SUSTAINABILITY FIRST – PAPER 7

Evolution of commercial arrangements for more active customer and consumer involvement in the electricity demand-side

ANNEX 3

Illustrative Case Study 4 –

Smaller PV Units and Demand-Side Interaction

(Small (below 30kW) & Large (over 30kW)).

Sustainability First Authors :
Syed Ahmed and Judith Ward.

Published April 2013

We would welcome any feedback on this paper – please email
syed.ahmed@sustainabilityfirst.org.uk

Annex 3

Illustrative Case Study 4 – Smaller PV Units and Demand-Side Interaction

(Small (below 30kW) & Large (over 30kW)).

Summary

1. This case-study explores in a very initial way some of the key physical and commercial interactions of photovoltaic (PV) units on the electricity system. The issues raised in relation to the export of PV electricity and its impact on the demand-side and the wider electricity system are complex and as yet not well-understood.

2. In high-level terms, the majority of PV output offers :

   - A source of low-carbon renewable electricity typically at the site of demand.

   - A characteristic day-time profile correlating generally with sunshine hours, tending to peak towards the middle of the day[1]. Output can fluctuate, depending on cloud cover, time of year, latitude etc.

3. From a demand-side perspective, given the UK's 'darkness-peak' characteristics of both system load generally and household load in particular [2], two key questions follow for this paper:

---

[1] For discussion of PV output generation profiles, see : . *Initial Load and Generation Profiles from CLNR Monitoring Trials December 2012 SDRC Report*, Durham University Energy Institute. Customer Led Network Revolution website

[2] See Sustainability First. Paper 2. GB Electricity Demand – 2010 and 2025. Initial Brattle Electricity Demand-Side Model. Scope for Demand Reduction and Flexible Response.

The most significant system peaks are in the early evening from around 17.00h from November to February, as darkness falls, lighting load kicks-in, commercial load is still high and household load increases.

Load Profile 1 – Household Load: shows a pronounced evening peak with a lesser morning peak – and generally lower consumption levels in the middle periods of the day. The most extreme load-peaks are at the onset of darkness in winter. Commercial load by contrast has a morning rise – and a relatively

- How does PV output currently interact with the electricity demand-side - in particular with respect to PV export / unmetered spill in the lowest voltage networks ?

- Could PV become better incentivised to achieve a better match with electricity consumption generally – and therefore make a more *cost-efficient* contribution in the electricity system overall ?

4. This case-study focuses chiefly on domestic scale PV systems – so those without a negotiated power purchase agreement and / or an export meter. This case-study does not discuss the added complexity of incentives for on-site use of PV for tenanted property with PV units on the roof (tenants of social landlords, for example). This is clearly a significant matter – but not considered in our case-study.

5. This paper explores in a preliminary way, whether for the longer term it may be feasible to achieve a better alignment than now between the physical electrical output of PV electricity - and approaches to incentivising its more cost-efficient use. If feasible and / or practicable, the aim would be to incentivise PV electricity to make a somewhat more cost-efficient contribution to the electricity system overall by achieving, where possible or feasible, a better match in PV output, and for unmetered spill in particular, with periods of high and low electricity demand.

6. This paper explores the mechanics of the Feed-In Tariff for PV; the present state of knowledge from available data about installed PV units and PV generation out-put ; current poor insight into the split between PV on-site use and unmetered spill, including time-related spill. This paper discusses whether the single export registers in household smart meters will help to address some of these uncertainties in the future.

---

flat consumption profile during the day – so could provide a good match with PV output. However, unlike much household load, and unlike most domestic PV units, larger commercial load may be connected to a different LV circuit , and so may not be a direct ‘near-neighbour’ in terms of direct spill-uptake.

Industrial load has a generally flat profile through the day and year.

7. PV output in GB, as currently incentivised by the Feed-In Tariff (FIT), is presently :

   - **Most cost-efficient where on-site consumption is maximised**[3].

   - **Generally not responsive to the demand-driven needs (and associated costs) of the electricity system, due to its largely 'must-run' nature** [4].

   - **Liable to result in at least some unmetered export / 'spill', unless all output is consumed 'on-site'.** This spill tends to flow to the 'nearest neighbour' on the same electrical phase, (or, possibly, 'uphill', back to the nearest transformer).

8. As of today, PV makes a relatively modest contribution to total GB electrical output.

9. Should PV installations - and PV output - grow substantially in the coming decade, then some of the basic operational characteristics of PV may need closer examination in terms of :

   - **Incentivising as much on-site PV use as possible** - to the extent that this is the most cost-efficient use.

   - **Improving the match of local PV export and / or unmetered spill with local electricity consumption** (including options for storage).

   - **Encouraging more cost-efficient operation of PV in the wider electricity system, especially in relation to any additional costs which may be caused by PV connections and / or spill.** At present, any such additional costs to the distribution networks or suppliers are simply shared across all non half-hourly consumers on a 'socialised' basis (so, shared amongst Load Profile 1-8 customers). In effect, and unlike for larger distributed generators, there is not presently a mechanism which can (1) recognise any additional costs caused by a PV connection and unmetered spill or (2) allocate those additional costs back

---

[3] Because the cost-saving to the PV owner *from avoided import to the home* considerably exceeds the export component of the FIT tariff.

[4] 'Must-run' due to : a combination of : (1) sun-related (2) relatively long paybacks required on PV capital investment, and because (3) both the 'generation' and 'export' elements of the FIT tariff are paid at a standard flat-rate, irrespective of time-of-day.

to the PV units which may cause them[5]. These costs may manifest themselves in different parts of the electricity system as follows :

a. **Distribution Networks –** the costs of network reinforcement necessary to accommodate PV, especially PV clusters (i.e. the costs associated with PV output / spill onto the local network due to voltage fluctuation, harmonics, transformer overload).

b. **Suppliers** –the unexpected / unaccounted-for costs of potential imbalance due to unmetered PV export / spill, should suppliers find themselves over-contracted in the wholesale electricity market, unless and until action is taken on adopting PV customer 'profiles'.

c. **System Operator –** in the future, if there are significant new volumes of PV output, the possible costs of constraining-off 'must-run' low-carbon plant at periods of extremely low demand (especially in summer).

10. This paper discusses some of these longer-term uncertainties for market actors and considers some key questions which arise for the electricity demand-side. For the future, if PV output markedly increases, some of these issues will become more material / pressing than today. Looking ahead, some key considerations are :

- **On-site consumption of PV electricity – is presently the most cost-efficient use of that power[6] - both for the PV household - and for the electricity system in general.**

- **There is a potential poor match between the characteristic daily shape of GB PV output** - against the highest and most costly periods of GB electricity demand.

- **The inefficiencies of unmetered spill** – and in particular the knock-on costs which may arise in different parts of the electricity system – and the current poor allocation of those costs back to where they originate.

- **The current administrative and commercial split of customer 'hats' for (1) receipt of PV FIT payments – and (2) being a retail-customer**. In effect, with a PV unit on the roof, it is perfectly feasible to be a single 'prosumer' in electrical terms – but it is not yet feasible to be 'joined-up' as a single 'prosumer' in *commercial* terms.

---

[5] This picture may well eventually change should there be an eventual requirement for metering / and or data recording of *actual* PV exports.

[6] Unless and / or until there is a very dramatic rise in wholesale and retail electricity prices

11. As installed PV volumes grow - the potential for such inefficiencies to add to costs in the future in the overall electricity system will also grow. The concluding section of this paper therefore explores whether for the long-run it may be possible to sharpen the FIT incentive to encourage greater on-site consumption wherever cost-efficient, as a way of improving overall cost-efficiency - **both for the PV owner and for electricity system**.

12. Also, in line with the general proposition explored for the other case-studies in Paper 7, a key aim is to try to understand whether some form of time-related price signal – either reflected (1) to the PV-owner and / or (2) possibly to communities or households immediately adjacent to PV units with unmetered spill[7] – might eventually support somewhat more cost-efficient PV operation at the very local level on the lowest-voltage networks.

13. This paper therefore also explores at a high level four possible 'strawman' approaches to introducing some form of time-related element for the future into FIT arrangements. These four possibilities are by no means definitive. They are :

    - **A FIT with some form of ToU element (eg perhaps in the export element of the tariff).**

    - **A FIT requirement for on-site storage** (be that thermal storage (heat, hot-water) or battery)

    - **A single 'within-premises' PV balancing tariff –** this would require a far more 'joined-up' customer approach than seems possible today[8] between (1) the administration arrangements for FIT payments (i.e. via FIT Licensee arrangements) – and (2) the consumer's wholly separate arrangements with their electricity retailer for their electricity supply.

    - **Some form of community / very local, perhaps post-code, ToU retail tariff – i.e some form of PV-twinning tariff -** designed to encourage very local uptake of PV metered and unmetered spill electricity at an immediate neighbourhood level (and so to minimise possible 'disturbance' impacts / costs of spill in the electricity system).

14. These and other PV tariff approaches face many unknowns : due in part to the nascent nature of the PV market in GB – but also due to the limitations discussed in Paper 7 regarding development at scale of ToU and time-related retail tariffs.

---

[7] And on the same electrical phase

[8] Including by data protection rules

15. The thinking behind such possible incentive approaches is to create : (1) greater encouragement for on-site use (i.e. where this is the most cost-efficient use of that PV); and (2) a potential better match between PV output and local demand ; and thereby, as national PV output grows (3) encourage somewhat more cost-efficient operation of PV in the electricity system for networks and suppliers, and, by 'knock-on', for the system operator too. Such approaches are therefore worth further consideration.

16. Work Stream 6 of the DECC / Ofgem Smart Grid Forum is starting to consider these cost-efficiency issues from a distribution network perspective, which will be very helpful.

17. As PV output grows, others such as DECC, market actors and the relevant trade bodies, will also wish to consider how to incentivise an improving match of PV output with (1) on-site and (2) local electricity consumption, in order to improve general PV cost-efficiency in the electricity system overall.

Paper 7 : Annex 3

Illustrative Case Study 4 – Smaller PV Units and Demand-Side Interaction

Contents

This PV case-study is organised as follows :

Paper 7 - Annex 3

Illustrative Case Study 4 – Smaller PV Units and Demand-Side Interaction

Contents (cont.)

Appendices

Section 1 : Feed-In Tariff - 'Basics' for PV

18. At the present time, almost all PV generated electricity is either :

- Used directly at the site of generation

and / or also

- Spilled / exported - and 'sold' to a FIT licensee and / or a licensed electricity supplier.

19. The FIT regime for PV operates around a key threshold set by government of 30kW:

- **Installations <30kW** - the use of export meters to measure spill electricity is entirely voluntary[9].

- **Installations >30kW -** the use of an export meter is mandatory in order to receive FIT payments.

20. The two main financial benefits from the Feed-In Tariff which accrue to the owner of a PV unit for the electricity it generates are the : [10]

- **Generation tariff –** the PV-owner is paid for each kWh of metered electricity generated.

- **Export tariff –** The PV generator can also receive an export-related kWh payment, on the basis that PV electricity which is not consumed onsite may be exported / or spilled onto the distribution network. For most small PV units, especially for the vast majority which do not presently have export meters, payment for Export kWh is currently based on a volume which is 'deemed'– currently set at *one-half* of the metered PV output / generation.

  The export portion of the FIT incentive is designed to be far less than the generation tariff (currently by a factor of around three) **– to make it far more cost-efficient for PV output first and foremost to be consumed onsite**.

