Department
of Energy &
Climate Change

UK Solar PV Strategy Part 1: Roadmap to a Brighter Future

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Contents

Foreword by the Rt. Hon. Gregory Barker MP, Minister of State for Energy and Climate Change

This is a truly exciting time for UK solar. In the last three years, under the Coalition Government, the sector has gone through a period of profound change, challenges and staggering growth.

We have deployed almost 2.5GW of solar and installed solar PV on nearly half a million homes as well as thousands of businesses and community sites.

The DECC central forecast estimates that the UK is likely to reach 10GW by 2020. But I believe we can go faster and further.

Along with many in the industry, I think that up to 20GW of deployed solar is not only desirable but also potentially achievable within a decade. But we will only meet such an ambitious level of deployment if we all work in even closer partnership and achieve grid parity sooner.

Delivering such an ambition will require even greater innovation, new skills, relentless downward pressure on costs - right through the whole supply chain and a much more dynamic grid network - all of which we will seek to examine in the full strategy which we will publish early next year.

But big ambition must also be matched by a much greater sensitivity to impacts on landscape, visual amenity and biodiversity. Local communities must be willing partners in solar expansion; not just consulted but respected and where ever possible, financial partners in local projects.

The global solar sector is going through a period of hyper-change. We must make sure we grasp solar PV's full potential, along with the British jobs and wide economic and environmental benefits that it can bring, as we compete with growing confidence in the global race.

Rt. Hon. Gregory Barker MP

Executive Summary

1. Solar PV is one of the eight key renewable energy technologies that can help to create a clean, balanced UK energy mix[1]. It has significant advantages: it is versatile and scaleable, with deployment possible in a wide range of locations including domestic and commercial buildings and where appropriate on the ground; solar projects can be developed and installed very quickly; and the fuel - solar radiation, is free.

2. The UK has seen a significant level of solar PV deployment together with significant cost reduction over recent years with installed costs estimated to have fallen around 50 per cent between 2010 and 2012[2]. The ability to deliver further reductions in the installed costs of solar PV will determine the level of sector growth and the ability for the levelised cost of solar PV to become competitive with other low-carbon electricity sources.

3. As of June 2013, the UK now has 2.4GW installed capacity generating 1.4TWh during July 2012 to June 2013[3]. The Government is committed to substantially increasing the deployment of renewable energy across the UK and recognises the potential role and contribution that solar PV can play in helping to meet the UK's target of 15 per cent renewable energy from final consumption by 2020[1], and in supporting the decarbonisation of our economy in the longer term.

4. The extensive deployment of solar PV across the UK has become increasingly visible to the public at all scales and is among the most popular renewable energy technologies. Recently solar received the highest public approval rating of all renewable energy technologies at 85 per cent[4]. We need to ensure that this level of support can be maintained – including by ensuring that solar PV is appropriately sited, and allow for greater community engagement. We do, however, expect on-going deployment of the technology to continue at all scales.

5. All these factors mean that the time is right for the Government to set out its vision of the strategic direction for solar PV in the UK – making sure that our policies support the appropriate deployment in a sustainable, cost-effective way. We need to provide certainty to investors, solar developers, and the households, communities and businesses affected by solar PV.

[1] DECC (2012) UK Renewable Energy Roadmap Update 2012
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/80246/11-02-13_UK_Renewable_Energy_Roadmap_Update_FINAL_DRAFT.pdf
[2] Provided as part of the FITs Comprehensive Review by Cambridge Economic Policy Associates (CEPA) Cambridge Economic Policy Associates Ltd and Parsons Brinckerhoff (2011) Updates to the Feed-in Tariff Model Documentation of Changes for solar PV Consultation
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48136/2174-cepa-paper.pdf
and Parsons Brinkerhoff (PB) (in October 2011[2]) and by PB (in May 2012) Parsons Brinckerhoff (2012) Solar PV Cost Update
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43083/5381-solar-pv-cost-update.pdf
[3] Energy Trends, September 2013, table ET 6.1 https://www.gov.uk/government/publications/renewables-section-6-energy-trends
[4] DECC (2013) Public Attitudes Tracker Wave 5
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/198722/Summary_of_Wave_5_findings_of_Public_Attitudes_Tracker.pdf

6. This Roadmap sets out four guiding principles, which form the basis of Government's strategy for solar PV. These principles are:

   I. **Support for solar PV should allow cost-effective projects to proceed and to make a cost-effective contribution to UK carbon emission objectives in the context of overall energy goals** – ensuring that solar PV has a role alongside other energy generation technologies in delivering carbon reductions, energy security and affordability for consumers.

