



Department  
of Energy &  
Climate Change

# UK Solar PV Strategy Part 2:



Delivering a Brighter Future

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# UK Solar PV Strategy Part 2: Delivering a Brighter Future

**Prepared by Department of Energy & Climate Change**

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# Foreword

The UK solar PV sector has undergone a huge transformation since the Coalition Government came to office in 2010. From almost zero, PV has now been deployed on over half a million buildings, with total installed capacity in 2014 set to exceed 4 GWp. Innovation and clean energy are at the heart of this Government's long term economic plan.

Most importantly, thanks to our reforms to the way solar PV is financially supported, this dramatic expansion is both affordable for consumers and offers a genuine long term and resilient platform for growth for the industry. However, big challenges still lay ahead, not least the drive to genuine grid parity.

The huge cost falls seen right across the PV supply chain, which have fuelled growth in the UK market, must continue if UK solar is to achieve its full potential. However, Government is not a spectator in this transition but a hands-on partner in growth.

This Solar PV Strategy, the first ever of its kind in the UK, sets out our clear ambition to see a further step change in deployment. In particular, this bold strategy focuses on a major opening up of the market for mid-size, commercial and industrial onsite generation and a new drive to work with industry to scale up domestic deployment, aiming for one million roof installations by the end of 2015.



Currently, there is 2.7 GWp of PV capacity in the UK, which places the UK firmly in the global top 10 economies for deployed solar.

But my personal ambition is far bigger than that. While the UK already has a legally binding EU obligation for 15 per cent of its energy to come from renewables by 2020, I believe that, as the sector drives the cost of solar PV down towards grid parity, the UK has the potential to install up to 20 GWp of solar early in the next decade.

The UK solar sector must also exploit opportunities to increase the amount of UK manufactured product

it deploys, attract more inward investment, as well as taking advantage of key overseas markets for its technology and expertise.

So how do we realise this big ambition? It can be quite easily summed up in two simple concepts: "deployment" and "cost reduction".

We need to deploy solar technology sensitively but also wherever it makes sense to do so. That requires us to be imaginative, but also to remove the red tape and the barriers which prevent perfectly sensible solar installations from taking place.

And with the costs of solar falling – with the potential to reach grid parity at all scales in the coming years – it is becoming more and more attractive for households, communities, and businesses to invest in PV.

I have spoken elsewhere of my vision of a far more decentralised energy economy and of the need for a proliferation of small energy enterprises creating a brand new energy market of insurgent new entrant suppliers. Not a market dominated by the “Big 6” but by the “Big 60,000”.

Solar sits at the heart of this vision for a more plural market, characterised by a host of distributed energy technologies. Decentralised energy opportunities which are installed as part of a much more coherent ‘D3’ approach – where demand reduction, demand response and distributed generation work hand in glove to help us meet our energy security and climate goals.

We have already made terrific progress, with 500,000 installed solar projects, but I want to see us go much further.

There are an estimated 250,000 hectares of south facing commercial roofs in the UK. With the obvious environmental benefits and financial advantages for any organisation installing solar PV it makes perfect sense to exploit this opportunity. We need to do more to encourage take up.

So the Strategy we are publishing today clears the way for widespread use of mid-scale solar by using space on top of factories, supermarkets, warehouses, car parks and other commercial and industrial buildings. We will work with developers, commercial property owners, planning authorities, and the solar industry to cut red tape and sweep away barriers to making use of empty industrial spaces to provide the electricity we rely on every day.

Government will be playing its part too, using the public estate such as MoD buildings, schools, and hospitals to make sure that not one inch of suitable Government roof space is wasted.

Government must build on the success of our own energy efficiency drive and now strive to install up to 1 GWp of solar PV on our own land and buildings over the coming years.

Private capital already stands ready to fund the first 500 MW across the Government estate so this partnership is already underway; and we expect to make substantial progress in 2014.

The market for domestic PV is also still in its infancy and set for further sustained growth.

Taking advantage of the opportunities created by the new Green Deal market; product innovation; reforms to the personal pension regime; and falling costs across the supply chain will drive demand for domestic PV to a new level.

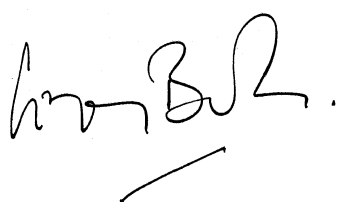
Solar power has been on a long journey but has now matured to become one of the most exciting prospects in the British energy mix. Costs are falling, technology is improving, and demand is increasing.

So I want to make sure we seize the opportunity which solar PV offers to the British economy, to the environment, to our energy mix, and to the people who could benefit directly from it.

We need to turn rooftops into power stations and help consumers move from just being supplied with energy by big firms to being “pro-sumers”, producing and using more of our own self-generated electricity.

Taken together this is a truly exciting prospect. Together, we will make this vision a reality.

Rt. Hon Gregory Barker MP



# Executive Summary

Solar PV is an important part of the UK's energy mix. The sector has seen very strong growth: last year saw **record levels of deployment**, with the industry maintaining strong levels of deployment at both domestic and large-scale.