---

[9] Elexon have reported that as at *"30 September 2012 there have been 329,757 Feed in Tariff (FiT) installations but the number of Non Half Hourly (NHH) export MPANs is 3,006."* Elexon Risk Operating Plan 2013/14 paper 'PAB142_04-ROP-Paper-2013_14' November 2012¬

[10] Both the generation and export tariffs are linked to the Retail Price Index (RPI).

21. Importantly, **on-site consumption also enables electricity bill savings to accrue to the consumer at those premises -** to the extent that on-site consumption displaces electricity purchases from a customer's electricity supplier.

22. See Appendix 1 for more detail on the FIT scheme, the FIT programme and the administration of FIT payments for PV, including the differential FIT rates which apply to PV systems of different sizes, together with the most current tariff rates which apply.

PV Output – A distinctive and consistent profile

23. PV output has a distinctive and consistent profile over the course of a day - which ramps up and down with the sunshine hours – peaking in the middle of the day.

22. A paper for the Customer Led Network Revolution Low Carbon Network Fund (LCNF) trial by Durham Energy Institute, shows this consistent load profile for PV-generated electricity from a sample of 11 PV arrays *(*the heavy red line shows the median for all of the units). Durham note a consistent single PV output profile, notwithstanding the '*variation across PV sites caused by building orientation, location and weather, and installed capacity*'.

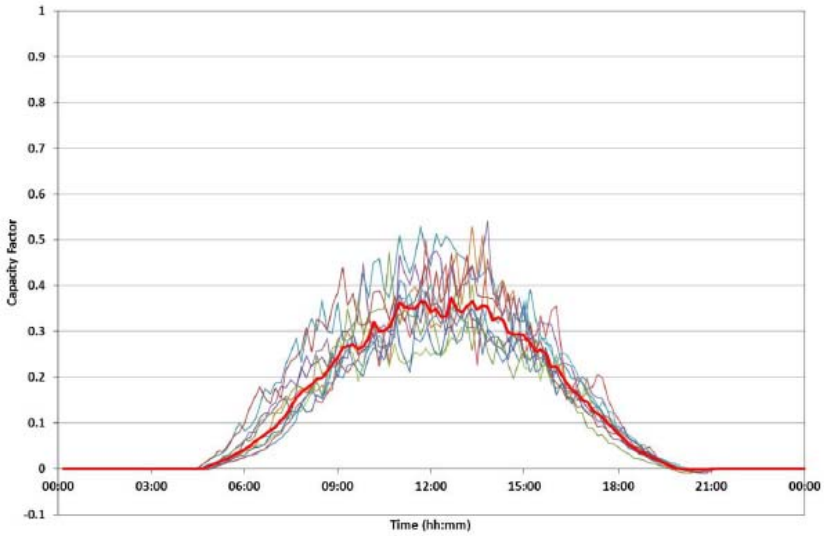


Figure 1. Median capacity factor for 11 PV generators for July 2012 – individual and aggregated[11]

[11] Figure 20 from *Initial Load and Generation Profiles from CLNR Monitoring Trials December 2012 SDRC Report*, Durham University Energy Institute. Customer Led Network Revolution website

Section 2 : Illustrative Case-Study : some likely 'physical' and 'commercial' characteristics of small photo-voltaic (PV) systems

Figure 2 depicts a simple 'case-study' **of the notional 'physical' electricity supply to a cluster of three homes. Of these, one household has a small-scale PV generation system[12] in place** (most domestic installations are no more than 4kW).

23. Figure **2 'maps' the physical electrical flows together with the commercial arrangements for electricity supply to each of the three households.**

24. To inform our thinking for this notional case-study, some possible interactions of PV-generation output with the following 'actors' were considered :

- PV generator / customer
- Energy supplier (both the FIT Licensee & electricity retailer).
- Distribution network
- System operator
- Near neighbours

25. **Further exploration of these interactions is set out in Appendix 5 as follows :**

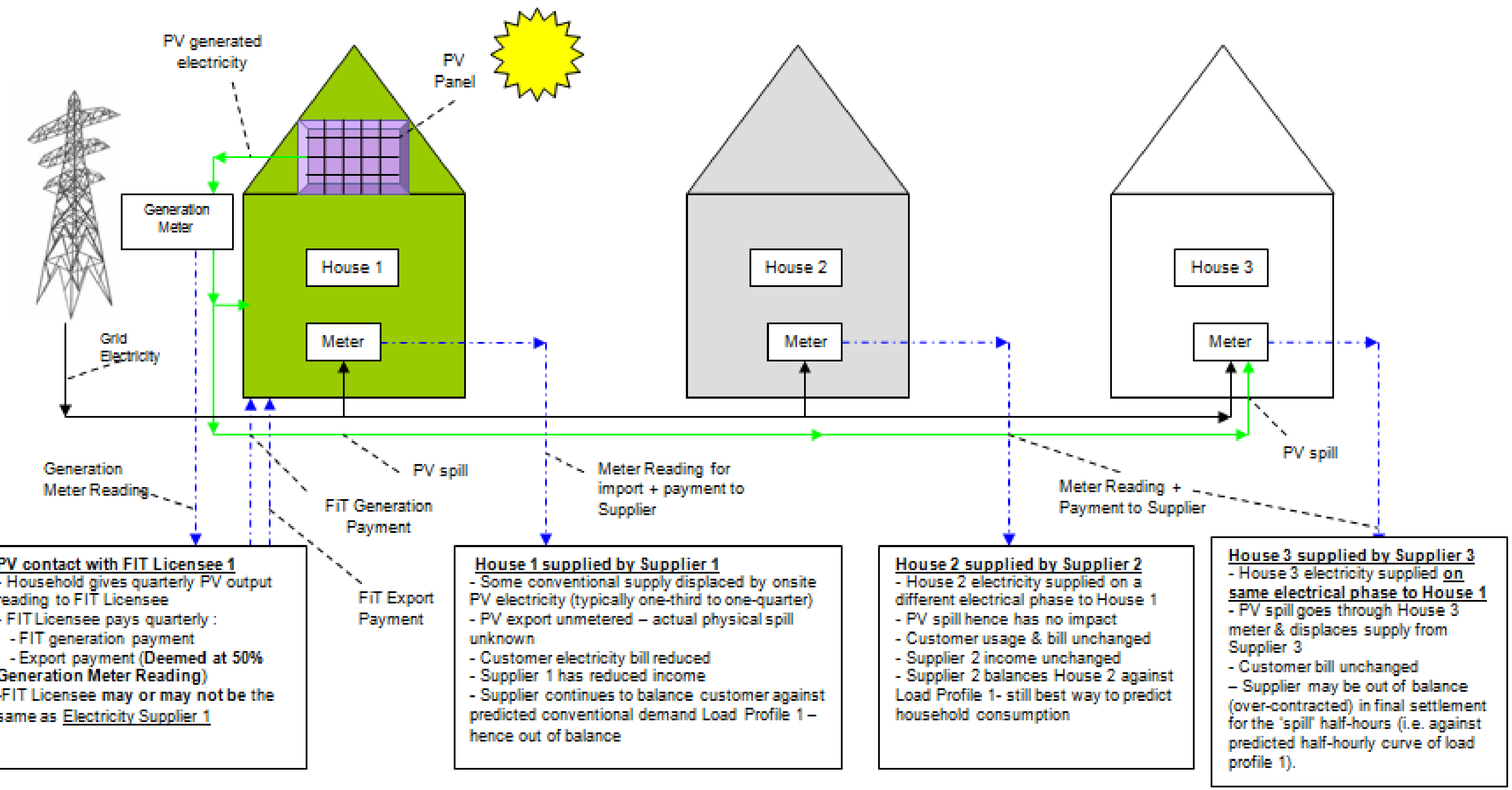
Table 4 : PV system <30 kW – On-Site Use of PV
Table 5 : PV system <30KW – Unmetered 'Spill'

Table 6 : PV system >30 kW – On-Site Use of PV
Table 7 : PV system >30KW – Electricity Export / Metered 'Spill'

26. **Our 'strawman' analysis points to a need for more detailed thinking on the likely physical and commercial interactions of increased PV installation and output for the electricity system.**

[12] 30kW is the present Small Scale Third Party Generating Plant Limit (SSTPGPL) which the BSC allows the BSC Panel to change with Ofgem's approval.

Figure 2 – Illustrative Case-Study : Likely Physical Flows & Commercial Arrangements of a Domestic PV Scheme (typically up to 4 kW)



Section 3 : PV Installations : output volumes, 'onsite-use' and export / spill

PV : Installed Capacity & Output

27. The FIT installation report from Ofgem[13], provides details of all accredited FIT installations under the Feed-in Tariff scheme. As at 31 December 2012, there were some 353,000 PV installations currently operating in the UK. Of these :

    350,000 are below 30kWe in size - totalling 1.1GW installed capacity – and

    2,853 schemes are above 30kW - totalling 325 MW installed capacity.

28. DECC presently report annually on the total kWh generation output of all PV installations[14]. Deemed exports can therefore be inferred at half this volume.

29. *Actual* kWh split between the on-site use of PV electricity and the likely volumes of PV export / spill can only be roughly estimated as the majority of installations, whilst having generation meters, do not have export meters in place.

Export / Spill for PV Installations over 30 kWe

30. Treatment of exported electricity for PV schemes over 30kWe, is set out in Table 1 below. This shows that there are 325 MW of installed capacity of these larger PV systems and that across these larger commercial arrays :

    - A significant proportion of schemes do not export – and so the electricity can be assumed to be used on-site

    - ~Two-thirds of exports take place via a **negotiated** export tariff (so, metered export output sold to an electricity supplier).

---

[13] *Feed in Tariff Installation Report* – Ofgem, 8 January 2013. Registered over the period 1 April 2010 to 31 December 2012.

[14] DECC presently report only on an annual basis. The latest data on FIT generators output – published in January 2013[14] - covers the period April 2011 – March 2012. DECC obtains the aggregated data from each FIT Licencee. In turn, the FIT Licensees receive quarterly metered kWh generation data from individual PV owners, in order to administer quarterly FIT payments. PV generation output for the period April 2011-March 2012 was 259,198 MWh, and estimated PV export was 82,459 MWh. See https://www.gov.uk/government/statistical-data-sets/feed-in-tariff-generation-statistics

- ~One-third of exports are '**deemed'** – so, unmetered spill, receiving a standard FIT export kWh tariff.

Export / Spill for PV Installations below 30 kWe

31. As noted in para 27, for the 1.1 GW of installed capacity across 350,000 small PV units, actual volume of unmetered spill onto the electricity system is not clear.

32. In the absence of export meters, export / unmetered spill is presently 'deemed' at one-half of metered generation – in the expectation that this is a reasonable proxy for actual average volumes of export / spill.

33. In practice :

- *Actual* export volumes cannot be separately or accurately measured until each PV unit is connected to an export meter. Smart meters[15] will include a single export register – so an export calculation should, in principle, become feasible.

- LCNF and other trials may start to offer some better basis for estimating the split between total PV output, and 'typical' volumes of on-site use and export/spill (clearly, however, this is likely to be very customer-specific).

- Understanding of the split between on-site use and spill volumes – especially at different times of the day - presently seems somewhat anecdotal / impressionistic.

34. This short and over-simplified account of current PV installations - and a seeming lack of detailed data on patterns of current PV output - in particular for unmetered export - suggests that DECC, Ofgem and the relevant trade bodies may wish to consider next steps to improve on present rather poor understanding of :

    - 'Typical' output patterns from installed PV capacity, including by region.