   II. **Support for solar PV should deliver genuine carbon reductions that help meet the UK's target of 15 per cent renewable energy from final consumption by 2020** and in supporting the decarbonisation of our economy in the longer term – ensuring that all the carbon impacts of solar PV deployment are fully understood.

   III. **Support for solar PV should ensure proposals are appropriately sited, give proper weight to environmental considerations such as landscape and visual impact, heritage and local amenity, and provide opportunities for local communities to influence decisions that affect them**.

   IV. **Support for solar PV should assess and respond to the impacts of deployment on: grid systems balancing; grid connectivity; and financial incentives** – ensuring that we address the challenges of deploying high volumes of solar PV.

7. This Roadmap sets out these principles – covering what has been done to date, and where further work is needed. Further work will be completed ahead of publishing the Solar PV Strategy in spring 2014 which will assist the development of policy and the growth of the sector.

8. This further work will be framed by the Solar PV Strategy Group and input from the Task Forces. It will include analysis and feasibility of cost reduction potential; analysis of the life cycle emissions of solar PV; greater understanding as to the likely proportions of domestic, industrial and ground mounted solar PV by 2020; and further analysis to explore how to manage the grid systems balancing with significant levels of solar PV deployment.

Section 1 - Introduction

Solar PV: The Policy Context

9. Solar photovoltaic (PV) technology is a mature, proven technology and is a reliable source of renewable energy with an important role to play in the UK energy generation mix. The Government is committed to increasing the deployment of renewable energy across the UK and recognises the potential role and contribution that solar PV could make in helping to meet the UK's target of 15 per cent renewable energy from final consumption by 2020 (see Box 1).

Box 1: 2020 Renewables Target

The 2009 Renewable Energy Directive set a target for the UK to achieve 15% of its energy consumption from renewable sources by 2020. This compares to 4.1% in 2012. Very good progress has been made, but the scale of the increase over the next seven years represents a huge challenge and will require strong contributions from all three sectors of electricity, heat and transport. The mix of renewable energy generation needed to meet the 2020 target will comprise several technologies able to make a significant contribution to meeting the target. Solar PV is one of the eight key technologies set out in the Renewable Energy Roadmap Update 2012[1].

10. Solar PV can be deployed in a variety of locations and contexts including domestic roofs, commercial and industrial properties, and on the ground in brownfield and greenfield sites. It enables consumers and businesses to independently generate electricity, providing greater competition in the market; increases consumer choice; and given the relative cost and ease of installation in comparison to other renewable energy electricity technologies, makes an attractive option for homeowners, helping them save on their energy bills while contributing towards the delivery of our renewables target.

11. Solar PV is not just important because of its energy generation potential – it can also contribute to UK economic growth. The solar industry in the UK has a thriving installation sector. There is also a manufacturing capacity in the UK, albeit small, particularly in innovative and building integrated solar PV. The rapid growth in the sector means that the long-term jobs and investment potential of the sector is difficult to predict with certainty but sector estimates[5] indicate that the industry holds the potential for tens of thousands of jobs (including within the dedicated solar PV and wider construction sectors that are focussed on solar PV installation and deployment). DECC will work with the sector and the National Solar Centre (NSC) to develop more-reliable methodologies to measure jobs and investment.