The Solar PV Roadmap, published in October, established the principles for solar PV deployment in the UK. This document, which comprises Part 2 of our strategy, focuses on **our ambition for the key market segments**, how they will be realised through innovation and partnership and the benefits that this will bring for jobs and investment in the UK, in addition to vitally important emissions reduction.

The Levy Control Framework sets annual limits on the overall costs of DECC's levy funded policies. Through Electricity Market Reform, our aim is to move to a technology-neutral competitive process as soon as reasonably practicable. Competition between developers is an important tool **for driving down costs and reducing the price that consumers pay** for decarbonising the electricity sector. Ultimately, we expect there to be a competitive market which delivers low-carbon electricity without the need for Government support. The solar industry is already amongst the most cost-competitive of renewable technologies, but will need to continue to show leadership and innovation to ensure it is well-placed to meet this challenge.

Our **ambitions for solar PV are high**, and as we begin to deploy at even greater levels, we will need to work closely with the sector to anticipate developments and to continue to iterate our policy framework in a predictable and timely way to respond to future challenges.

For example, the public response to large-scale solar farms which have sometimes been sited insensitively has begun to erode the otherwise record levels of **public acceptability** the solar PV sector as a whole enjoys. The stronger than anticipated deployment of large-scale solar farms has implications for our financial support framework for the whole PV sector, which is constrained under the Levy Control Framework.

DECC wants to **support well-sited and well-designed solar** while maintaining budget control. Our ambition for the current dominant sector of **small-scale roof-top** projects remains high. In addition, we wish to maximise the potential of the as yet little tapped **mid-size projects on commercial and industrial rooftops**. This sector has major advantages in terms of economies of scale, the ability to use the power generated on site and reduce energy bills, and potentially lower impacts on landscape and visual amenity. The Government is leading this effort through its programme to deploy 1 GWp of solar on the **Government estate**, with projects already being identified and assessed for their suitability.

Realising this ambition across the key market segments will require further innovation. **Innovation in technology**, manufacture and installation is needed to reduce costs and see the sector cost-competitive with other major low-carbon players. PV modules are only part of the cost and there are opportunities for significant further cost reduction through installation, purchasing and finance efficiencies.

The UK is at the forefront of global research into **third generation solar** including some of the most exciting new technologies, such as building integrated solar, wafer thin devices and glass technologies to deploy solar on tall buildings. Technology innovation can also bring better carbon savings as the lifecycle emissions of solar PV devices are improved.

Realising our ambition will also require **innovation in financing models** to help companies, communities and individuals to invest. We set out here some of the most recent developments.

As well as committing to invest, developers need to know they will be able to connect their project to the electricity grid. Ofgem has put new regimes in place on standards of performance and penalties when agreed timeframes and provision of service are not met.

Our highest levels of ambition for deployment will also require **innovation in grid systems balancing** if it is not to become a constraint. Breakthroughs with smart grid technology, responsive market incentive structures and cutting edge developments in energy storage will all help to find a way through.

In addition to the obvious advantages for emissions and energy security, our ambition for solar PV will also bring substantial **benefits in terms of UK jobs, investment and global exports**. We present within this Strategy the latest assessments from industry.

The expansion of the solar PV sector in the UK has led to the generation of significant levels of skills and expertise in the design and installation of solar PV systems. This is in addition to the innovative solar PV products which are being developed in the UK. DECC will continue to work actively with UKTI, our Embassies and High Commissions and the sector to promote this expertise overseas and ensure that the UK benefits from export opportunities in the global race for a piece of the fast-growing worldwide solar market.



# Actions

- Taking the actions needed to drive an ambitious step-change in the deployment of solar PV in the UK by 2020 through:
  - Cost reduction;
  - Driving innovation;
  - Strong focus on mid-size on-site generation;
  - Improving the supply chain and access to skills and training;
  - Removing barriers to deployment;
  - Putting solar at the heart of an ambitious 'D3 strategy' for businesses and communities.
- The Government aims to install 1GW solar PV generating capacity on the Government estate through a major programme led by DECC and Cabinet Office. As part of this, the Government will lead an initiative specifically targeted at England and Wales' 24,000 schools.
- This year, Government will identify the first 500MW of deployment and seek private finance partners to incentivise installation. As the benefits of solar deployment on public buildings are realised, we would expect deployment across this sector to increase substantially.
- DECC will work with the Department for Communities and Local Government on extending permitted development rights in England for building-mounted solar PV to rooftop systems up to 1 MW. CLG expects to consult on this over the summer.
- DECC Ministers will meet with senior representatives of the large retail and finance sectors in the early summer to identify how the complexity of the relationship between landlords and tenants might be overcome.
- DECC is considering the implications of current trends of deployment on the financial incentives available in GB to solar PV under the Renewables Obligation (RO) and Feed-in Tariff (FiT), and would consult on any proposals for amendment.
- DECC will consider whether businesses that relocate to a new site should be able to take their existing PV installations with them and retain eligibility for Feed-in Tariffs, and depending on findings we would look to consult on changing the Feed-in Tariff scheme.
- The Government will be publishing shortly its response to last year's consultation on next steps for zero carbon homes from 2016.
- To support the Department for Education's energy initiative, DECC will provide clear, straightforward guidance for schools on how to install solar PV. This will outline the benefits and provide advice on: how to get started, raise funding, and a check list of key considerations.
- DECC will work with Ofgem and the solar industry to better understand the issues that can lead to delays, with a view to streamlining and simplifying the ROO-FiT process for all installations over 50 kWp to speed up the application process for the Feed-in Tariff.

