owners are guaranteed payments for at least 20 years from the date they register with the scheme, therefore the 'Year 3' total is approximately the minimum payment level that will be made to all installation owners collectively, by all electricity suppliers collectively, in each year, for the next 20 years.[9]

Table 4: Payments made by electricity suppliers to installation owners (£)

	Year 1	Year 2	Year 3	Total
E.ON Energy Ltd	1,028,878	19,018,800	98,667,400	118,715,080
SSE Energy Supply Ltd	1,434,202	12,629,921	79,198,384	93,262,512
Good Energy Ltd	1,058,186	13,019,171	62,302,036	76,379,392
British Gas Trading	723,577	10,496,887	59,298,912	70,519,376
Smartest Energy	1,748,682	17,845,460	31,954,092	51,548,232
EDF Energy Customers Plc	764,313	11,554,920	38,962,112	51,281,348
ScottishPower Energy Retail Ltd	928,864	8,380,618	31,714,592	41,024,076
Npower Ltd - GB	962,233	6,070,307	24,772,760	31,805,300
Npower Northern Limited	290,345	4,532,595	17,066,348	21,889,288

[8] It seems that the Government did not deliberately relinquish authority for the cost distribution by setting out in legislation that this would be the remit of the electricity suppliers. Rather, it seems that by not dealing with the question of who would be responsible for the cost distribution question, responsibility for it has fallen to the electricity suppliers by default.

[9] This is the 'approximate' minimum because some of the installations that registered with the scheme in 2010 and 2011will have begun to fall out of the payment flow by 2033. Also, some installation owners are guaranteed payments for 20 years and others for 25 years depending on when they registered with the scheme. The number of registered installations continues to increase year on-year meaning the payment flow will peak in the 2020s then slowly decline as installations' guaranteed payment periods expire.

Opus Energy Ltd	77,864	516,849	15,519,690	16,114,403
[Other]	1,487,929	10,556,012	37,778,367	49,822,308
Total	**10,505,073**	**114,621,540**	**497,234,693**	**622,361,315**

Note: the total yearly FiT payment made by an electricity supplier is calculated as (generation payments + export payments – deemed export payments). This is in line with the formula set out for calculating FiT payments under the levelisation scheme and in the FiT annual reports. The data for this calculation comes from quarterly FiT levelisation reports published by Ofgem (2010 – 2013).

That the cost of the scheme – nearly £500 million per year – is being paid for by electricity customers and not by tax payers has important distributional implications. In the UK the taxation regime is generally progressive. Rich households are obliged to contribute more as a proportion of income than poor households, at least in terms of income tax. Under the FiT statutory and regulatory frameworks, however, electricity suppliers are authorised to spread the cost of FiT payments across their electricity customers according to a cost-spreading formula that they themselves decide. This arrangement relinquishes the Government of the authority to determine how the funds are raised, instead passing responsibility to the electricity suppliers.[10]