12. The UK is an increasingly important player in the European market for solar PV. In May 2013, the European Photovoltaic Industry Association report indicated that the UK has a 6 per cent share of deployed capacity across Europe (in comparison to Germany with 44 per cent and Italy with 20 per cent)[6]. Although the UK has less sunshine (and

[5] Renewable Energy Association (2012) Made in Britain http://www.r-e-a.net/resources/rea-publications
[6] EPIA (2013) Global Market Outlook for Photovoltaics 2013 – 2017 Page 20
http://www.epia.org/fileadmin/user_upload/Publications/GMO_2013_-_Final_PDF.pdf

therefore lower load factors[7]) than other countries, our climate - in southern England in particular – is similar to that in Germany[8], where deployment of solar PV is considerably higher[9].

Box 2: Solar PV Cost Reduction

The UK has seen a significant level of solar PV deployment together with significant reduction in costs in recent years, with installed costs estimated to have fallen by around 50%[2]. Large-scale solar PV is already comparable with other key renewable energy technologies - cheaper than offshore wind, but more expensive than onshore wind. There is a progressive cost reduction trajectory assumed in the period out to 2016 and 2020, reflecting the advancements made in technology development and supply chains, indicating a reduction in levelised costs of around 20% by 2020.

If this rate of cost reduction continued into the 2020's, solar PV would be competitive in levelised costs terms with other large-scale generation technologies such as combined cycle gas turbines (CCGT) by 2025[10] (see Figure 6 for more information).

13. Solar PV currently accounts for 12 per cent of renewable electricity capacity in the UK and 2.9 per cent of renewable electricity generation[11]. As of the end of June 2013, 2.4GW installed capacity (with electricity generation during July 2012 to June 2013 of 1.4TWh[11]) of which 1.7GW is small-scale (mainly domestic) Feed-in Tariffs (FITs) and 0.2GW (mainly) large-scale under the Renewables Obligation (RO)[12]. As set out in the UK Renewable Energy Roadmap Update 2012, analysis indicates that there is a potential deployment range of 7-20GW (equivalent to 6-18TWh), with 20GW being the technical maximum level of solar PV deployment by 2020[1].

14. More recently, the publication of the draft Electricity Market Reform (EMR) renewable energy strike prices has shown a modelled expectation for solar PV of 1.8GW – 3.2GW coming forward under the RO and CfD to 2020. In addition to this, central assumptions for small-scale FITs indicate 7.5GW of solar during the same period, giving a modelled total of 9.3GW -10.7GW solar PV deployed out to 2020[13]. This represents a mid-range scenario based on the draft strike prices quoted across the technologies[14]. As explained in the Roadmap Update, movement towards the 20GW top limit of deployment (or above 10GW as National Grid have indicated by their modelling[15]), without generation being frequently constrained off, is likely to require significant technology cost reduction

[7] Defined as average load divided by the peak load in a specified time period.
[8] GIS data indicates[8] by calculating the annual average between the period 2004 and 2010, in Germany irradiation levels vary from 850kWh/m² in the north west to 1200kWh/m² in the south; whilst in the UK levels vary between 700 kWh/m² in the north to 1200 kWh/m² in the south. SolarGIS © 2013 GeoModel Solar s.r.o. Germany: http://solargis.info/doc/_pics/freemaps/1000px/ghi/SolarGIS-Solar-map-Germany-en.png UK: http://solargis.info/doc/_pics/freemaps/1000px/ghi/SolarGIS-Solar-map-United-Kingdom-en.png
[9] Energiewende (2013) Germany's Recent Solar Energy Record In-Depth http://theenergycollective.com/thomas-gerke/248721/sunday-solar-sunday-germany-s-july-7-solar-power-record-depth.
[10] DECC (2013) Electricity Generation Costs 2013, Table 13 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223940/DECC_Electricity_Generation_Costs_for_publication_-_24_07_13.pdf
[11] Energy Trends (September 2013) Tables 6.1 https://www.gov.uk/government/publications/renewables-section-6-energy-trends
[12] Energy Trends (September 2013) Table 6.4 https://www.gov.uk/government/publications/renewables-section-6-energy-trends
[13] National Grid (2013) EMR Analytical Report p40 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223655/emr_consultation_annex_e.pdf
[14] DECC (2013) EMR Consultation on the draft Delivery Plan on p.32. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/238867/Consultation_on_the_draft_Delivery_Plan__amended_.pdf
[15] National Grid (2012) Briefing Note for DECC on Solar PV Deployment https://www.gov.uk/government/publications/solar-pv-electricity-systems-and-the-national-grid-a-briefing-note-for-decc

together with developments in tools to help balance the supply and demand of electricity including demand-side response utilising smart meters, energy storage, interconnection and flexible generation[1].