- Ofgem will assess the RIIO-ED1 DNO Business Plans which will include an evaluation of how the DNO's strategies for RIIO-ED1 efficiently accommodate scenarios for deployment of low carbon technologies, including solar PV, within their region. Ofgem will make a final determination on all plans by November 2014, setting the outputs that the DNOs need to deliver for their customers.
- DECC will continue to work closely with the National Solar Centre (NSC) to understand the scale and impact of the levels of irradiance. We expect NSC to publish aggregated data on load factors, split by technology size and region later in the year.
- DECC will work with the Green Investment Bank to explore the scope to support solar PV as part of commercial energy efficiency projects in the UK using GIB funding.
- DECC will promote DCLG's planning guidance on large-scale solar farms. The guidance sets out particular considerations for solar farms, such as their visual impact, and underlines that it is important that the planning concerns of local communities are properly heard in matters that directly affect them.
- DECC will continue to work with the PV industry to maintain high levels of public support and promote industry best practice, including the Solar Trade Association's 10 principles and the NSC's biodiversity guidance to ensure deployment is sympathetic to the countryside.
- The Low Carbon Innovation Co-ordination Group will report in early 2015 on a Technology Innovation Needs Assessment (TINA) for Solar PV technologies that will identify the key innovation needs in the short- and medium-term necessary to meet our long-term objectives.
- DECC encourages the solar PV sector to take up opportunities through the third phase of the Energy Entrepreneurs Fund, that launched a further £10m of available funding in January 2014.
- DECC is supporting energy storage research through two innovation competitions, with a combined budget of up to £20m.
- DECC will increase collaboration with BIS and UKTI to attract inward foreign investment to support domestic R&D, innovation and manufacturing.
- DECC will continue to encourage overseas investment, such as in support of our commitment to establish renewable energy workshops for the Governments of the Overseas Territories.
- DECC will work with the Skills Funding Agency and the Solar PV Strategy Group to encourage the PV sector to maximise the opportunities for skills development across all aspects of the supply chain. We would like to see options for apprenticeships as well as studying at higher and further education level.
- DECC will commission the Solar PV Task Forces on Innovation and Land Use to develop guidance on design and installation to encourage the design of more visually attractive and flexible solar PV installations.
- DECC and Defra will work with industry to understand better the effects (both positive and negative) of solar farms on biodiversity.

- DECC will commission the Solar PV Strategy Group, over the next six months, to report on opportunities to reduce the overall costs of installation and deployment by addressing UK specific barriers including grid connection, planning and financing costs, as well as on opportunities to continue to reduce costs across the supply chain; with the particular aim of highlighting areas to reduce installed costs for solar PV to domestic, commercial and industrial customers. DECC will work to provide a levelised cost comparison of mid-sized solar PV with domestic and large-scale PV; and to understand and monitor how soon different markets might achieve grid parity.
- DECC will collaborate with the Solar PV Strategy Group, to identify how to reduce the costs of BIPV, making it more cost-effective to incorporate into new-build and include potential findings into the TINA.
- We will continue to engage with industry through the Solar PV Grid Task Force to obtain an on-the-ground perspective of solar PV connection costs and waiting times, and consider whether steps can be taken to remove any barriers to deployment and speed up the process of connecting to the grid. We will obtain grid connection data from National Grid and Distribution Network Operators to better understand the connection process, timing and the volumes of solar PV installations across the UK. This will feed into the Whole Systems Modelling project that will provide a greater understanding of the impact on grid and costs of connecting significant volumes of solar PV to the transmission and distribution network.
- DECC will work with the Solar PV Innovation Task Force to encourage UK companies within the industry to adopt carbon lifecycle accreditation and to identify ways of reducing the carbon footprint of the UK Solar PV supply chain.
- DECC will encourage the industry to open up employment in the sector to greater numbers of women.
- DECC will work with industry to exploit opportunities overseas to promote British solar PV products, and expertise in design and installation of solar PV, and innovation through a programme of trade missions, working closely with UKTI, BIS, and the FCO.