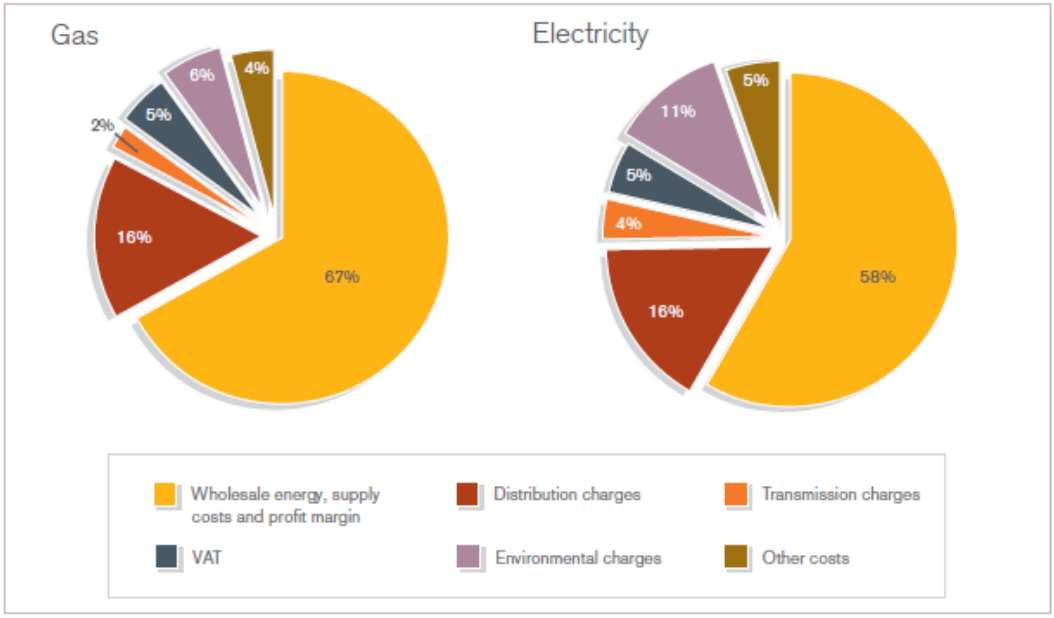
Compared with the microgeneration promotion programs in Australia and California considered in the next section, the British FiT scheme is alone in raising funds from electricity customers without implementing a policy mechanism to insure fairness of uptake. The Australian program was paid for out of the national environmental expenditure budget under an agreement reached in 1999 called 'Measures for a Better Environment' (Hill, 2000; Macintosh and Wilkinson, 2010). Rich households may have made greater use of the program than poor households, but rich families probably paid proportionally more into the general fund pot to support it. The California program was funded by customers of the state's three main utilities, but provisions were put in place to make sure that 10 per cent of all raised funds went to support uptake by low and very low income households. The British FiT scheme by contrast is funded by electricity customers but makes no provision to ensure uptake by

[10] Policy officers at Ofgem and DECC confirmed this point in conversation with the author.

poor households. So while all electricity customers pay for the scheme, rich customers are more likely to participate than poor customers.[11]

One reason for the low level of awareness about the distributional issues connected to the FiT scheme is that there is very little information in the public domain about how exactly electricity suppliers pass through the cost of the scheme to electricity customers. The cost of the FiT scheme does not appear as an itemised levy on customer bills. Instead it is embedded in the energy prices or other levies that electricity customers pay. Ofgem publishes information about the breakdown of a typical UK electricity bill across wholesale energy costs, VAT, transmission and distribution charges, other costs, and environmental programs (Ofgem, 2013b).

Figure 4: Environmental charges in a typical UK gas and electricity bills



The average bills above are based on average annual consumption figures of 3,300 kWh for electricity and 16,500 kWh for gas, averaged across all big six suppliers and across Great Britain. Please note that the numbers may not sum to 100% due to rounding.

Source: Ofgem, 2013

[11] The potential for negative distributional impacts was recognised in the regulatory impact assessment performed for the proposed FiT scheme in July 2009, prior to launch in April 2010 (DECC, 2009): 'Distributional impacts, including in respect of fuel poverty, will depend on a number of factors such as which groups take up and hence benefit from small-scale low carbon electricity generation, levels of electricity consumption, how electricity companies will pass on the policy/subsidy costs of FITs to different consumer groups through different tariff structures, and the potential for households to undertake energy efficiency measures to reduce their energy consumption and hence mitigate the impact of higher bills'

Note: the cost of the FiT scheme is borne not by central government but by all electricity bill payers in an energy supplier's service area. According to Ofgem, environmental programs like the FiT scheme accounted for approximately 11 per cent of the average UK electricity bill in 2013 (gas left, electricity right).

As of January 2013 the cost of environmental programs aimed at saving energy, reducing greenhouse gas emissions and dealing with climate change accounted for about 6 per cent of the average UK gas bill and 11 per cent of the average electricity bill. Specific programs funded by these charges include the Warm Homes Discount, the Energy Company Obligation, the Renewables Obligation, and Feed-in-Tariffs. Ofgem estimates that the FiT scheme adds approximately £6 to the average annual UK domestic electricity bill (Ofgem, 2013b). The regulatory impact assessment conducted in 2009 estimated this figure at £10 (DECC, 2009). The FiT scheme is said to have no impact on gas bills.