    - Likely balance between volumes of on-site PV use - and metered and unmetered spill.

35. **For the future, if PV output continues to grow, without this more detailed picture of (1) PV output patterns and (2) a better understanding of the split between on-site use and export / spill, it is likely to prove very hard in any meaningful way to assess the physical and commercial impacts which PV creates on the electricity system – and therefore, eventually, to identify possible ways to tackle better cost-allocation and cost-efficiency.**

---

[15] SMETS 2

Table 1: Export status of over 30kWe PV schemes

	Non Domestic (Industrial)		Non Domestic Commercial		Domestic		Community			
	No. of schemes	Total kW	No. of schemes	Total kW	No. of schemes	Total kW	No. of schemes	Total kW	**Total No. of schemes**	**Total kW**
No Export (off grid)	2	96	12	537	0	0	0	0	**14**	**633**
No Export	121	11,529	1,109	70,567	630	28,695	70	3,787	**1,930**	**114,578**
Export (std tariff)	24	11,824	187	45,752	163	9,035	16	874	**390**	**67,485**
Export (negotiated tariff)	26	8,921	234	120,994	155	8,453	10	619	**425**	**138,987**
Export (deemed)	5	168	30	1,322	54	1,921	5	199	**94**	**3,610**
Totals	178	**32,538**	1,572	**239,172**	1,002	**48,104**	101	**5,479**	**2,853**	**325,293**

Sustainability First analysis of Ofgem FIT Installation Report. December 2012

Section 4 : Discussion of likely physical and commercial interactions of increasing volumes of installed PV on the wider electricity system.

36. As noted, as of today, the total amount of installed PV capacity is extremely modest compared with total GB generation capacity. Hence the impact on the wider electricity system of PV export and unmetered spill is relatively minor and localised.

37. However, looking ahead, should volumes of PV increase substantially by 2020[16], these impacts may become more material in terms of the physical impacts and the knock-on costs potentially created elsewhere in the electricity system.

38. For the near-term the impact of PV output on the electricity system, is likely to make itself most felt at the level of the local low voltage electricity network. However, once PV is at scale the effect of PV output may also begin to manifest itself system-wide.

39. Paras 21-22 above note how PV output has a distinctive and consistent profile over the course of a day :

   - Ramping up and down with the sunshine hours – and reflecting day-time length through the year ;
   - Consistently peaking in the middle of the day ;
   - Liable to local fluctuation / variation with cloud cover.

40. In considering the likely broad match of PV output with GB electricity demand over the course of the day and the seasons, (in very general terms), we can therefore say :

   - The morning ramp-up of PV output may offer some match with morning peak (to some extent) – perhaps offering a stronger match in summer than winter.
   - PV output could possibly offer a good 'match' with commercial electrical load, which tends to have a comparatively flat day-time profile (ie less of a dip in the middle of the day) – perhaps especially electric heating, ventilation and air-conditioning load.
   - PV output will not directly support the highest period of GB electricity demand at winter evening peak (and the most costly demand to meet) – albeit

[16] Upper end of DECC forecast range for *technical* potential is 20 GW by 2020

for the longer term, development of appropriate / affordable storage which could be deployed at winter-peak could change that.

- PV output tends to peak towards the middle of the day when national, system demand may be low in comparison with other times of the day. Unless PV is used on-site, it seems fair to assume that there may be a relatively higher proportion of PV 'spill' in the middle of the day – so at periods of generally low demand (be that local demand or total system demand).

41. This simplified description of the possible coincidence of electricity demand and PV output, means that :

- On-site use of PV is highly efficient **from an electricity system perspective**

- **PV unmetered spill –** especially if in the middle of the day – may lead to knock-on interactions and costs for the electricity system.

42. Given these basic characteristics of PV output and spill against patterns of GB electricity consumption - and on the basis that PV output may continue to grow in the future - we draw in this section upon Tables 4-7 in Appendix 4 to explore at a high-level, some possible 'headline' interactions with PV from the perspective of market actors as follows :

- Distribution network
- Electricity supplier
- System operator

Distribution Network (DN) Perspective

43. The impact of PV or PV clusters is highly localised. From a distribution network perspective, the impact of a single small PV unit may be negligeable. The impact of PV clusters may perhaps be largely neutral, somewhat disruptive or perhaps even beneficial. This impact is likely to depend upon many interactions particular to that part of the low voltage network. For example, available head-room on the network, loading patterns from demand, what other distributed or micro-generation may be active nearby, and, the extent of either on-site PV use – and / or near-neighbour use - of the PV electricity.

44. For a distribution network, a PV installation or PV cluster may give rise at a particular location for network reinforcement or other action to tackle local voltage management and / or other network disturbance issues.

Limited data on : PV capacity, location, on-site use and spill volumes

45. Distribution networks currently have relatively limited information about the PV installations on their networks and so therefore face uncertainty in their management of the physical and commercial 'knock-on'. For example :

- The local DN must be informed by a PV installer of any new PV system connected to its network, regardless of size. Basic information such as the capacity of the installation and also details such as the roof orientation and angle of inclination of the system are submitted to the DNO by the installer. This information is required within a 30 day period after the installation of the PV system. DNOs therefore have an indication of the kW PV capacity installed within their area. At present there seems to be a process very largely of 'fit and forget', and the extent to which DNOs collate or deploy this data to inform network management is not known.

- DNOs presently do not have the tools to 'see' / monitor generation output from PV sites. Better data and insight on the characteristics and profiles of PV output is becoming available to DNOs from trials, including Low Carbon Network Fund (LCNF) such as Northern Power Grid's 'Customer Led Network Revolution project17 and Western Power Distribution.

- PV output varies with time of day and of year, as well as location. Systems in southern latitudes generally have higher output levels. At present, the south-

---

[17] See CLNR Load Profiles Report 21 December 2012 at http://www.networkrevolution.co.uk/industryzone/projectlibrary

east and south-west of England have the highest concentration of FIT installations (50,000 and 60,000 installations respectively) potentially causing particular issues in relation to spill electricity[18].

Uncertainty over spill volumes, including times-of-day when spill likely to occur

46. A present a key unknown for the distribution networks relates to the general lack of knowledge / uncertainty over (1) spill-volumes and (2) the time-of-day spill is most likely to occur on a particular part of the network.

47. In general terms we know that :

- Most >30kW schemes generate either for own-consumption - or – export on a negotiated tariff.

- Across all installed PV installations, only 206 MW is separately metered for export. Exports are most likely to be recorded on a single meter register (so, any export data is not time-differentiated).

- The 350,000 installed PV units below 30 kW at December 2012 – mostly domestic systems <4kW – with a total capacity of 1.1 GW : **the electricity spill from these units is not metered.**

48. A broad rule-of-thumb used for forecasts by the distribution networks of how much electricity could potentially spill onto the local network from installed PV systems, appears to be the government's present 'deeming' estimate of 50 per cent of electricity generated [19]. Similarly, DECC's quarterly Energy Trends[20] also splits PV on-site generation and export at 50 per cent on an estimated basis.

49. However, such estimates give no insight into whether the pattern of spill may change during the course of the day; nor at what time of day most spill may occur.

---

[18] For example: BBC, 12 March 2013 'Cornwall renewable energy schemes 'strain electricity grid'' : '*Renewable energy projects are putting parts of Cornwall's electricity grid under severe strain… Western Power Distribution (WPD) said that without expensive investment the grid would struggle to cope with taking any more power'*.

[19] DECC has stated that they will continue to determine on an annual basis the arrangements for deeming, and for how exports are considered in the FITs cost levelisation process.

[20] Posted at: https://www.gov.uk/government/publications/renewables-section-6-energy-trends. 'Renewables' chapter of DECC's quarterly energy statistics publication

50. As noted above, a fair assumption would seem to be that highest spill volumes are likely to take place in the middle of the day at times of highest overall PV output. If this is indeed so, highest spill periods can therefore also reasonably be assumed to coincide generally with periods of lower electricity demand, at times of day when the PV output may offer least demand-side value, and, potentially, therefore also create higher knock-on 'disturbance' costs in the network[21].

51. Elexon have suggested that a 50 per cent deemed export level may be 'on the generous side'[22] . DECC research[23] of FIT installations to the end of the 2011 suggests a slightly different perspective, noting that 'high electricity consuming households were more likely to install a PV installation than low electricity consuming households'.

52. Clearer data on *actual* PV export / spill output will therefore be very helpful.

[21] This may be an incorrect assumption where there is a summer day-time cooling load, in central London for example.

[22] Para 2.6 Elexon Risk Operating Plan 2013/14 paper 'PAB142_04-ROP-Paper-2013_14' November 2012

[23] Identifying trends in the deployment of domestic solar PV under the Feed-in Tariff scheme, DECC June 2012, URN 12D/247

Some commercial considerations for distribution networks on PV

53. Current likely knock-on cost impacts on the distribution networks of connection and unmetered spill from small PV units is not known. Any such costs may also become more material in the future as PV installations grow. From a commercial perspective the DNO :

- Cannot presently require a connection charge, or charge Generator Distribution Use of System charges, for a small installed PV unit, even though this may have a physical impact on the local network, with a related cost impact (and notwithstanding post-install notification of the PV units to the DN).

- Recovers the costs of any network reinforcement or actions necessary to manage voltage or other network disturbance problems caused by a PV unit (or local PV cluster) on a socialised basis via its Distribution Use of System charges, payable to the DN by suppliers. It is fair to assume that these additional reinforcement costs are eventually passed back by the suppliers to their non half-hourly customers (Load Profiles 1-8), via retail tariffs.

- May perhaps see a marginal reduction in their DUOS income paid by electricity suppliers – reflecting fewer kWh supplied to customers with PV units (and as allocated in the supplier volume allocation process at each Grid Supply Point group)[24].

- May expect some better information on PV export / spill to become available at an individual household level once smart meters with a single export register are installed. But, the DNO would need access to that data via the Data Communications Company (DCC), (and for which there may be a cost).

[24] **Distribution Use of System Charges :** For the 29 million LP 1-4 customers connected at low voltage, suppliers pay a p/kWh DUOS charge (plus a p/kWh charge for Economy 7). There is also a fixed pence/day/customer fixed charge (in effect a standing charge) to reflect fixed costs of supply – with a capacity related element factored into the calculation.

Electricity Supplier Perspective

Lack of 'joined-up' supplier role : FIT Licensee and Electricity Retailer

54. Current commercial uncertainty for electricity suppliers from PV (similar to the uncertainties for the distribution networks) would seem to relate to their relatively limited knowledge at an individual customer level about :

- **Which of their retail customers have PV units**

- **For their customers with PV units** : the likely output ; how much is likely to be used on-site - and therefore how much power might be displaced which the retailer might otherwise expect to supply to their customer.

- **In a particular local area** : how much PV might be installed there – and what the impacts of un-metered spill might be on the consumption of their retail customers in that locality **– irrespective of whether those customers have PV units**.

55. This uncertainty for a supplier about PV output is compounded by the fact that *at an individual customer level*, a PV generator has at least two distinct relationships with an energy supplier[25].

56. **Importantly, these supplier / customer interactions do not presently appear to combine or 'join-up' into a single customer relationship** and are as follows :

- **FIT Licensee arrangements –** for administration and payment of the Feed-In tariff. A PV generator has a relationship with a FIT Licensee in order to receive their FIT payments. Under the FIT rules, this is required to be a licensed electricity supplier. The FIT Licensee administers the FIT payments to the PV generators[26].