# Introduction

1. The first part of the Solar PV Strategy, published in October 2013, set out our vision for the solar PV sector in the UK. The vision is based around four guiding principles:
  - 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 of gross 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.
2. This document, the second part of our Solar PV Strategy, builds on those principles, setting out our ambitions for the different main markets for solar PV in the UK: domestic roofs (typically smaller than 4 kWp); midsize roofs often on commercial and industrial buildings but also on public buildings, such as schools and hospitals; and large-scale ground-mounted solar farms. In particular, it sets out our ambitions for the mid-size commercial rooftop sector going forwards, recognising this sector has lots of untapped potential and particular advantages - good match of onsite use of electricity, potentially fewer visual impacts than either domestic or ground-mounted.
3. In addition to the three main markets, there is a nascent and growing market for building-integrated photovoltaics (BIPV), where we consider the potential is significant and growing, both in the UK and globally. Innovation is a key characteristic of UK solar PV sector, with work underway both in academia and industry, identifying new options and solutions.
4. This Strategy explains how we are working with industry to maximise the potential and to encourage continuing high deployment of solar PV, while maintaining public acceptability. It reflects the on-going work of the five Task Forces that were set up to progress work with industry and government to develop understanding of some key issues in more depth, and report to the Solar PV Strategy Group. The Task Forces have looked at: land use for the deployment of large-scale solar farms; engagement and encouragement of building-mounted deployment; grid connection; innovation; and finance. In future they will also develop a code of best practise for aesthetics of deployed PV, especially in the built environment.

5. In particular, the Task forces have addressed the following issues:
- Land Use: Chaired by the NFU, this group works to promote best practice in site selection and sustainable land use. It has worked with the Solar Trade Association on “10 Commitments” of good practice in solar farm development. It has also worked on the management of solar farms for biodiversity, to be published as National Solar Centre guidance. Future work will develop guidance on visual amenity.
  - Engagement: Chaired by the Solar Trade Association, this group works to identify and address the barriers to the wider use and acceptance of PV, particularly on commercial and industrial roofs. Future work will include engagement with landlords, tenants and financiers to ensure improved deployment on PV on commercial and industrial buildings.
  - Grid: Chaired by the National Grid, this groups works to provide timely and affordable grid access for solar generation and to minimise the cost of integrating high levels of solar PV into the electricity market. Work completed has included: working with ENA to set out where connections can be made quickly, easily and at low cost, through the use of ‘Hot Spot’ maps produced by DNOs; with RegenSW developing a mechanism to allow a number of solar developers to share the costs of network reinforcement.
  - Innovation: Chaired by the Centre for Renewable Energy Systems Technology at Loughborough University, this group focuses on opportunities by identifying products and systems that would be attractive in the UK market and those with export potential.
  - Finance: Chaired by the British PV Association, this group acts to identify and address financial barriers to PV deployment. This includes: consideration of cost reduction; economic growth opportunities; and financing. The group has been addressing innovative and flexible solutions for investment and how best to use those solutions.
6. Our policy framework has evolved in response to recent strong growth in the UK solar PV sector and is now deliberately designed to be flexible and iterative, to support cost reduction and to ensure that future deployment is affordable and manageable. This responsive approach helps us to stay ahead of issues arising from cost and grid capacity. Given the finite nature of the budget to support renewable and low-carbon generation we have the ability to iterate our policy to amend levels of support, should deployment across the sector or in sub-sectors be higher than anticipated. For example, ‘degression’ in the levels of support offered through the Feed-in Tariff is based on deployment levels to provide some automatic self-correction within the FiT. We are also considering whether any amendment to the financial incentives for solar PV may be required in order to manage calls on the overall budget as well as the likely requirements of State Aid rules.<sup>1</sup> If we do identify such amendments then they would be subject to consultation, and we would seek to protect developers who have made significant investments in projects from the impact of those changes.

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<sup>1</sup> In January we put out a consultation on approach to competitive allocation under CfD:

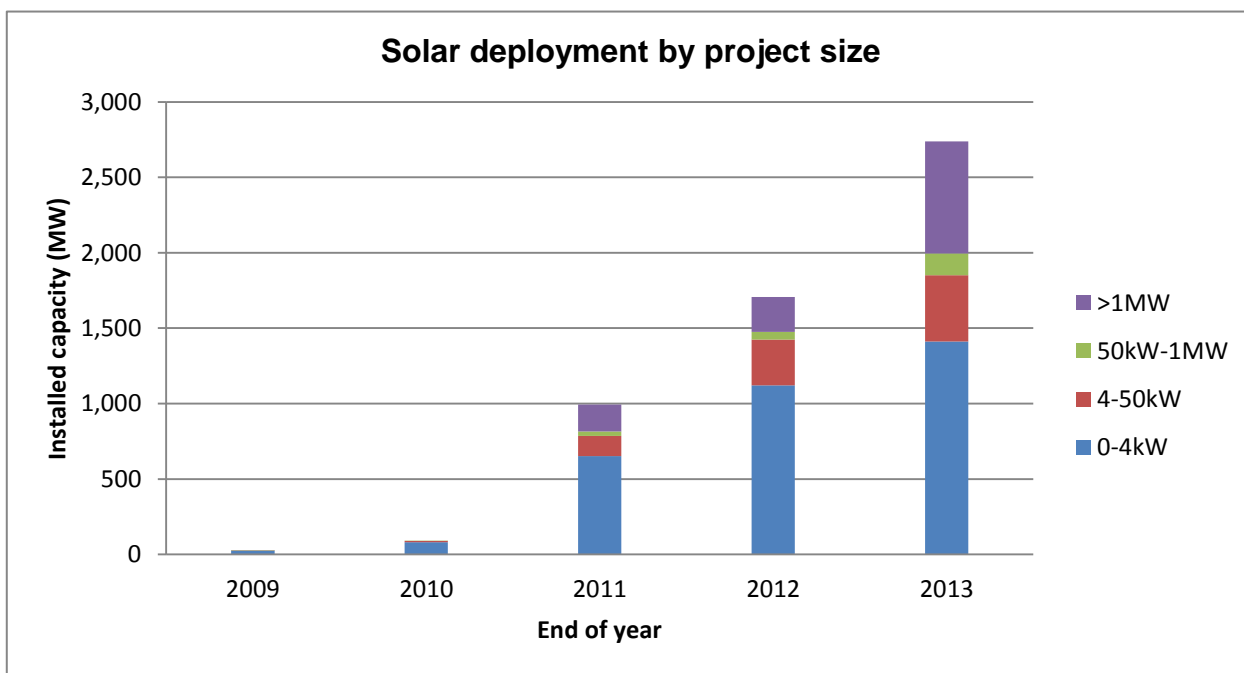
[www.gov.uk/government/consultations/electricity-market-reform-allocation-of-contracts-for-difference](http://www.gov.uk/government/consultations/electricity-market-reform-allocation-of-contracts-for-difference)