15. Solar PV policy is not without its challenges. In particular, solar PV deployment requires careful consideration to ensure appropriate use of land and buildings, and ensures that the views of local communities are heard (see page 24). There are also uncertainties associated with effects of significant deployment, particularly because large volumes of solar PV is embedded generation and can create challenges for grid systems balancing (see page 29). Gaining access and connecting to the network also creates local grid issues (see page 32). Government also needs to ensure that financial incentives are working to encourage deployment and are cost-effective (see page 33).

Solar PV in the UK

16. At present, there are three main markets for solar PV in the UK - domestic, building mounted[16] and ground mounted. In addition to this, there is a small but growing market for building-integrated photovoltaics (BIPV).

17. **Domestic:** Solar PV is a reliable and well established method of generating electricity, suitable for a vast number of homes in the UK. Sunlight is free so once the installation has been paid for, electricity bills can be reduced - protecting the homeowner against the rising costs of electricity while reducing carbon emissions. It enables consumers to independently generate electricity, providing greater competition in the market and increase their level of consumer choice. A typical domestic installation can be as large as approximately 4kW capacity.

18. **Building Mounted:** There are a range of commercial and non-domestic properties in the UK that vary in size and category. These include, but are not limited to, offices, industrial property, hospitals, schools, hotels, retail, farm buildings, and warehouses. Small commercial buildings can typically accommodate PV systems between 4kW and 100kW, while larger commercial buildings allow larger arrays, the largest in the UK currently being 5MW. PV systems for commercial use have similar benefits to those of domestic systems but with the added advantage of generating larger amounts of electricity and generally being able to better match on-site generation with on-site demand.

19. **Ground Mounted:** These differ from building mounted PV systems because they generally supply power at grid distribution level. The land area required for a 1MW fixed tilt array including security fencing is approximately 6 acres (or 2.4Ha; the equivalent size of four football pitches). Output from ground mounted PV can also be optimised in terms of orientation and tilt by using mechanisms to track the Sun.

20. **Building Integrated:** Building Integrated PV (BIPV) refers to photovoltaic systems that generate electricity and function as part of the building. Products such as windows, walls, façades and roofs can be designed as BIPV (e.g. solar shingles/tiles) and architects can use these products to provide both function and style. This emerging

[16] In this context this refers to solar PV installed on commercial and industrial buildings and other building mounted installations at a larger scale than domestic systems (e.g. schools, community buildings).

market, which straddles the building industry and the solar power industry, offers a new way to develop revenue streams for both parties.

21. A framework of policies is in place to drive investment in solar PV in the UK at a wide range of sizes, and in a wide range of locations. Box 3 sets out the financial support framework which solar PV projects can access.

Box 3: Financial support for solar PV

Government's main mechanism to drive the deployment of solar PV is the financial support it provides. Without this support, solar PV would not be able to compete in the electricity market as its costs are currently higher than those of conventional generation. Over time, however, as costs of solar PV come down, this support will be reduced.

Large-scale solar PV generation (in the main above 5MW but also down to 50kW) is currently supported by the **Renewables Obligation** (RO). This places an obligation on UK electricity suppliers to source a specified proportion of the electricity they supply to customers from renewable sources. It is administered by Ofgem who issue Renewables Obligation Certificates (ROCs) to generators for every megawatt hour (MWh) of eligible renewable electricity they generate. ROCs can be sold to a supplier, which allows generators to receive a premium in addition to the price of their electricity. A comprehensive review[17] of the RO support rates was concluded in 2012 and is leading to a reduction in subsidies for the majority of technologies.