5. Comparison to similar programs

It is useful to compare the distributional aspects and other features of the British FiT scheme to similar microgeneration promotion programs in other countries. This section briefly describes two such programs: the Australian Government's Solar Homes and Communities Program (SHCP – the Program) which ran between 2000 and 2009, and the State of California's California Solar Initiative (CSI) program which began in 2007 and is expected to continue until 2016. The policy aims, policy design, funding source, implementation cost, outcomes and distributional aspects are considered for each.

a. The Australian Solar Homes and Communities Program

The program that preceded the Australian Solar Homes and Communities Program (the ASHCP), which was called the Photovoltaic Rebate Program (PVRP), began accepting applications in January 2000. The new Labour government rebranded the PVRP as the ASHCP following its election victory in November 2007. The four main aims of the ASHCP were: to promote the uptake of renewable energy, to reduce greenhouse gas emissions, to help the development of the Australian solar PV

industry, and to increase public awareness and acceptance of renewable energy (Australian Government, 2006; Australian National Audit Office, 2010). In 2000 the ASHCP was funded by what was then the Australian Department of Environment and Heritage.

The ASHCP set out to achieve these aims by providing a financial incentive in the form of a rebate to individuals who installed PV systems at their homes or on other buildings. The level of the incentive changed several times during the 10 years that the ASHCP ran, but at its peak was set at AUD$8 per watt of installed capacity up to a maximum of AUD$8,000. The government agency administering the program made the full rebate payment directly to individual applicants, generally within six weeks of receiving an eligible application.

Approximately 109,634 PV installations were registered under the ASHCP during the period January 2000 to April 29th, 2010 (compared to 379,531 in Britain in three years). The total installed capacity of all systems was approximately 128 MW (compared to 1,792 MW in Britain). As in Britain the vast majority of systems were installed at domestic premises. Also, as in Britain the rate of installation uptake was uneven over time. During the first seven years there were 13,538 successful installation applications or about 1,700 per year. In the final 18 months before the ASHCP was terminated there were over 94,000 (Australian Department of Climate Change and Energy Efficiency 2010). The total cost of the ASHCP is officially estimated to have been AUD$1.1 billion (Australian National Audit Office, 2010).

Partly to deal with oversubscription issues in the later phase of the ASHCP, the Government introduced a means test in May 2008. The means test limited eligibility under the program to households with a combined annual taxable income of less than AUD$100,000 (Australian Government, 2008). The means test was partly a response to oversubscription issues, which were themselves the result of the Government taking the decision to double the rebate rate from AUD$4 to AUD$8 per installed watt in May 2007. Eventually the means test was scrapped and shortly after the program was terminated, on June 9th, 2009.

Concerns about distributional impacts of the ASHCP have been raised. One study[12] found that 66 per cent of all successful applicants under the ASHCP resided in postcodes that were rated as medium-high or high by the Australian Bureau of Statistics' Index of Relative Socio-economic Advantage and Disadvantage (Macintosh and Wilkinson, 2010). Uptake seems to have been more equitable in the early years of the program. The study finds that in the first two years, 25 per cent of successful applicants resided in postcodes that fell in the first quartile of the socioeconomic status distribution. By the last two years this number had fallen to 11 per cent. This implies that policy instability and subsequent rush-to-register behaviour – of the same kind that was observed under the British scheme - may be linked with a pattern of uptake that disfavours poor households.

b. The California Solar Energy Initiative

The California Solar Energy Initiative (CSI) began to take shape in 2006 via a collaboration between the California Energy Commission and the California Public Utilities Commission. The CSI put in place a 10 year policy framework running to 2016. The CSI program started making payments to eligible installations on January 1st, 2007. Funding for the CSI is collected from electricity customers. The California legislature authorised the funds to be raised in this way in Senate Bill 1 in 2006 (CPUC, 2013).