We also asked stakeholders to indicate whether they would respond differently to consultation questions if we later had to take action to constrain the RO. We are currently carefully considering responses to that consultation, which will feed into our final policy position on RO.

7. The Levy Control Framework (LCF) sets annual limits on the overall costs of DECC's levy funded policies: the Renewables Obligation, the Feed-in Tariffs scheme, Warm Homes, Investment Contracts for the Final Investment Decision Enabling for Renewables process, and Contracts for Difference. As the LCF forms one overall capped amount, any increase in spend for one sector under these financial incentives will reduce the level of support available for other sectors under the LCF. Future decisions on support levels for solar and other technologies will be taken with this in mind, and the proposals set out in this Strategy are, where relevant, subject to those decisions. Our aim is to deliver the EMR Delivery Plan ambitions for a diverse mix of renewable technologies and achieve value for money for consumers. Through Electricity Market Reform, we will move to a technology-neutral competitive process as soon as reasonably practicable. Competition between developers is an important tool for driving down costs and reducing the price that consumers pay for decarbonising the electricity sector. Ultimately, we expect to reach a point where there is no longer a need to issue CfDs due to the existence of a competitive market which delivers low-carbon electricity without the need for Government support. The solar industry will need to continue to show leadership and innovation to ensure it is well-placed to meet this challenge.

# 1. Our ambitions for deployment

8. Here we consider the most important markets for solar PV in the UK. Some markets have grown faster than others, and in setting out our vision we identify where we see potential for the strongest growth in future and where Government expects to target its effort. It explains how we are working with the industry to overcome some of the potential barriers that have been identified and to mitigate impacts.
9. Last year was a record year for solar PV in the UK, with the industry continuing to push on with significant levels of deployment after the realignment of financial incentives with market prices. Solar PV has seen enormous growth in the UK, with total capacity growing by almost 1,000 MWp (nearly 60 per cent) in 2013, bringing the total installed capacity to 2.7 GWp as at the end of December 2013.<sup>2</sup> Solar PV accounted for 14 per cent of renewable electricity capacity in the UK at the end of 2013, generating over 2 TWh during the year. The sector has demonstrated its ability to deploy at all scales – from domestic and commercial buildings to large, utility scale facilities, and growth has been seen across the spectrum.



10. Government scenarios in the Final EMR Delivery Plan indicate that about 10-12 GWp of solar PV could be deployed in UK by the end of the decade.<sup>3</sup> With recent growth, additional capacity already in the pipeline could get us close to that level of deployment. But as set out in the Solar PV Roadmap, the Minister and the sector have expressed a desire to see the sector move towards grid parity over the next few years which would create scope for more **ambitious deployment**, perhaps approaching 20GW early in the next decade.

<sup>2</sup> [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/295356/6\\_Renewables.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/295356/6_Renewables.pdf)

<sup>3</sup> [www.gov.uk/government/consultations/consultation-on-the-draft-electricity-market-reform-delivery](http://www.gov.uk/government/consultations/consultation-on-the-draft-electricity-market-reform-delivery)

11. The ability to achieve such a high level of deployment will be predicated on a number of factors. These include available budget within the Levy Control Framework, finding significant further cost reductions such that solar PV is able to compete with other low-carbon technologies, and finding affordable ways of upgrading the electricity grid to accommodate the additional renewables. Innovation will be key to achieving this, as described in the next section.
12. Realising this high ambition will also require us and industry to think carefully about the impact of PV installations on the appearance of local areas. Solar PV enjoys the highest public approval rating of any energy technology, typically above 80 per cent.<sup>4</sup> Sensitive siting and design are important in maintaining this. Large-scale solar farms, particularly when on agricultural land, can attract opposition due to concerns over changes in land use and cumulative impact. Clusters of rooftop installations in residential areas can affect visual amenity. Industry will need to continue to innovate to improve the appearance of roof-mounted solar installations and to achieve best practice in design.
13. **DECC will commission the Solar PV Task Forces on Innovation and Land Use to develop guidance on design and installation to encourage the design of more visually attractive and flexible solar PV installations.**