- **Possible power purchase arrangements –** for exported electricity. Would typically apply to only the largest PV installations[27].

---

[25] And for larger PV units with a negotiated export tariff, it is possible even to have three

[26] See footnote 30 in Appendix 1 for further detail. Ofgem manage the Feed in Tariff via a levelisation fund, made up of payments from suppliers based on their kWh market share. . Once these payments are received, Ofgem then pays each FIT licensee the payment amount they have claimed on behalf of their FIT generators.

[27] It is entirely possible for a larger PV owner to have (1) an electricity supply contract for their metered export with one supplier and (2) their contract for FIT-payments with another supplier (the FIT Licensee) and (3) an agreement for their top-up electricity purchases /imports from another.

- **Electricity retailer** - The PV generator[28] also has a conventional agreement with an electricity retailer to purchase their 'top-up' electricity supplies. It is probable that the FIT Licensee will also be the PV generator's supplier – but this is not a requirement for receipt of the FIT[29].

57. Importantly, even if a PV generator has the **same supplier** - both for their FIT contract and for their retail supply agreement **- the two different 'arms' of the electricity supplier may not share data on the customer's metered generation**[30]. In discussion with suppliers, it appears that their retail arm is generally not notified that their customer is a PV generator. **Hence, no account is presently taken by suppliers that as a PV generator their *retail* customer almost certainly has a distinctive PV load profile.**

58. As of today, supplier retail arms therefore cannot readily factor in the potential procurement and imbalance implications of their individual customers having PV on the roof (e.g. the supplier may, initially at least, be over-contracting for that customer in the wholesale markets). This has a minor impact today for electricity retailers, but as PV volumes increase in the future, this lack of knowledge about their customers' PV installations may become more material – *especially in a half-hourly settled world.* See following section for more on this.

---

[28] Unless off-grid

[29] Presumably, so that a customer can continue to choose to switch supplier should they so wish .

In practice, some suppliers very understandably look to encourage a a PV generator also to be their

[30] This separation is likely to reflect data protection arrangements

Commercial uncertainty for suppliers from unmetered spill

59. From an electricity supplier perspective, a key impact of PV, in principle at least, seems to relate to the physical and commercial uncertainty associated with unmetered spill.

60. There presently seems to be little knowledge of and / or insight into the extent of possible supplier imbalance due to this unmetered PV generation. Any additional balancing costs which may arise from unmetered spill are not regarded as significant today, and, anyway, in broad cost-terms for each supplier, are spread equally among all their end-customers[31].

61. Figure 2 depicted how :

- **On-site consumption of any PV output may displace electricity bought by electricity retailers in the wholesale markets to meet their customers' needs.** Suppliers will have no knowledge of the time of day of the on-site consumption.

- **PV spill is likely to be consumed by a near-neighbour on the same electrical phase –** but their supplier will not be aware that their power is being displaced by spill electricity, nor at what time of day [32].

62. In both these examples, until a supplier makes adjustments for their customer's reduced usage due to PV, a supplier may find themselves *over-contracting* in the wholesale market[33].

63. At present, such issues do not seem to unduly concern suppliers. This may be so while PV output is relatively modest, and while the imbalance costs for the non half-hourly customer base are very largely socialised via settlement[34].

---

[31] Due to supplier imbalance charges being allocated across the non half-hourly customer-base on a common 'socialised' basis (via the 'supplier volume allocation process' in the settlement system). This may change with individual half-hourly settlement.

[32] Or, failing that, flow 'upstream' to the nearest transformer

[33] As of today, supplier wholesale purchases for their smaller customers tend to be informed by the half-hourly shape of their Load Profile 1 customers. As of today, this would mean that any supplier imbalance costs arising from their customers' PV output would be most likely to leave them being over-contracted in the wholesale market for the hours noon to 16.00h, rather than under-contracted (so, 'long' rather than 'short'), and for which the associated imbalance charge penalties will tend to be less.

[34] Should this eventually become a concern, and once there are smart meters, it will be possible for suppliers, to be much better informed about the daily consumption patterns of their customers,

64. In the period to 2020 however, the impact of unmetered spill could be expected to concern suppliers more :

- Should PV output increase significantly
- Once smart metering enables more accurate information about a customer's half-hourly consumption pattern – by which to predict a particular PV customer's use. This will allow more accuracy in prediction and procurement of wholesale energy
- With half-hourly settlement - because settlement will be on the basis of *actual* customer usage. Charges associated with imbalance will no longer be largely socialised in settlement across the entire customer base, but will sit clearly at the level of the individual customer, and therefore with their electricity supplier.

System Operator (SO) Perspective

65. With ~1.5 GW of installed PV today, the uncertainties relating to today's modest levels of PV output are of little immediate concern for the system operator.

66. Instead, there is a longer-term interest for the system operator in the prospect of very high levels of installed PV, and how this might sit with the needs and costs of their duties economically and efficiently to :

- Match total system demand and supply at all times
- Balancing the system

67. PV currently does not play a role in either. There are two main reasons :

- PV capacity is still relatively modest and so changes in output do not have a large impact on the overall system.

---

including those with PV – allowing them to improve their prediction tools for their wholesale purchases.

- And, as of today, information on PV output is not available and *'distribution networks are not 'smart' enough to monitor these generation sources and feed information back to the SO.'*[35]

68. Elexon previously undertook some work [36] to consider a forecast level of UK PV penetration of 4.6 GW by 2020[37] . This indicated that at this level, the PV 'export' spill and generation will reduce the overall demand 'take' in a Grid Supply Point Group (GSP). However, they note that the necessary Grid Correction Factor (GCF) to be applied to take this level of PV generation into account would only be very modest. To put this into context, the Grid Correction Factor would amount *to only one-third* of that typically applied to take account of daily temperature variations and seasonal profile changes.

69. However, using more recent Government projections to reflect the significant take-up of PV since the beginning of the FITs programme, National Grid produced a paper for DECC[38] which highlights concern on the potential impact of high volumes of PV generation and spill on System Balancing.

70. Using the mid-value of Government's *technical* potential of around 20 GW of PV by 2020 ie ~10GW PV by 2020 – National Grid suggest that in the long run PV generation and spill could create a particular problem in summer – when electricity demand is typically at its lowest.

71. Potentially, National Grid say, this could lead to a scenario where choices would be needed on which 'must-run' low-carbon plant (nuclear, wind) - might need to be constrained-off - and what the associated costs might be. The paper notes that at present the system operator has neither the appropriate (1) technical tools nor (2) commercial arrangements to influence the output of high volumes of solar PV.

72. At the higher levels of PV penetration forecast by Government, the National Grid note concludes that with 22GW solar PV '*the system would require an unacceptable dependence on the ability to export over the interconnectors, or the construction of additional storage'*.

73. A recent paper by the European Photovoltaic Industry Association (EPIA) also discusses that increasing levels of PV will impact on the distribution and

---

[35] *Electricity System: Assessment of Future Challenges-Annex* – 9 August 2012, DECC

[36] Elexon paper' FiTs and Group Correction Factors: Materiality Analysis' forwarded to Sustainability First

[37] This related to 2009 DECC forecast modelling – the most current at the time of Elexon's work

[38] *National Grid PV briefing note for DECC*, December 2012

transmission system, and that there will be a need for the use of flexible generation plant to ensure system integrity. However their research goes on to suggest that the electricity system will be capable of dealing with this:

'On a regional scale, hourly variability plays a role during region-wide power ramps (when demand increases or decreases), especially in the morning and evening (easy to forecast), but also during special events, such as a storm front (more or less predictable), or vanishing fog affecting a large area (currently difficult to predict).

Morning and evening ramps are mostly tackled in the day-ahead and long-term markets (because they are predictable). PV ramps often occur as demand ramps in the same direction, which is an advantage; but sometimes there is a time shift in both ramps. ***As a result, flexible plants need to compensate for this brief discrepancy in countries with high PV penetration. In winter, this can occur in the evening; in the summer, it typically happens in the morning****.'*

74. The report goes on to say that PV generation output forecasting will be required:

'Forecasting PV on a regional scale is relatively new (in Germany and Spain since 2010). Commercial PV forecasting on a single-plant scale is very new (only since the beginning of 2012). As a result, there is still a high potential for improvement. Increased accuracy is also expected to result from continuous improvement of weather predictions…accurate forecasting will lead to lower system operation costs'.

'While fast but rather small fluctuations can be easily balanced, the real challenge is posed by the steep and high ramps that in the worst-case scenario require additional flexible sources'.

75. Despite these system impacts, the report concludes on a confident note that:

'In fact these ramps can be easily met and such variations can be easily followed by currently installed flexible sources until 2020. Arguments that very steep ramps cannot be met are groundless'.

Section 5 : Smart meters, the export register, and unmetered spill.

76. A key question is the extent to which the single export register in a household smart meter might start to resolve at least some of today's physical and commercial uncertainties from PV output and, in particular, from unmetered spill for market actors - distribution networks, suppliers, and system operator..

77. Smart meters (SMETS 2) will have 48 import registers and a single export register. In theory at least, this should enable a calculation of :

    - Total PV export

    - An *estimate* of export for each half-hour

78. However, there does not so far appear to be a clear consensus across the FIT sector on how far incorporation of an export register into all smart meters will in practice serve to record or to report on *actual* PV export volumes by PV generators – nor, importantly, how it will give either data or insight on PV export *on a time-related basis*.

79. DECC has stated that they '*will review the arrangements for deeming of exports from FITs generators, and will set a longer term trajectory for moving towards the accurate metering of all electricity flows that benefit from FITs*[39]*'*.

[39] See Feed-In Tariff scheme: decision on deeming in relation to Smart Meters' DECC March 2010 URN 10D/589

Section 6 : How PV output could perhaps be incentivised to make a more *cost-efficient* demand-side contribution in the electricity system.

80. Discussion in the preceding sections notes some key uncertainties about PV output today - and some key questions in relation to the electricity demand-side. For the future, if PV output markedly increases, some of these issues will become more material / pressing. Looking ahead, some key considerations are :

- **On-site consumption of PV electricity – is presently the most cost-efficient use of that power**[40] :both for the PV household and for the electricity system in general.
- **There is a potential poor match between the characteristic daily shape of GB PV output - against the highest and most costly periods of GB** electricity demand.
- **The inefficiencies of unmetered spill** – and in particular the knock-on costs which may arise in different parts of the electricity system – and the current poor allocation of those costs back to where they originate.
- **The current administrative and commercial split of customer 'hats' for (1) receipt of PV FIT payments – and (2) being a retail-customer.** In effect, with a PV unit on the roof, it is perfectly feasible to be a single 'prosumer' in *electrical terms* – but it is not yet feasible to be 'joined-up' as a single 'prosumer' *in commercial terms*.
- **As installed PV volumes grow - the potential for these and other inefficiencies to add to costs in the future in the overall electricity system.**

81. In this section we therefore explore in a very preliminary way, whether for the longer term it may be feasible to achieve a better alignment than now between the physical electrical output of PV electricity - and approaches to incentivising its more cost-efficient use. If feasible and / or practicable, the aim would be to incentivise PV electricity to make a somewhat more cost-efficient contribution to the electricity system overall by achieving, where possible, a good match in PV output with periods of high and low electricity demand.