The aim of the CSI is to install 1,750 MW of solar PV capacity by 2016 within the service areas of California's three main investor-owned utilities: Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric. The total CSI program budget was set at USD$2.167 billion. Other aims of the CSI are to promote research and development in solar technologies, to provide incentives for solar hot

[12] Macintosh, A and Deb Wilkinson, 2010, *The Australian Government's solar PV rebate program: An evaluation of its cost-effectiveness and fairness*. Policy Brief No. 21. Prepared by the Australia National University Centre for Climate Law and Policy and the Australia Institute. Pp. 9.

water and other solar thermal technologies, and to provide solar incentives specifically to residents in single family and multi-family affordable housing units.
The CSI is designed to incentivise the installation of PV system and the production of PV electricity. Eligible customers can access two types of incentives, one (known as the Performance Based Incentive) which rewards the output of PV electricity, the other (known as the Expected Performance Based Buydown Incentive) which rewards the installation of PV equipment.

The Performance Based Incentive is designed to support installations that are larger than 30 kW. Payments are made to the system owner over a five year term for each kWh produced (this is a much shorter funding period than the 20-plus years guaranteed under the British FiT scheme). This motivates the system owner to focus on proper system siting, installation, maintenance and performance. The second incentive type is a more like a rebate (as under the Australian program) than a production incentive. The Expected Performance Based Buydown Incentive makes a single upfront payment to the system owner for each watt installed. This incentive is aimed primarily at installations with ratings of less than 30 kW. An energy efficiency audit is required for all existing commercial and residential buildings to be eligible for the CSI incentive.

The actual value of the payment under both incentives is linked to an 'incentive trigger mechanism' that reduces payments gradually over the 10 years of the program, in line with the fulfillment of 'steps'. The regulator sets out an amount of installed PV capacity for each step with a corresponding incentive level. When installed capacity reaches the quota in the first step, the incentive level changes to the next step and the new, lower incentive rate is triggered. The trigger framework was designed so that the average payment rate is reduced by about seven per cent per year from 2007.

Table 5: California Solar Initiative incentive trigger framework (US$)

Step	MW in step	Performance Based	Expected

		Incentive	Performance Based Buydown
1	50	-	-
2	70	$0.43	$2.75
3	100	$0.38	$2.45
4	130	$0.30	$2.15
5	160	$0.25	$1.80
6	190	$0.19	$1.35
7	215	$0.12	$0.90
8	250	$0.08	$0.60
9	285	$0.06	$0.47
10	350	$0.04	$0.37
Total	**1,750**		

Note: rates are given as the simple mean of residential, commercial and government/non-profit rates. See California Public Utilities Commission (2013) page 5 for detail.

According to the official data reporting website of the CSI, by the end of the first quarter of 2013 an estimated 1,621 MW of solar PV capacity had been installed in the form of 156,704 installations (California Solar Statistics, 2013). Approximately 93 per cent of installations are residential or small commercial systems, less than 10 kW in size. Different to the British FiT scheme, systems that are larger than 10 kW account for approximately 63 per cent of installed capacity (Hughes and Podolefsky, 2013). According to the Director of the University of California Energy Institute, the average rebate over the life of CSI has been US$1.40 per watt US of installed capacity (Borenstein, 2013).

Ten per cent of the total USD$2.167 billion CSI budget (US$216 million) was set aside for incentivising solar PV uptake by low-income California residents. The CSI aims to install 190 MW of solar PV capacity additional to the core goal of 1,750 MW among this demographic by 2016. The low-income provision was set out in the legislation that enabled the CSI. Only solar PV installations are available under the low-income programs. The incentive structure is higher than the ordinary market incentive and it is stable over time. It does not decrease in line with the trigger framework.