### Case Study 1: King's Cross Station

The newly redeveloped King's Cross Station has underlined how innovative projects can support jobs in the UK: the system was installed by Sun Dog Energy of Penrith, Cumbria, using glass manufactured by Romag, based in County Durham. A total of 1,392 glass laminate solar units covering 2,300m<sup>2</sup> on the Main Train Shed roof, provide approximately 10 per cent of the station's electricity, with a public screen showing in real time how much energy is being generated. The installation is expected to generate 175 MWh per year and should save over 100 tonnes of CO<sub>2</sub> emissions. Solar PV cells that convert sunlight directly into electricity are integrated into custom made glass laminate units that now form part of two massive new barrel vaulted glass roofing structures spanning the main platforms of the Grade 1 listed building.



*Image: Courtesy of Hufton & Crow*

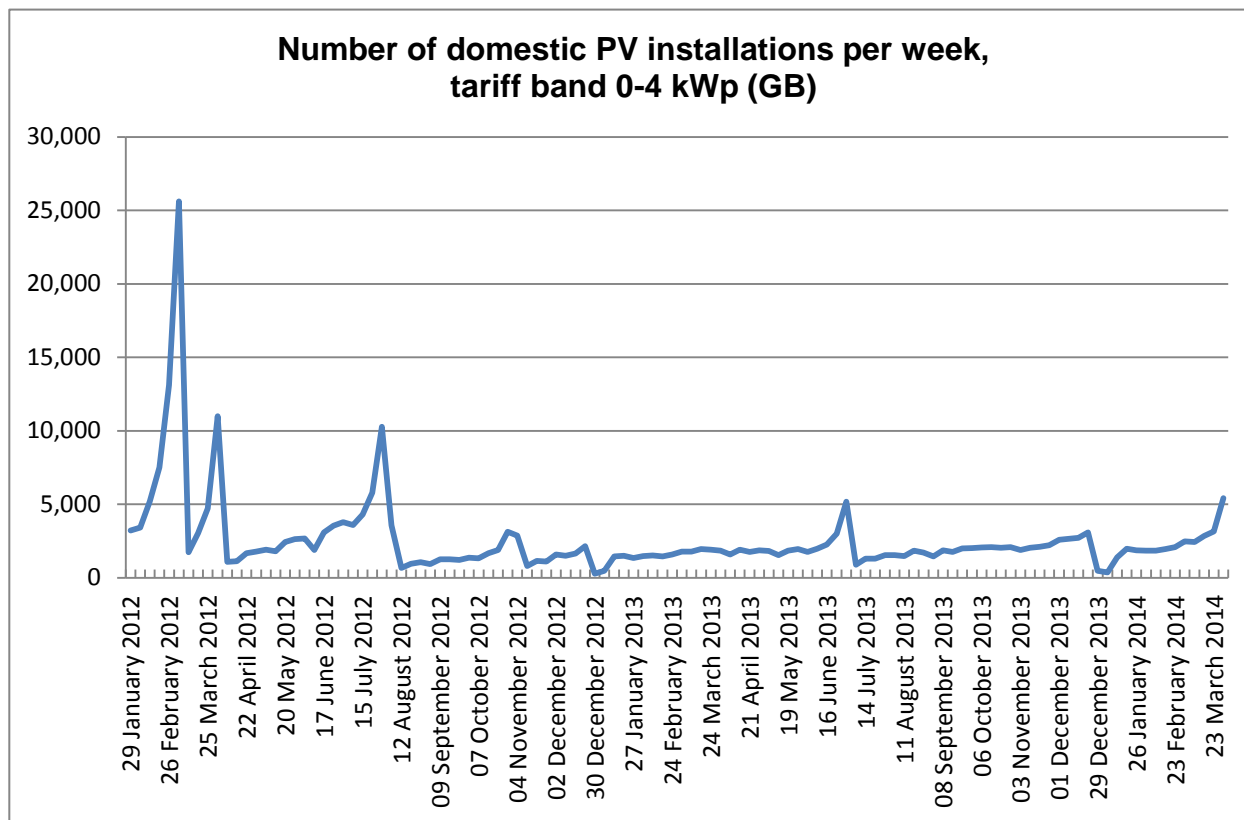
<sup>4</sup> [www.gov.uk/government/collections/public-attitudes-tracking-survey](http://www.gov.uk/government/collections/public-attitudes-tracking-survey)