The RO will close to new generation on 31 March 2017. From 2014 onwards, the primary financial support mechanism for new large-scale renewable generation will be **Contracts for Difference** (CfDs). A CfD is a long term private law contract that pays the generator the difference between an estimate of the market price for electricity (the 'reference price') and an estimate of the long term price needed to bring forward investment in a given technology (the 'strike price'). The fixed strike price means that investors in low carbon plant are protected from wholesale price volatility and costs to the consumer will be capped. The EMR Delivery Plan consultation[18], published in July 2013, proposed strike prices for large-scale solar PV[19] .

The **Feed-in Tariffs** (FITs) scheme was introduced in April 2010 with the intention of encouraging deployment of small-scale (up to 5MW), low-carbon electricity generation. The scheme has been a success with over 450,000 installations (2.2GW capacity) registered by June 2013. Of these, around 99% are solar PV installations. FITs generators receive three financial benefits from the scheme: a generation tariff for all electricity generated by the installation; an export tariff for surplus electricity exported to the local grid; and savings on their electricity bill from generation used on site. The FITs Comprehensive Review[20], which concluded in July 2012, sought to improve value for money and reduce tariffs in light of falling costs. It introduced for solar PV a new 'degression' mechanism to enable tariffs to respond more nimbly to market developments by allowing tariffs to reduce in line with deployment.

[17] DECC (2012) Consultation outcome Renewable Obligation Banding Review https://www.gov.uk/government/consultations/renewables-obligation-banding-review
[18] DECC (2013) Consultation on the draft Electricity Market Reform Delivery https://www.gov.uk/government/consultations/consultation-on-the-draft-electricity-market-reform-delivery
[19] Both Ground mounted and Building mounted
[20] DECC (2012) Feed-in Tariff Comprehensive Review Phase 2a https://www.gov.uk/government/consultations/solar-pv-cost-controls-comprehensive-review-phase-2a

22. As at the end of December 2012, solar PV represented 1.8 per cent of total generating capacity[21]. There has been 1.4TWh of total generation by solar PV in this year to the end of June 2013, representing 0.4 per cent of the UK's total generation[22], Figure 1 shows the deployment split across the UK, showing that the majority of deployment is based in England[22]. Figure 2 shows solar PV installed capacity across the different size markets, showing the dominance of domestic installations[21]. Figure 3 shows the most recent data up to end June 2013 of solar PV deployed across the financial incentive schemes, with the small-scale FITs seeing the most up-take[23].

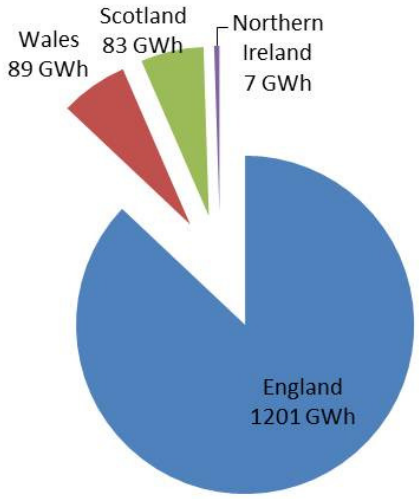

Figure 1 Solar PV generation (GWh) end Dec - end June 2013 across the UK[22]

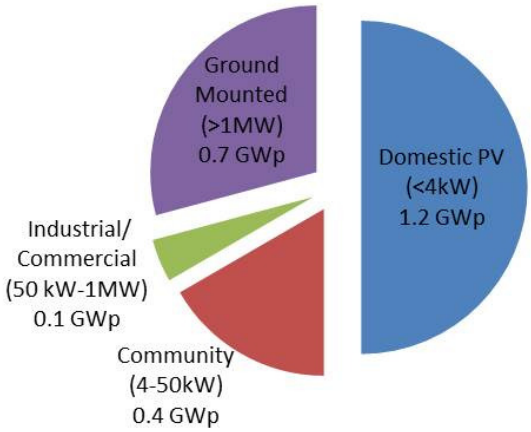

Figure 2 Solar PV installed capacity end Dec – end June 2013 (GWp) across the different size markets[21]