Households whose income is less than 50 per cent of the area mean can qualify for highly subsidised, though not free, solar PV systems. The California Public Utilities Commission expects 5,000 households to be eligible for these systems through incentives, tax credits and other financing mechanisms. The exact size of the subsidy depends on the household's income tax liability. Subsidies cover between 50 and 75 per cent of the system installed cost. The CSI facilitates low-interest loans for the remainder of the cost.

Very low income households whose income is less than 80 per cent of the area mean can qualify for fully-subsidized 1kW solar PV systems. The Commission estimates that 1,800 households will qualify for these systems (California Public Utilities Commission 2013). These are homes that the Commission expects are unable to take out a loan to cover even part of the cost of a solar PV system. The subsidy is capped at USD$10,000 per qualifying household. A maximum of 20 per cent of the CSI's low-income funds will be used to support systems for very low income households.

Both low-income programs had experienced strong uptake as of 2013. Funding is targeted separately at single-family low-income households ('SASH' units) and multi-family low-income housing units ('MASH' units). According to the CSI annual program assessment, 3,386 applications had been received for SASH funding resulting in 10.3 MW of capacity either installed or pending, with USD$64 million disbursed. For MASH projects, 370 projects have been completed or are in progress for a total of 29.7 MW of installed capacity. The volume of applications for MASH funding quickly absorbed some resource areas and new applications were placed on a waiting list.

6. Findings

Under the British FiT scheme there are currently no safeguards in place to ensure that distributional incidence of the FiT scheme is not unfair or regressive. There are no provisions in place to ensure that the households that are least able to participate are

sufficiently supported to do so. The British scheme differs from the Australian and Californian programs because it leaves to electricity suppliers the authority to decide how the cost of the scheme is distributed and because it includes no measures to support uptake by poor households.

The available evidence implies that uptake of the FiT scheme during its first three years has been significantly skewed away from poor households and that poor households are receiving a significantly smaller proportion of total FiT payments than they would if uptake across income groups were even. This is not because the FiT scheme itself is skewing uptake but because poor households are less able to participate in the scheme for reasons related to dwelling type, technology type, spatial location, and capital access. The lack of transparency on the cost distribution side of the scheme is concerning.

It is estimated based on conservative assumptions [13] that the less prosperous half of British households receives between £14.2 and £26.6 million less per year in FiT payments than they would if uptake were perfectly distributed across income groups. By this calculation the more prosperous half of households is benefitting disproportionately by the same amount. Over 20 years of FiT payments this would amount to between £284 million and £532 million.

While the FiT scheme is probably facilitating the flow of wealth across income groups from relatively poor to relatively rich households, it also appears to be facilitating the flow of resources from the economic core to the economic periphery. The maps of installation uptake in Figure 2 imply that FiT scheme uptake is primarily a non-urban phenomenon with installations tending to concentrate in less densely populated, often peripheral areas. There also appears to be a strong association with the level of

[13] For any indicator in Figure 3 calculate the mean number of installations per decile. Subtract this from the number of actual installations in each decile giving the difference between perfectly equitable uptake across income groups and the status quo. Taking the sum of differences for income groups below the median gives the estimated 'installation deficit' relative to the mean. The average FiT payment per year per installation is assumed to be £500. On the cost side the assumption that the electricity suppliers spread the cost of the scheme perfectly across bill payers according to their ability to pay. Calculations available from the author.

measured annual solar radiation. The spatial dimension is a notable and probably not fully anticipated outcome of the FiT scheme that has implications for spatial redistribution and economic development policymaking.

Anecdotal evidence suggests that the 'rush-to-register' behaviour that destabilised the FiT scheme at the end of 2011 and throughout 2012, and which was caused by unexpected policy changes, might have exacerbated the equity issues highlighted here. This is an area for further research, but evidence from the Australian program suggests that periods of policy stability were more conducive to equitable uptake than periods of policy instability.