---

[40] Unless and / or until there is a very dramatic rise in wholesale and retail electricity prices

Note : This section does not consider the very important question of the incentive match for efficient PV consumption as between PV-owners and tenanted property with PV units on the roof (eg tenants of social landlords). This is clearly a significant matter – but not considered in this paper.

Why sharpen incentives to the PV Owner to increase on-site consumption ?

83. For the long-run, (and provided this remains cost-efficient) it would seem to make sense to aim to sharpen the FIT incentive to encourage greater on-site consumption as a way of improving overall cost-efficiency of PV output - both for the PV owner and the for electricity system.

84. As noted, **on-site use of PV electricity** is presently (and for the foreseeable future) the most cost-efficient use of that power:

- **For the PV premises / household.** The maximum benefit for a PV household is obtained from the FIT where the PV owner can :

    - Maximise their p/kWh metered generation whenever the sun-shines. This also determines their 'deemed' export p/kWh income (presently set at 50% of metered out-put)[41] – *plus* –

    - **Maximise their on-site PV electricity-usage during the day-time** - in order to maximise the total savings they obtain from their avoided-purchase of electricity – (otherwise imported at the full supply rate). **The latter is what gives on-site PV use its financial advantage over export.**

- **For the electricity system in general** (lower costs relating (chiefly) to unmetered spill).

85. As noted in section xx, the vast majority of PV units do not presently have export meters, and the underlying FIT assumption is that one-half of PV output is exported (although in practice, this may be more or less). The assumption on export is also irrespective of the time-of-day, because, as also noted, PV generates on a 'must-run' basis. Our working assumption is that it is likely that any

[41] Export is currently rewarded at a flat 4.5p/kWh rate and deemed at 50 per cent of electricity generated (as recorded through the generation meter) for the majority of sites (ie the vast majority of PV installations are below the 30kW threshold).

unmetered spill will tend to be greatest around the middle of the day, simply because that is when PV output is greatest (and when demand tends to be lower).

86. Given that for the foreseeable future, the greatest all-round cost-efficiency both for the PV owner and for the electricity system is likely to come with onsite consumption of the PV electricity it seems reasonable to consider whether it may be feasible to evolve or adapt the PV FIT arrangements for the long-term **to incentivise greater on-site use and to reduce unmetered spill.** In the long-run, this could perhaps be incentivised by measures such as :

- Payment of the export part of the FIT tariff on the basis of *actual* rather than *deemed* export. In effect, moving from unmetered spill as now, to metered spill. An export meter would be necessary irrespective of the size of the PV unit (this may become feasible given the export register in household smart meters).

- Payment of a generation-only tariff via the FIT. Any payment for export would become payable only as part of a negotiated arrangement for metered export (as now for larger PV schemes).

How could a time-related incentive (in the FIT, in retail tariffs) support greater cost-efficiency for PV output ?

87. In line with the general proposition underpinning the other case-studies in Paper 7, a key aim is to understand whether and how some form of time-related price signal might eventually support somewhat more cost-efficient PV operation at the very local level on the low-voltage network (and so for the electricity system more generally). Some form of time-related price signal could be reflected either :

- **To the PV-owner directly - and / or**

- **To customers located adjacent to PV units and who are able to use unmetered spill.**

88. This section therefore concludes by exploring four possible 'strawmen' approaches to introducing some form of time-related element into future PV-FIT arrangements and / or to incentivise near-neighbours to use spill electricity.

89. Our 'straw-men' approaches are :

- **A FIT with some form of Time of Use element (ToU)**
- **A FIT requiring onsite storage**
- **A Within-Premises PV Balancing Tariff**
- **Some kind of community-level / postcode ToU Retail Tariff - to encourage uptake of spill** (in effect a PV-twinning tariff).

90. These four ‘strawmen’ possibilities are by no means definitive – there are certainly others.

Strawman 1 - FIT with some element of Time of Use (ToU)

91. Other than sharpening the FIT as outlined above to promote on-site use, a further way to encourage (1) a higher proportion of PV output to be consumed on-site and (2) to discourage unmetered spill – especially at times of day when electricity demand is low – may be to introduce some form of time-related element to the FIT payments.

92. In principle, some time-related variation in FIT payments (eg in the middle of the day payment of a lower generation tariff - and no (or a very low) export tariff) could perhaps help send a signal to PV customers about the overall efficiency of their output for the wider electricity system. However, and importantly, the potential benefit of introducing time-related signals to PV generators *within* the FIT regime – either via the generation tariff – (or in the export portion of the tariff) could in the end be outweighed by the knock-on practical issues for PV owners : a time-related incentive would (i) ignore the basic day-light characteristics of solar PV and (ii) may unrealistically extend investor pay-back periods.

93. In general for the UK therefore, there would seem to be little benefit to the PV-owner in incorporating a time-related element directly into the PV FIT - given that sunny periods tend to coincide with when overall system demand is typically lowest during the main daytime hours. Furthermore, UK demand is generally at its lowest during the summer, when PV output is generally at its highest.

94. In the long-run, more dynamic time-related rewards or, more likely, separately negotiated power purchase agreements for metered export, probably for very local export and matched to certain loads, could perhaps be used to reward PV exports at certain times of the day or year. For example:

- To match local day-time electrical load (commercial buildings, offices etc).
- Cold and sunny but anti-cyclonic days in winter when demand is generally high and wind generation output may be reduced.
- If there was a significant increase in electrical air conditioning/cooling load[42] . Elsewhere, PV output is seen to offer high value to the electricity system during 'office hours' in summer, especially in urban areas. This may also be eventually true for some GB city centres too.

[42] The Government's Market Transformation Programme predicts a 50 per cent in electrical cooling product sales by 2030 (from a year 2000 base).Further information at http://efficient-products.defra.gov.uk/cms/product-strategies/subsector/non-domestic-air-conditioning#viewlist and in DECC's recent Future of Heating strategy paper (March 2013)

Strawman 2 - FIT to require onsite storage

95. Consistent with maximising on-site use of PV - and to minimise unmetered spill for reasons of overall electricity system efficiency - one longer-term option may be for receipt of a FIT incentive to be tied to some demonstrable form of storage.

96. Storage could significantly help to improve the current poor match of PV output with periods of high demand (e.g. winter evening peak) and provide an on-site / local use for PV output at periods of low demand, so reducing unmetered spill. There are many storage approaches which could combine with PV, including :

    - On-site or adjacent off-site storage
    - Battery – be that for electric vehicle (EV) battery charging or stand-alone batteries.
    - Thermal storage – e.g household hot-water tank ; storage-heaters ; thermal hot-water stores for heat-pumps etc

97. However, tying FIT eligibility to storage could (1) prove expensive in terms of pay-back and (2) may bring its own complexity, including verification etc.

98. In particular, the use of stand-alone batteries currently remains an expensive option for storage of PV output and commercially may still be some way off.

Strawman 3 - A 'Within-Premises' PV Balancing Tariff

99. 'Within-premises' balancing of PV with some form of storage is widely seen a highly desirable step for improving the over-all cost efficiency of PV output in the future. PV owners too, seem keen to 'maximise' the use of their PV.

100. Two Low Carbon Network Fund trial projects are presently trialling 'within premises balancing of PV' together with storage, as follows :

- **Customer Led Network Revolution Trial** (Northern Powergrid and British Gas).

  The CLNR project has one trial sub-group where 'within-premises balancing' with PV is being trialled. Equipment has been installed for 10-minute monitoring of PV generation, import and export electricity – designed to *automatically* divert any 'excess' potential spill-electricity into hot water storage (EMMA system). This is primarily a technical rather than a commercial trial – and a new tariff / incentive is not being tested with this trial sub-group.

- **Western Power Distribution Network (WPDN) - SOLA BRISTOL project**. By contrast, this trial is linking onsite energy storage options with a ToU tariff. Customers taking part in this trial are provided with a variable tariff to encourage electricity use at times of high PV generation and to use electricity stored by the battery when the network is heavily loaded. Importantly, WPDN is able to communicate with the battery and discharge it to help with network management.

101. As discussed in section 4 above, arrangements for administration and payment of the FIT – and a customer's arrangements for their electricity supply - are at present wholly separate[43]. As a result, customer interactions with a supplier do not presently appear to combine or readily 'join-up' into one single commercial relationship, which presently makes it commercially difficult to create a single within premises PV Balancing tariff.

102. It seems reasonable to assume that many domestic PV generators also have their FIT Licensee contract with their same energy supplier[44]. Nonetheless, the PV generator receives its FIT generation and export payments from one arm of the supply company – and is sent an electricity supply bill based on their 'import'

[43] (1) To continue to facilitate customer switching – and (2) Data protection rules.

[44] No data is available on this through the FIT programme.

consumption by another arm of the same company. The retail side may in fact be completely unaware that their retail customer is a PV generator. From informal discussion, it appears that this mostly the case.

103. In producing this case-study[45] , we have not come across existing market products which look to bring these two elements together into something like a within-premises 'customer PV balancing tariff'.

104. Any such tariff might take into account the different electricity demand profile of the customer as a result of generating electricity through a PV system onsite, allowing the supplier to better predict the demand of the customer and potentially offer a more appropriate tariff to incentivise (1) on-site use or storage when electricity system costs are low and (2) discharge of the storage when electricity system costs are high.

105. With smart meters, it could also allow the supplier to introduce a ToU tariff appropriate for a PV generator[46] : and potentially also foster long-term relationship between supplier and customer.

[45] Other than the Western Power Distribution trial

[46] See Durham Energy Institute PV output profile on page 11.

Strawman 4 – Community & Postcode ToU Retail Tariffs for PV Twinning - to encourage uptake of spill

106. An area which, if developed, could potentially offer PV generators a market for their export, would be if PV electricity generated could be sold directly to end consumers. There is however significant complexity under present market / licence arrangements to over-come for a PV generator to do this directly.

Larger PV Generators and Community-Led Approaches – Uptake of Metered Spill

107. **Larger PV generators may in time be able to develop community / neighbourhood PV-twinning tariffs**. For example, generators could operate under licence exempt rules[47] with allow a supply of up to 2.5 MW to the residential sector or 5MW in total. Above these limits, generators could enter into a 'licence-lite'(also known as a 'junior supply licence) arrangement with a fully licensed supplier, the rules for which were introduced by Ofgem in 2009 in order to make it easier for distributed energy developments to operate as a licensed supplier on the public network[48].The Greater London Authority (GLA) is currently exploring the opportunity to take on such a licence in order to help support smaller scale generation schemes in London sell their output to customers.[49]

108. There are an increasing number of community-led PV systems which have used share offers to raise funds for the development of their scheme. Such projects may also wish to use the licence arrangements outlined above to sell their output to shareholders who have directly invested in the PV system.

109. Equally, PV systems – such as community or local authority led developments[50] - may wish to offer their output through a supply contract to consumers in the vicinity.

---

[47] The Electricity (Class Exemptions from the Requirement for a Licence) Order 2001

[48] Further information on the following weblink: http://www.ofgem.gov.uk/Sustainability/Environment/Policy/SmallrGens/DistEng/Pages/DistEng.aspx

[49] For further information see http://www.energyforlondon.org/gla-to-apply-for-a-junior-electricity-supply-licence/

[50] It should be noted that local authorities have only been able to receive payments on the export of renewable electricity since 2010, when DECC amended legislation. See DECC Press Release '*Huhne Ends Local Authority Power* Struggle' August 2010 https://www.gov.uk/government/news/huhne-ends-local-authority-power-struggle

110. As can be seen from Table 1, some 425 PV schemes, have contracted 139 MW of PV export on the basis of a PPA through a negotiated tariff. 87 per cent of this output is from non-domestic commercial PV installations. No information is available however as to the market rate these generators are being paid for their output, but it will likely be only a small increase over the standard price, and, once again, it will be at a flat-rate, in that there will be no ToU element to the payments.