14. We see the future for the industry in the UK centred primarily in two key markets:
  - growing the momentum on deploying **PV at smaller scale** (typically smaller than 4 kWp, but up to 50 kWp) on and in housing, small commercial premises and community buildings; and
  - increasing significantly **mid-size deployment** (larger than 50 kWp and up to 1 MWp), particularly on commercial and industrial buildings but also on larger public and community buildings.
15. Both these markets have the advantage of using the existing built environment rather than previously undeveloped land. While it is impossible to quantify the potential, building integrated PV (BIPV) would push the maximum capacity which can be deployed on roofs higher than that achievable with conventional PV panels alone. UK companies are strongly represented in the BIPV supply chain. Encouraging deployment on buildings in the UK should help to boost this emerging sector, which has enormous potential globally.
16. In addition, PV installed on buildings allows the electricity to be both generated and used on site, giving benefits such as reduced electricity bills and, by reducing pressure on the grid, scope for greater overall levels of deployment and lower distribution losses.
17. Large-scale ground-mounted solar deployment has been much stronger than anticipated in government modelling. This can have impacts on visual amenity, and siting and design are important. It also has the potential to affect the financial incentives budget under the Levy Control Framework. Given the finite nature of this budget it will be necessary for the Government to continue to monitor the overall pipeline of projects against our ambitions for a diverse mix of renewable technologies and achieving value for money for consumers.
18. All of the Government's initiatives regarding financial support need to be deliverable within the overall budget of the Levy Control Framework. The government is considering the implications of current trends of deployment on the financial incentives available to solar PV under the RO and FiT, and would consult on any proposals for amendment.
19. We discuss below our ambition for the main solar PV market sectors:
  - Small-scale rooftop installations on housing
  - Mid-size commercial and industrial rooftops
  - Public buildings
  - Building-integrated solar (BIPV)
  - Large-scale ground-mounted.
20. **DECC will commission the Solar PV Strategy Group, over the next six months, to report on opportunities to reduce the overall costs of installation and deployment by addressing UK specific barriers including grid connection, planning and financing costs, as well as on opportunities to continue to reduce costs across the supply chain; with the particular aim of highlighting areas to reduce installed costs for solar PV to domestic, commercial and industrial customers. DECC will work to provide a levelised cost comparison of mid-sized solar PV with domestic and large-scale PV; and to understand and monitor how soon different markets might achieve grid parity.**

## 1.1 Solar PV on housing

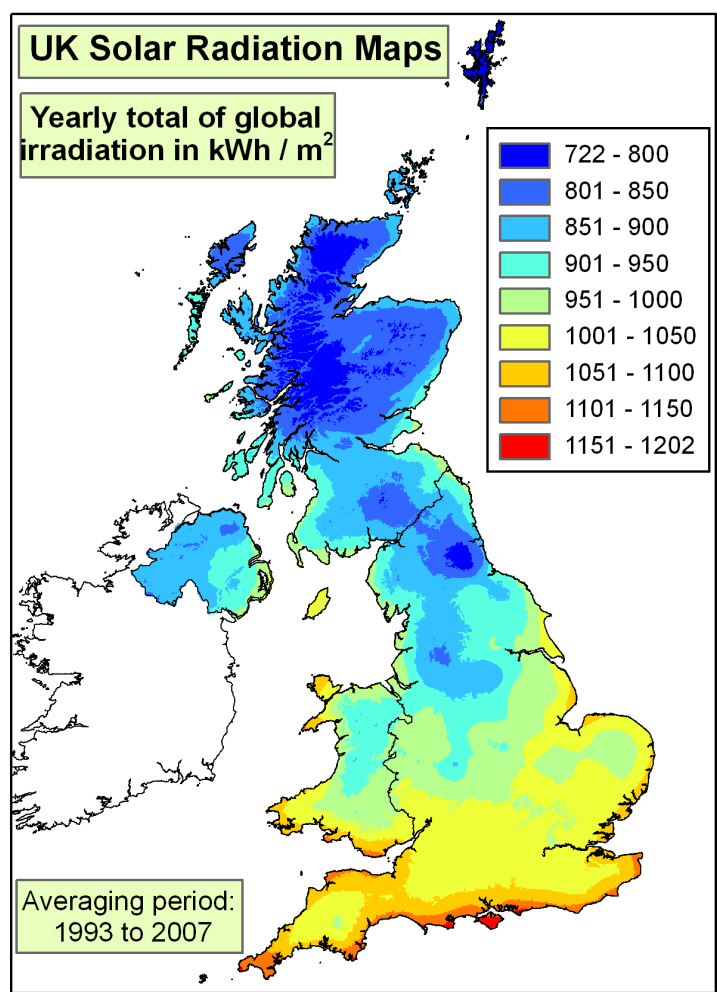
21. We have seen domestic roof-top projects become an established part of the transition to a low carbon economy, with around 2000 being installed each week.<sup>5</sup>



22. Installing solar PV on housing (systems typically <4 kWp) is the largest sub-sector of the UK solar PV market, both in terms of number of installations and the total capacity installed. Recent data shows that more than half a million homes now have solar panels. This is a remarkable achievement given that, as recently as 2010, that number stood at fewer than 15,000. Deployment remains strong and growing.
23. The main drivers for the growth in the domestic sector have been the introduction of the Feed-in Tariff in 2010, the dramatic reduction in installed costs, particularly the price of the panels themselves, and the increasing confidence and familiarity that consumers have with the technology and the benefits that it can bring. The financial incentives available for the deployment of solar PV at domestic scale provide homeowners with the opportunity to reduce their electricity bills and recoup the costs of installation. This rests alongside the benefits to the consumer of insulation from electricity price volatility. As the cost of solar PV at a domestic scale continues to fall, ultimately towards grid parity, the benefits to consumers will be proportionately greater.
24. To ensure on-going growth, industry will need to continue to innovate and provide an increasing quality and range of services and products at increasingly competitive prices. It is vital that products perform as promised and are attractive to potential customers. For example, the new '**Rated Solar Installer**' initiative launched in February 2014 by the industry, is intended to enable customers to rate their experience of solar PV installations and, as the site database continues to be populated, should increasingly help empower consumers to make good choices in the market place. We welcome this initiative and others like it, which should give more homeowners and businesses the confidence to invest in PV.