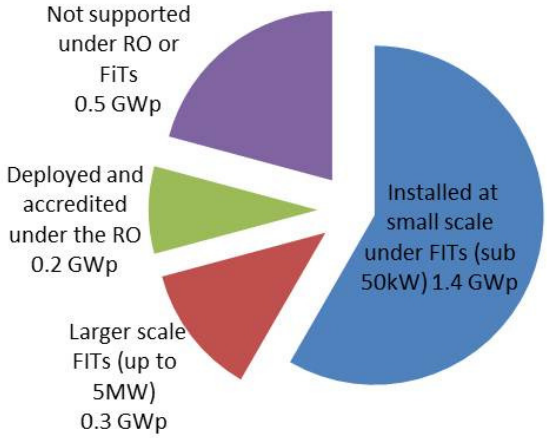

Figure 3 Solar PV installed (GWp) capacity as at end of June 2013 across financial incentive schemes[23]

[21] DUKES (2013) Table 5.13: https://www.gov.uk/government/publications/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes
Ground-mounted (>1MW) includes stand-alone schemes.
[22] Energy Trends (2013) Tables 5.1 and 6.1: https://www.gov.uk/government/publications/electricity-section-5-energy-trends and https://www.gov.uk/government/publications/renewables-section-6-energy-trends
[23] Energy Trends (September 2013) Table ET 6.4 https://www.gov.uk/government/publications/renewables-section-6-energy-trends
'Not supported under RO or FiTs' includes MCS registered <=50kW; ROOFIT accredited >50kW- 5MW; sites not yet accredited under FiT, RO or ROOFIT from the Renewable Energy Planning Database. Also includes any unaccredited part of capacity at RO sites.

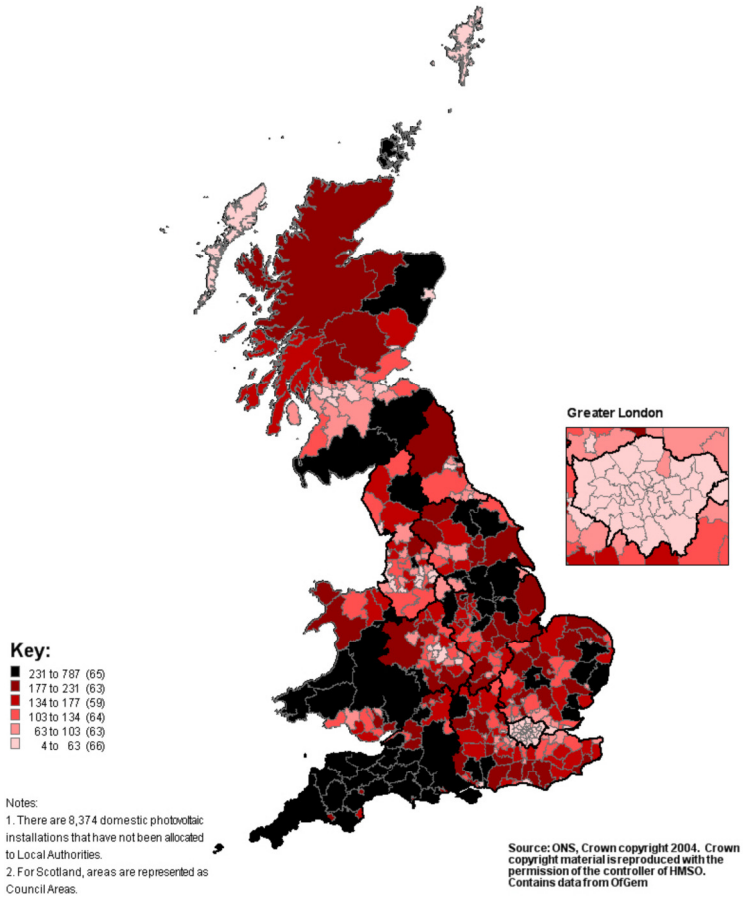

Figure 4: Feed-in Tariffs in the UK – Number of domestic PV installations per 10,000 households by Local Authority, as at end of June 2013