111. For the kind of example outlined above, economies of scale, along with the cost and complexity of putting in place all the necessary arrangements, including metering and billing, will determine the viability of such schemes.

Post-Code / Near-Neighbour ToU Retail Tariff – Uptake of Unmetered Spill

112. Arguably, a highly local / neighbourhood approach could perhaps address the cost inefficiency of unmetered spill, especially in locations with PV clusters on the very low-voltage network. This could involve the development of **local or neighbourhood PV ToU tariffs, designed to incentivise local take-up of unmetered spill electricity. In effect, to create 'PV-twinning' tariffs at a very local / neighbourhood level between a PV generator and their near-neighbours**.

113. The basic aim would be to encourage a commercial match between the pattern of very local PV output and very local 'willing' customers. Effectively, a tariff which may encourage 'neighbour uptake' and or 'near-neighgour storage'.

114. The key feature of such a ToU tariff would be a design with an extremely discounted kWh rate in the middle of the day – and a far higher peak-related kWh rate in the early evening (and perhaps in the morning, too). Such ToU tariffs could potentially be offered by :

- ESCOs who also provide / install PV
- Electricity retailers at a particular location, if they become significantly concerned at some future point about their local imbalance due to unmetered spill from PV clusters - or, possibly -
- A distribution network to address the impact of local network disturbance from spill.

116. Initially, such tariffs would seem to be of most benefit at a very local level. However, encouraging very local uptake of unmetered spill could also address some of the wider electricity system impacts of PV output at scale. With mid-range projections from government of >10 GW of PV by 2020, smart meters may perhaps eventually enable more 'dynamic' time-related tariffs suited to addressing

national system-level mis-matches between PV output and customer demand (especially in summer).

117. The commercial 'pull' for the different market actors to offer such local PV ToU retail tariffs is not clear. Not least, it will be necessary to align a number of disconnected / fragmented drivers – plus overcome the associated transaction costs and potential complexity – all of which may militate against.

118. Nevertheless, some commercial examples of market actor engagement at a community and neighbourhood level on local renewable generation are beginning to emerge.

- **Good Energy** - have created the first such renewable electricity 'regional supply arrangement to residents who live in defined postcodes around the Delabole wind farm in Cornwall (further information on this is supplied in Appendix 3).

- **UK Power Networks and EDF Energy** : LCNF Wind Twinning tariff trial – launched in February 2013. A trial of 1,100 customers with smart meters being sent **day-ahead price alerts related to ToU and forecasts of windy days** - to establish household customer willingness to adapt their electricity use at relatively short notice on the basis of 'dynamic' day-ahead prices. Similar weather-forecast linked 'dynamic' approaches could perhaps also eventually apply to PV twinning.

- **Los Angeles** - ToU arrangements already in place for retail customers. Due to a substantial summer cooling load, this can lead to a modest but positive enhancement in the value of PV output – because PV generation coincides high system demand in summer.

Conclusion – Possible time-related approaches to incentivise greater demand-side cost-efficiency for PV

119. These issues are complex, and we do not have all the answers.

120. This analysis has been based on the assumption that to make PV more cost-efficient - both for PV customers and for the electricity system – that it will be important in the future to aim to :

  - To maximise on-site consumption (in so far as cost-efficient).

  - To minimise the cost-impacts of unmetered spill.

121. This section has therefore explored how (1) possibly sharpening the FIT incentive to encourage on-site PV use and (2) considering a variety of time-related approaches to better incentivise PV output and the use of PV spill, may eventually serve to promote a better match between the physical output from GB PV

installations and patterns of GB electricity demand - and therefore greater cost-efficiency in the overall electricity system.

122. The kinds of approach tentatively suggested above are worth further consideration.

123. Work stream 6 of the DECC / Ofgem Smart Grid Forum is starting to consider these cost-efficiency issues from a distribution network perspective, which will be very helpful.

124. However, others including DECC, market actors and the appropriate trade bodies, will almost certainly wish to consider how to improve and incentivise demand-side cost-efficiency for PV installations in the electricity system overall.

Annex 3 : Appendix 1

Background to the FIT scheme

The Government introduced its Feed in Tariff (FIT) policy on 1 April 2010, under powers in the Energy Act 2008. FITs look to encourage the greater uptake of – predominantly[51] - renewable micro-generation technologies and the majority of schemes installed are typically domestic-scale installations below 5kWe. Support is however provided under the FIT scheme for systems up to 5MWe in capacity and DECC have stated that through the use of FITs, they hope to '*encourage deployment of additional small-scale (less than 5MW) low-carbon electricity generation, particularly by organisations, businesses, communities and individuals that have not traditionally engaged in the electricity market'.*[52]

There are two main financial benefits arising out the electricity generated from the PV[53].

- **Generation tariff –** the electricity supplier of the generator's choice pays for each kWh of electricity generated

- **Export tariff –** any electricity generated not used onsite, can be exported back to the grid. The generator is paid for exporting electricity as an additional payment (on top of the generation tariff)

In addition, there are electricity bill savings as less power will need to imported onsite.

The FITs scheme has had considerable revision since it inception in 2010, with PV levels of support coming under particular scrutiny. Government has recently introduced[54] a new support degression policy for PV where tariff rates for new installations will be set by Government every three months starting 1 November 2012, depending on how much PV has been deployed in the preceding quarter. The most recent levels of support for PV can be seen in Appendix 2. Government have improved the tariff rate for the export of electricity for all new PV installations,

---

[51] Gas-fired micro Combined Heat and Power (CHP) – up to 2kWe - is also included within the FIT programme.

[52] See http://www.decc.gov.uk/en/content/cms/meeting_energy/Renewable_ener/feedin_tariff/feedin_tariff.aspx

[53] Both the generation and export tariffs are linked to the Retail Price Index (RPI).

[54] Consultation on Comprehensive Review Phase 2A: Solar PV Cost Control, DECC, May 2012

raising the unit price to 4.5p/kWh. The latest changes to FIT also include a reduction in the tariff lifetime for new PV installations and extensions from the current 25 years to 20 years.

There has been considerable demand for the installation renewable energy systems under the FITs scheme: as at the end of December 2012 over 330,000 installations have been registered under the FIT scheme (since its inception at 1 April 2010) with 1.6 GW of Total Installed Capacity registered (and representing 11 per cent of all renewable electricity capacity[55]). Of this, photovoltaics installations making up more than 90 percent of installed capacity (see Appendix 6 for growth of PV since April 2010). The Government's latest projections[56] for PV capacity to 2020 in the UK predicts a central scenario of 11.9 GW of capacity. However, the impact assessment suggests that deployment could range from 3.5GW to 21.1GW depending on the rate of future PV cost reductions.[57]

The range for potential PV capacity operating in the UK by 2020 remains highly uncertain, however the mid-to- higher levels of installation levels currently being estimated would clearly point to the PV demand-side commercial impact potentially being very material. If Germany is a model eventually mirrored by the UK, it is interesting to note that cost-reductions in PV panel prices have led to the installation in Germany of 7,634 MW in 2012 alone. This is double the German Government's original target. This is on top of PV installation rates of 7.5 GW in 2011 and 7.4 GW in 2010. In Germany, PV capacity stands at over 25GW at present, supplying over 18 TWh of power.

FITs and FIT Licensees (suppliers)

The FIT scheme creates an obligation for certain[58] Licensed Electricity Suppliers to make tariff payments to eligible installations for the generation and export of renewable and low carbon electricity.

---

[55] December 2012 Energy Trends: section 6 – renewables, DECC

[56] Impact Assessment: Government Response to Consultation on Feed-in Tariffs Comprehensive Review Phase 2A: Solar PV Tariffs and Cost Control, DECC, May 2012

57 DECC's Renewable Energy Roadmap (December 2012) states that between 7-20 GW of solar could be operational in 2020. DECC will publish a solar strategy later in 2013 looking at again at projections It says 7-20 gigawatts of solar could be operational in 2020 and reveals that DECC will this year publish a solar strategy that "will set out a clear vision for solar PV through to 2020, seeking to provide long-term investor confidence"..

58 Effective from 1 August 2012, Licensed Electricity Suppliers are defined as Mandatory FIT Licensees if they have a minimum of 250,000 domestic customers as at 31 December of the immediately preceding FIT year. Licensed Electricity Suppliers with fewer than 250,000 domestic customers can elect to register and make FIT payments to certain eligible generators. These Licensees

There are considerable requirements placed on FIT Licensees, which include the following responsibilities:

i. Taking all reasonable steps to verify that a FIT applicant‘s installation is eligible for the FIT scheme and that information provided by the FIT applicant is accurate.

ii. Assessing applications for Microgeneration Certification Scheme (MCS) FIT accreditation against the Energy Efficiency Requirement and multi installation rules.

iii. Submitting details in relation to Eligible Installations to Ofgem for entry onto the Central Fit Register (CFR), including those verified as community organisations or education providers by Ofgem.

iv. Taking all reasonable steps to ensure the data submitted to Ofgem for entry on the CFR is accurate, and, if necessary, updating and amending the CFR with new information.

v. Acquiring generation and/or export meter readings: and taking all reasonable steps to satisfy themselves that these generation and/or export meter readings are reasonable and within expected tolerances for that particular installation.

vi. Verifying generation and/or export meter readings at least once every two years.

vii. Calculating and making FIT payments in accordance with the information held on the CFR and ensuring that FIT Generators and nominated recipients only receive FIT payments which they are eligible for.

viii. Ensuring that FIT Generators registered with the FIT Licensee for both their electricity supply and FIT payments are not discriminated unreasonably in terms of changing electricity supplier or the price paid for electricity supply.

In relation to meters, FIT licensees must check that the import MPAN (and export MPAN as applicable) provided is valid and correct. Where the FIT Licensee is the supplier for the MPAN it is expected that a check is made against their own records. Where they are not the supplier of the MPAN a check should be made against ECOES. Alternatively as a minimum the first 2 digits (Distributor ID) should be checked to ensure it starts with a value in the range 10-28 as this refers to the Distribution Network Operator (DNO) or Independent Distribution

---

are classed as Voluntary FIT Licensees. Further information is detailed in Ofgem's *Feed-in Tariff Scheme: Draft guidance for licensed electricity suppliers (Version 5) – November 2012.*

Treatment of Purchase of Deemed Electricity by Electricity Suppliers

DECC has indicated that, unlike for *actual* metered exports, suppliers who are also FIT Licensees and so responsible for paying FITs to PV generators will **not** have the opportunity to benefit directly from the purchase of that deemed electricity[59]. Instead, DECC go on to say that : '*Payment of deemed exports will therefore be included in the levelisation process as part of the total cost of the FITs scheme. However, because these exports will be spilled onto the electricity system, there is a benefit to electricity suppliers through lower grid correction factors. This benefit will be estimated as part of the levelisation process based on the BSC system sell price and will be netted-off the value of deemed export payments according to market share.'*

[59] See Feed-In Tariff scheme: decision on deeming in relation to Smart Meters' DECC March 2010 URN 10D/589

Exporting Electricity from PVs

Generators with a total installed capacity over 30kW

An accredited FIT installation with a total installed capacity of over 30kW must have an export meter to receive export payments from the FIT Licensee.