The FiT scheme is one of several programs in Britain designed to correct socially undesirable outcomes that electricity markets tend to deliver when left to operate on their own. Some of these programs, like the Warm Homes Discount and Winter Fuel Payments, are specifically designed to assist low income and vulnerable groups with the cost of their electricity bills which might otherwise be unaffordable to them (Advani et al., 2013).[14] These programs mitigate some of the negative distributional impacts of the FiT scheme when they are considered with the FiT scheme as a total package of social-environmental electricity market policies. It is concerning nonetheless that the original regulatory impact assessment performed on the FiT scheme recognised the potential for negative distributional impacts but that no safeguards were put in place in light of this information. The impact assessment did not achieve the purpose for which it was intended in this respect.

7. Policy recommendations

There is an opportunity to address the negative distributional impact of the FiT scheme today, given that over 350,000 new installations are to be registered with the scheme by 2020. This may be done in two ways: by adjusting how the cost of the

[14] Other programs like the Carbon Emission Reduction Target (CERT), Warm Front and Decent Homes have directed or continue to direct support to support to poor households to correct these market outcomes, though little of this support has targeted microgeneration installation uptake.

scheme is distributed across electricity customers and by supporting greater uptake by households that are at greatest risk of being shut out from participation.

On the cost distribution side:

- The electricity suppliers that participate in the FiT scheme should be obliged to state on electricity customers' bills the amount of the bill that goes to pay for the FiT scheme. This would take the minimum necessary step to ensure that the cost of the scheme is transparent to the group that pays for it. It would also evenly and neutrally spread awareness of the scheme across potential participants.

- This information should ideally be stated alongside information about the proportion of the bill that is attributable to the wholesale price of electricity, VAT, transmission and distribution costs, other environmental program charges, and other costs. This cost information should be calculated for individual customer bills rather on the 'average bill' basis currently being provided by Ofgem (2013b), since the average bill calculation method is not sensitive to the distributional incidence. This would raise awareness by the bill payer of the cost contribution of the FiT scheme *relative* to other costs.

- Ofgem should review how the electricity suppliers that participate in the scheme are distributing the cost of FiT payments across their electricity customers. Ofgem should use this information to estimate the actual distributional impact of the cost-distribution methods, and it should publish the findings of the review.

- Based on the review's findings about cost distribution methods and their impact, Ofgem should produce guidance on what constitutes best cost-distribution practice from the point of view of government. This guidance should discuss the distributional implications of passing on the cost of the scheme through fixed and variable charges respectively. Ofgem should consider which enforcement mechanisms are necessary to ensure that the electricity suppliers implement this

best practice. Ofgem should take steps necessary to ensure that the electricity suppliers implement this best practice where the electricity suppliers have not achieved it voluntarily within a year.

On the installation uptake side:

- Ofgem and DECC should together set a target for a proportion of future installations to be registered to owners situated in the lower quarter of the income distribution, for example 10 per cent of all remaining installations under the scheme (35,000). Ofgem and the Department of Energy and Climate Chnage should consider establishing a parallel tariff scheme to facilitate sustained uptake by these installation owners particularly. Ofgem and the Department of Energy and Climate Change should set interim targets to register around 5,000 installations to low income households in each year to 2020, reporting on progress against those targets each year in the FiT Annual Report.

- The Department of Energy and Climate Change should facilitate a public awareness campaign targeted at relatively low income households to raise awareness about the FiT scheme among this group of potential participants specifically. This may be complemented by an incentive scheme to induce installer companies registered under the Micro-generation Certification Scheme to target low income households through the marketing methods they are already using.

- Multi-household dwellings like council estates present unique barriers to installation uptake. These include the need to distribute electricity output and/or FiT payments across individually metered occupants; the weak incentives landlords have to install systems on behalf of tenants; the failure of financial gains to flow to tenants; and the collective action and legal issues that delay uptake relative to single private households. The Department of Energy and Climate Change and Ofgem should include some number of multi-family dwellings in the 10 per cent low income installations target. The Department of Energy and

Climate Change and Ofgem should produce guidance on overcoming the installation issues faced by these dwellings specifically, and take any other action as necessary to fulfil the installation target for these dwellings.

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