23. Figure 4 shows the distribution of domestic installations in the UK indicating that deployment of solar PV across the UK is highest in south west England[24]. Estimates of large-scale deployment under the RO indicate approximately 44 per cent are also located in south west England[25]. This clustering effect can create difficulties in local grid management – this is addressed on page 32. The FIT has also driven rapid growth in Scotland[26], Wales[27]and Northern Ireland, which has also experienced considerable interest in solar PV at all scales, particularly at domestic level but also increasing interest in the non-domestic sector including farm buildings[28].

[24] DECC (June 2013) Sub-regional Feed in Tariff statistics https://www.gov.uk/government/statistical-data-sets/sub-regional-feed-in-tariffs-confirmed-on-the-cfr-statistics
[25] DECC (October 2013) REPD Database https://restats.decc.gov.uk/app/reporting/decc/monthlyextract
Currently there are 284 operational solar projects within the UK. 126 of these are in the South West, representing 44.4% of the national total. Of these 126 projects, 123 or 98% of them have an installed capacity ≥50kW and 49 or 39% of them have and installed capacity ≥5MW.
[26] 25,850 installations in Scotland. DECC (June 2013) Sub-regional Feed in Tariff statistics. https://www.gov.uk/government/statistical-data-sets/sub-regional-feed-in-tariffs-confirmed-on-the-cfr-statistics
[27] 28,622 installations in Wales. DECC (June 2013) Sub-regional Feed in Tariff statistics. https://www.gov.uk/government/statistical-data-sets/sub-regional-feed-in-tariffs-confirmed-on-the-cfr-statistics
[28] Current overall deployment is approximately 6 MW from over 1000 generating stations accredited under the Northern Ireland Renewables Obligation (NIRO). Whilst small in UK terms, this represents a more than 200% increase since late 2011.

Case study 1: Solar PV - Bentley Motors – UK's Largest Rooftop Array

The Bentley Factory in Crewe built in the 1940s is ideally situated to generate solar power as the "saw tooth" factory roofs are south facing at an angle of 20 degrees. It is the UK's largest rooftop solar PV array, owned and operated by solar power generator, Lightsource Renewable Energy and installed by main contractor Solarcentury.

Over 20,000 solar PV panels have been installed generating enough electricity adequate to power over 1,200 households covering 3.45 hectares of roof space which would otherwise be un-utilised. Lightsource Renewable Energy entered into a power purchase agreement with Bentley Motors, making it possible for the electricity generated during working hours to be used directly by the factory and for the electricity generated at weekends and times of low demand, to be fed back into the National Grid. At peak generation times, the system will produce up to 40% of Bentley's energy requirements.

The installation on Bentley's factory demonstrates the potential for solar energy to be generated on commercial roof-tops in the UK and is a clear example of how businesses can gain greater pricing certainty for the future whilst reducing their carbon footprint. With the build only taking 16 weeks, it shows the speed at which installations of this size can be completed even when constructed in tandem with existing business activity.

Developing engagement with the solar industry

24. The Government has increased its strategic focus on the solar PV industry as deployment has increased. The Solar PV Strategy Working Group held its inaugural meeting in March 2013, jointly chaired by DECC and the NSC. It includes members from the main trade bodies, manufacturers, financiers, developers, installers, and others. It provides a forum for discussion of Government policy relating to solar PV deployment; and identifies solutions to barriers to the sustainable deployment of solar PV in the UK.

25. Reporting to the main Strategy Group, five Task Forces are proactively addressing issues and barriers. These address: Land Use and Sustainable Deployment; Engagement; Grid and Networks; Innovation; and Bankability and Finance.

26. The findings of this work will be presented as part of the forthcoming full Strategy document. This analysis will enable us to develop a set of actions for the future development of solar PV in the UK that will shape future policy decisions.