Generators have to make an initial choice whether to opt into the FIT export tariff system and receive the guaranteed export payment (currently 4.5p kWh for new systems) or to sell exported electricity on the open market through a Power Purchase Agreement (PPA). Suppliers are required to explain this choice to FIT generators.

Generators who **opt in** to receive FIT export payments are not able to opt out and sell exported electricity on the open market, and vice versa, until at least the first anniversary of their participation in the scheme. After that date, FIT generators are permitted to change their selection to opt in or out, but no more than once every 12 months.

Suppliers are not be able to assist with the installation of an export meter, but register the export MPAN and record the generator for export payments. For an export meter to be fitted, the generator/installer should contact :

- A local meter operator to see if they are able to offer an export meter operator agreement

- The local DNO to obtain an export MPAN number

In addition to the cost of installation of the export meter there are ongoing annual charges by the meter operator which can range from between £350-800.

Where an export meter is installed, the FIT Licensee can elect to register it with the Balancing and Settlement Code (BSC) for the purpose of settlement. Such registration is the responsibility of the FIT Licensee.

Generators with a total installed capacity below 30kW

For a PV array below 30kW an export meter is optional. This is because the Government has indicated that the expense of providing export meters for small scale generators may potentially lead to stranded costs ahead of the future national roll-out of smart meters which begins in 2014. Generators can pay for an export meter to be fitted, in which case the output from this must be used to determine export payments – however in general suppliers are encouraging customers to wait for the introduction of smart meters. Smart meters with a single export register may be rolled out by some energy suppliers from 2014 onwards[60].

Government have put in arrangements, strictly as an interim measure, for the export element of these smaller systems to be 'deemed'. The Secretary of State determines the percentage of electricity deemed to be exported, and this currently stands at 50% of generation meter recorded output. A PV owners FIT payment will be based on this amount no matter what their actual export is.

Generators however do have the opportunity to opt out of this fixed price and can try to negotiate a better rate with their electricity supplier if they choose to.

For both larger and smaller systems, supplier payments to the generator are made on a quarterly basis. For >30kWe systems meter readings must be received by the supplier before payments are made.

Currently domestic scale scheme payments are made independently of the electricity supply bill. An example calculation of income from a PV system is provided in Appendix 3.

[60] SMETS 2 meter (Smart Meter Electricity Technical Specification 2).

Annex 3 : Appendix 2

Ofgem Feed-in Tariff Payment Rate Table for Photovoltaic Eligible Installations for FIT Year 4 (2013/14)

Table 2

Description	FIT Year 4 2013/2014			
	For Eligible Installations with an Eligibility Date on or After 1 February 2013 and before 1 May 2013		For Eligible Installations with an Eligibility Date on or After 1 May 2013 and before 1 July 2013	
	(p/kWh)		(p/kWh)	
Solar photovoltaic with Total Installed Capacity of 4kW or less, where attached to or wired to provide electricity to a new building before first occupation	Higher rate	15.44	Higher rate	15.44
	Middle rate	13.90	Middle rate	13.90
	Lower rate	7.10	Lower rate	7.10
Solar photovoltaic with Total Installed Capacity of 4kW or less, where attached to or wired to provide electricity to a building which is already occupied	Higher rate	15.44	Higher rate	15.44
	Middle rate	13.90	Middle rate	13.90
	Lower rate	7.10	Lower rate	7.10
Solar photovoltaic (other than stand-alone) with Total Installed Capacity greater than 4kW but not exceeding 10kW	Higher rate	13.99	Higher rate	13.99
	Middle rate	12.59	Middle rate	12.59
	Lower rate	7.10	Lower rate	7.10
Solar photovoltaic (other than stand-alone) with Total Installed Capacity greater than 10kW but not exceeding 50kW	Higher rate	13.03	Higher rate	13.03
	Middle rate	11.73	Middle rate	11.73
	Lower rate	7.10	Lower rate	7.10
Solar photovoltaic (other than stand-alone) with Total Installed Capacity greater than 50kW but not exceeding 100kW	Higher rate	11.50	Higher rate	11.50
	Middle rate	10.35	Middle rate	10.35
	Lower rate	7.10	Lower rate	7.10
Solar photovoltaic (other than stand-alone) with Total Installed Capacity greater than 100kW but not exceeding 150kW	Higher rate	11.50	Higher rate	11.50
	Middle rate	10.35	Middle rate	10.35
	Lower rate	7.10	Lower rate	7.10
Solar photovoltaic (other than stand-alone) with Total Installed Capacity greater than 150kW but not exceeding 250kW	Higher rate	11.00	Higher rate	11.00
	Middle rate	9.90	Middle rate	9.90

	Lower rate	7.10	Lower rate	7.10
Solar photovoltaic (other than stand-alone) with Total Installed Capacity greater than 250kW		7.10		7.10
Stand-alone (autonomous) solar photovoltaic (not attached to a building and not wired to provide electricity to an occupied building)		7.10		7.10
EXPORT TARIFF		4.64		4.64

The **lower rate** applies to installations that do not meet the energy efficiency requirement in buildings where PV installations are installed.

The middle rate is the multiple installation tariff – it applies to installations that meet the energy efficiency requirement (if applicable), and where the generator or nominated recipient for FIT payments is already the generator or nominated recipient for 25 or more other solar PV installations.

The higher rate is the standard tariff for installations that meet the energy efficiency requirement (if applicable) and do not fall into the definition of multiple installations.

Annex 3 : Appendix 3

Sample domestic scale PV income calculation[61]: Example for a 3kWe PV array

Inputs

Such a system would take up approximately 21m^2 and – at present - cost between £5,000-£7,000 (depending on type of PV and installation price).

-Typical output: 2,550 kWh/y[62]
-Generation tariff: 15.44 p/kWh
-Export tariff: 4.5 p/kWh – applied to a deemed 50% of metered generation output
-Assumed electricity import price: 15p/kWh

For illustration purposes – assuming the FIT tariff rates stayed as they are:

- the calculation assumes further costs reductions and considers PV installation prices of £4,000 and £4,500.
- Increased levels of electricity import price are also assumed (16p/kWh and 17p/kWh)

Other issues to consider:

- Using more PV output onsite would increasing savings (ie offsetting importing electricity)
- The generation and export tariffs index linked to RPI – a simple payback is provided above. In reality the PV outputs would be of greater value.

Government is now reviewing PV rates on a three-monthly basis.

---

[61] December 2012

[62] Load factors are determined by differing levels of radiation across the UK. There is a significant scope for variance in load factor. Data from FITs for a typical UK installation indicates 9.7% (850 kWh/kWp) http://www.decc.gov.uk/assets/decc/11/consultation/fits-comp-review-p1/3365-updates-to-fits-modeldoc.pdf and for installations in the south west it is possible to generate significantly higher load factors of 12% (1050kWh/kWp/yr)

Table 3

Cost	Output/kWh	15.44 p/kWh generation tariff A	50% export at 4.5p/kWh B	Electricity import avoided at 15p/kWh (assuming 50% PV output used onsite) C	Total PV income A+B+C	Payback time/years	Payback time/y at 16p/kWh import price	Payback time/y at 17p/kWh import price
4000	2550	393.72	114.75	191.25	699.72	5.72	4.36	4.25
4500	2550	393.72	114.75	191.25	699.72	6.43	4.91	4.78
5000	**2550**	**393.72**	**114.75**	**191.25**	**699.72**	**7.15**	5.46	5.31
5500	**2550**	**393.72**	**114.75**	**191.25**	**699.72**	**7.86**	6.00	5.84
6000	**2550**	**393.72**	**114.75**	**191.25**	**699.72**	**8.57**	6.55	6.37
7000	**2550**	**393.72**	**114.75**	**191.25**	**699.72**	**10.00**	7.64	7.43

Annex 3 : Appendix 4

Illustrative Tables to work-through some high-level physical and commercial interactions of PV installations (below and over 30kW) on the electricity system.

These illustrative Tables work-through at a very high-level some potential future interations which may arise from greater quantities of PV being introduced onto the electricity system.

- **Tables 4 & 5** - work through some of the possible high-level physical and commercial impacts - that we have explored with our notional <30kW PV generation 'case-study' .

  Table 4 : PV system <30 kW – On-Site Use of PV
  Table 5 : PV system <30KW – Unmetered 'Spill'

- **Tables 6 & 7** similarly work through in more detail some of the possible high-level physical and commercial interactions **for a non-domestic scale PV scheme over 30 kW**.

  Table 6 : PV system >30 kW – On-Site Use of PV
  Table 7 : PV system >30KW – Electricity Export / Metered 'Spill'

Illustrative Case Studies : PV Systems with a total installed capacity of below 30kW

<u>Table 4:</u> PV system <30 kW – On-Site Use of PV

PV system <30kW – On-site use of PV					
	Customer	**Supplier**	**DNO**	**System Operator**	**Neighbour**
Physical Impacts	Generation of electricity through the use of onsite PV will lead to a reduction in power imported by the customer.	A generation meter will have been fitted as standard. The customer will be monitoring the PV output and reporting this to the FIT Licensee in order to receive FIT payments. The supplier will be supplying less units of electricity to the customer.	The installer of the PV system is required to report installation to the local DNO and follow the required engineering recommendations – G83 - after the PV has been connected. Information submitted includes size of system, orientation of roof and angle.[63] For small systems (this corresponds to 3.68	Negligible at present	No changes.

[63] Interestingly, a recent Elexon paper has reported that a distribution operator stated *"that in its experience they are only notified of around two thirds of installations"* Elexon Risk Operating Plan 2013/14 paper 'PAB142_04-ROP-Paper-2013_14' November 2012

		None of the FIT licensees currently require any form of 'smart meter' installed alongside the installation of a PV.	kW on a single-phase supply and 11.04 kW on a three-phase supply.)		
Commercial Impact	The customer will see a reduction in their electricity bill from their supplier. Exactly how much will depend on how much of the PV generated electricity is used on-site. In general, customers will gain maximum financial benefit by using as much of the PV generated electricity onsite as possible as the generation tariff is worth more than the export tariff. The customer receives quarterly generation payments and export payments (deemed at 50% of metered generation) from the FIT Licensee on the basis of their generation meter reading.	The supplier will be selling less units of power to their customer and hence have reduced income. The reduction in the electricity supply bill will depend on how much PV electricity generated is used on site by the customer. The customer's electricity demand profile will also change with 'own-use', and the supplier may eventually need to consider taking into account such changes in relation to settlement of that individual customer and / or in managing its imbalance risk.	The DNO will see : For PV-owner as <u>import customer</u> • Marginal reduction in its kWh-related DUOS income, if any (via volume allocation through the application of a Grid Correction Factor at the Grid Supply Group point). • Possibly slightly greater reduction in DUOS income, should the supplier adapt the individual customer Load Profile for settlement (ie amended LP 1). Probably not likely.	Negligible at present	No changes.

Table 5: **PV system <30KW – Unmetered 'Spill'**

PV system <30kW – Impact of Unmetered spill					
	Customer	**Supplier**	**DNO**	**System Operator**	**Neighbour**
Physical Impacts	Any electricity unused by the customer will spill offsite. There will be no physical impact on the customer in relation to this spill. The customer may continue to import their electricity at the same time of day as before they installed the PV units.	An export meter is not required for these smaller systems. One can be fitted, but that is entirely at the customer's discretion – so all spill electricity is completely unmetered. This makes the spill unknown / hard-to-predict both in terms of volume and time-of-day.	The customer will now also be spilling power from site. This could create local voltage management problems.	Negligible at present	The physical flow of the spill electricity will be for it to go to the site of nearest of demand **on the same electrical phase**. Hence, neighbouring consumers– on the same phase electricity supply as the PV generation site- will be directly using any spill output from the PV – and neither they

					or their supplier will be aware this is happening.
Commercial Impact	The customer will be rewarded on a ‘deemed basis by the export tariff for electricity spilled to the network. This currently stands at 50% of the generation output of the PV.	The FIT Licensee will pay the customer on a quarterly basis the export tariff for units spilled. Currently this is at a flat standard rate of 4.5p/kWh, as set by Government. Importantly, DECC have indicated that unlike metered exports, suppliers paying FITs will **not** have the opportunity to benefit directly from the purchase of that deemed electricity.	DUOS of customer’s imported electricity – no impact, because their supplier would not need to adjust their Load Profile. Distribution networks are designed (and paid for) around coping with highest system peak loads. PV output tends to miss typical system peaks which occur in early morning and late afternoon/early evening – hence PV spill not at present a principle concern in terms of charges related to reinforcing the network for peak – but more so perhaps for voltage management.	Negligible at present	Electricity going to a neighbour from a PV which spills will be metered on the neighbour’s site as being supplied from their own supplier Hence will the neighbour’s supplier be paid for electricity not physically supplied.? Will the neighbour’s electricity supplier therefore possibly be out of balance?

Systems with a total installed capacity of <u>more</u> than 30kW

<u>Table 6:</u> PV system >30 kW – On-Site Use of PV

PV system >30kW – On-Site Use of PV					
	Customer	**Supplier**	**DNO**	**System Operator**	**Neighbour**
Physical Impacts	Generation of electricity through the use of onsite PV will lead to a reduction in power *imported* by the customer.	A generation meter and an export meter will have been fitted as standard. The customer will be monitoring the PV generation output and reporting this to the 'FIT Licensee' in order to receive FIT payments. The supplier will be supplying less units of electricity to their customer.	The installer of the PV system is required to report installation to the local DNO and follow the required engineering recommendations – G83 - after the PV has been connected. Information submitted includes size of system, orientation of roof and angle.	Negligible at present	No changes.
Commercial Impact	The customer will see a reduction in their electricity bill from their supplier. Exactly how much reduction depends on how much of the PV	A supplier will sell less units of power to the customer and hence have reduced income. The reduction in the bill for electricity supply will depend on how much PV electricity	The DNO will see : • Marginal reduction in its kWh-related DUOS income, if any (via volume allocation through the application of a	Negligible at present	No changes.

	generated electricity is used on-site. In general, customers will gain maximum financial benefit *by using as much of the PV generated electricity onsite as possibl, as the generation tariff is worth more than the export tariff*. The customer also receives their quarterly generation payment on the basis of their generation meter reading. Payments are made by the FIT Licensee with whom they have their FIT contract with	generated is used on site by the customer. The customer's electricity demand load profile will also change with 'own-use' - , and the supplier may need to take into account such changes in relation to settlement of that individual customer against their standard Load Profile - and/or in managing its imbalance risk.	Grid Correction Factor at the Grid Supply Group point). • Possibly slightly greater reduction in DUOS income, should the supplier adapt the individual customer Load Profile for settlement. Probably not likely.		

<u>Table 7:</u> PV system >30KW – Electricity Export / Metered 'Spill'

PV system >30kW – Impact of electricity export / metered spill from					
	Customer	**Supplier**	**DNO**	**System Operator**	**Neighbour**
Physical Impacts	Any electricity unused by the customer will spill offsite. There will be no physical impact on the customer in relation to this spill. *Import* would also change as a result of any onsite use	An export meter will have been fitted as required under FIT rules and hence the FIT Licensee will be aware of the volume of power spilling from the PV installation.	DNO is aware of metered spill – because the system has been notified. Customer spill could create un-intended stability issues (voltage) on the LV network [unless large enough to be subject to G59 connection arrangement].	Negligible at present (covered in further detail below)	The physical flow of the spill electricity will be for it to go to the site of nearest of demand. Hence, neighbouring consumers – on the same phase electricity supply as the PV generation site - will be directly using any spill

					output from the PV.
Commercial Impact	The customer will be rewarded under the FIT on the basis of *actual* units exported - as measured by the mandatory export meter.	The FIT Licensee will pay the customer on a quarterly basis the export tariff for metered units 'spilled'. Currently this is at a flat standard rate of 4.5p/kWh, as set by Government. **Power Purchase Agreement (PPA):** Alternatively the customer/generator could look to arranging a Power Purchase Agreement (PPA) for its export power with a supplier, and a number of PV systems are already doing this (see below). The terms of the PPA will be commercially negotiated – but could incorporate some time-related value of the PV exports The FIT Licensee can elect to register the export meter with the Balancing and Settlement Code (BSC) for the purpose of settlement. If a FIT Licensee does not do so, all suppliers could face imbalance in that locality. Industry comments for this study have suggested that very few of these export meters are in fact registered. The reason for this is that the meter does not need to be	Supplier DUOS – if we assume no change to the *import* at this site, there will be no impact to DNO in terms of DUOS revenues received from suppliers. Distribution networks are designed (and paid for) around coping with highest system peak loads. PV output tends to miss typical system peaks which occur in early morning and late afternoon/early evening – hence PV spill not at present a principle concern in terms of charges related to reinforcing the network.	Negligible at present. For long run (say ~10+GW PV 2020) may create problem at summer 'system minimum load'. Could lead to choices on whether 'must-run' low-carbon plant must be curtailed - & at what cost.	Electricity going to a neighbour from a PV which spills will be metered on the neighbour's site as being supplied from their own supplier Hence will the neighbour's supplier be paid for electricity not physically supplied.? Will the neighbour's electricity supplier therefore possibly be out of balance?

		registered under the BSC unless the Supplier wants to be paid for the energy through Settlement. Where the meter is registered for Settlement, the SSTPGPL[64] requires Half Hourly metering for sites above 30kW. There will be a trade-off between the cost of metering and the value of the export volume settled.			

[64] Small Scale Third Party Generating Plant Limit

Annex 3 : Appendix 5

The Delabole Local Tariff

Completed and commissioned in 1991, Delabole was the UK's first commercial wind farm.

Good Energy bought the wind farm in 2002 and has owned and operated it since that time. In 2009 Good Energy invested £11.8 million to develop a second generation of turbines on the site.

The Delabole Local Tariff was launched by Good Energy in January 2013 and is only available to households within a two kilometre radius of the substation at Delabole wind farm. The tariff is only available to domestic properties.

Table 8

Good Energy state that the tariff will 'A*lways be 20% cheaper than our standard electricity tariff and with an annual windfall bonus when the Delabole turbines produce more electricity than we predict, this tariff is the first in the country to put communities at the heart of renewable energy generation*'. **Delabole Local tariff pricesTariff**	**Standard prices**		**Economy 7 prices**		
	Standing charge	Unit charge	Standing charge	Day	Night
Delabole	**11.40**	**12.36**	**15.19**	**13.56**	**6.50**

Prices effective from 8th January 2013

Further information is available at: http://www.goodenergy.co.uk/switch/our-prices/delabole-local-tariff

Annex 3 : Appendix 6

Figure 3 below illustrates the number of sub 50kW solar photovoltaic installations installed at the end of each week that are recorded on The Microgeneration Certification Scheme – (MCS) Installation Database. The statistics are the most recent up to week ending 31 March 2013. DECC publishes these weekly statistics at:

https://www.gov.uk/government/statistical-data-sets/weekly-solar-pv-installation-and-capacity-based-on-registration-date

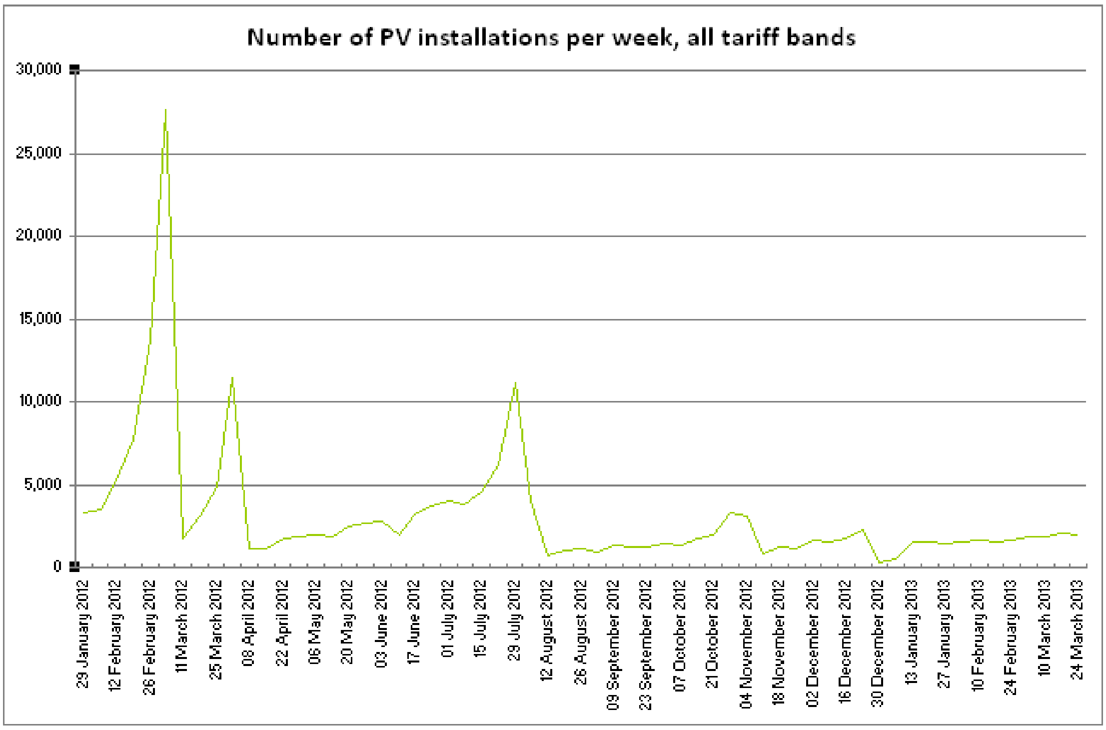


Figure 3

Sustainability *First*

Sustainability *First* was set up to develop new approaches to sustainability. Its primary focus is on policy and solutions within the UK, but draws on experiences and initiatives both within and outside the UK.

Sustainability *First* develops implementable ideas in a number of key policy areas – notably, energy, water and waste - where it can make a difference. It undertakes research; publishes policy and discussion papers; organises high level seminars and other events. Sustainability First is a registered charity.

 Its projects are developed by the trustees and a number of associates and consultants.

Sustainability *First's* Director is Judith Ward.

Sustainability *First*'s associate is: Gill Owen.
Maria Pooley is Sustainability *First*'s research officer.

Sustainability *First* is a registered charity number 107899.

Sustainability First
10 Dean Farrar Street
London
SW1H 0DX

www.sustainabilityfirst.org.uk

Email info@sustainabilityfirst.org.uk

Sustainability *First*