<sup>5</sup> [www.gov.uk/government/statistical-data-sets/weekly-solar-pv-installation-and-capacity-based-on-registration-date](http://www.gov.uk/government/statistical-data-sets/weekly-solar-pv-installation-and-capacity-based-on-registration-date)

25. One concern identified by the Task Forces was a lack of recognition of the economic value of solar on domestic and commercial properties. Task Force representatives have met with the Royal Institute of Chartered Surveyors, who acknowledged the issues and have agreed to write guidance. This will help provide their members with the tools needed to inform property buyers and sellers of the income from the FIT and the electricity saved from properties which incorporate PV.
26. Better information about weather and solar radiation in different regions is also becoming available, and this shows an optimistic picture with optimum performance being higher than previously thought.<sup>6</sup> **We will continue to work closely with the National Solar Centre to understand the scale and impact of the levels of irradiance.** The Government is also analysing real life performance of installed equipment of different sizes and in different locations. This will provide further information for customers of what to expect from their installations. **We expect NSC to publish aggregated data on load factors, split by technology size and region later in the year.**<sup>7</sup>



© British Crown copyright 2014, the Met Office.

<sup>6</sup> Until recently, the solar industry estimated likely generation figures using satellite based Met data, giving optimum performance between 960 kWh/kWp in South West England to 700 kWh/kWp in the North of Scotland. As more data on actual performance have become available, the range has been revised to 1132 kWh/kWp to 837 kWh/kWp. Even these revised figures may be conservative. The NSC is working with the Met Office with the intention of enabling more accurate predictions in the future.

<sup>7</sup> Regional breakdowns of installations under the FIT scheme are available here:

[www.gov.uk/government/statistical-data-sets/sub-regional-feed-in-tariffs-confirmed-on-the-cfr-statistics](http://www.gov.uk/government/statistical-data-sets/sub-regional-feed-in-tariffs-confirmed-on-the-cfr-statistics)

27. **Social housing** is an important and growing market for solar PV. We would like to see more social landlords follow the lead of those that have installed solar PV on their housing stock already and passed on the energy cost savings to the tenants. This has social benefits in helping to alleviate fuel poverty and spreads the benefits of solar PV across the social spectrum.
28. The FiT level is reduced by 10 per cent for installations on multiple sites (i.e. 25 or more), based on assumed economies of scale. Anecdotally, a number of PV developers in the social housing sector have told us that these economies of scale are outweighed by other costs, which has resulted in solar PV being installed on fewer properties than might have been the case, meaning that fewer tenants have benefitted. It has proven difficult to find firm evidence but we will continue to work with developers to understand the impact of the aggregation rule.
29. Solar technologies can already be used by developers to meet carbon target requirements in the Building Regulations that have been strengthened twice since 2010 and reducing costs will make these a more attractive way for developers to meet their obligations cost effectively. The Government consulted last year on next steps on zero carbon homes.<sup>8</sup> This included allowable solutions, a scheme to allow developers to meet part of the zero carbon standard by supporting off site measures which could include renewable technologies. The consultation also asked for views on whether and carbon targets for on-site provision such as solar technologies previously recommended by the independent Zero Carbon Hub, should be the starting point for consideration of specific Building Regulations' requirements in 2016. The Government will publish its report on the consultation shortly.
30. **The Government will be publishing shortly its response to last year's consultation on next steps for zero carbon homes from 2016.**
31. Solar panels are noticeable additions to the roofs of homes and other buildings and as deployment has increased have become an increasingly common sight. Products designed to look more like conventional slates or tiles are now available (see case study on Graylingwell Park below) will help to widen the market for solar PV by addressing concerns about **aesthetics**. Solar tiles and slates can integrate seamlessly with new and existing roofs and are compatible with a wide range of roof tiles and slates. They are particularly well suited to new builds and re-roofing projects. Solar tiles are economical because they can make better use of the available roof space.

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<sup>8</sup> [www.gov.uk/government/consultations/next-steps-to-zero-carbon-homes-allowable-solutions](http://www.gov.uk/government/consultations/next-steps-to-zero-carbon-homes-allowable-solutions)

## Case study 2: Graylingwell Park

Graylingwell Park, near Chichester, is a carbon neutral development of 750 homes. Achieving carbon neutrality has two main elements: installing solar PV roof panels on some homes and a combined heat and power plant. The low energy design strategy also includes achieving Level 4 in the Code for Sustainable Homes.

This was a challenging project as the homes were built to a new design that had not been done at scale, and a target of zero-carbon for a volume of houses was a new level of complexity compared to a show house at an experimental site.

The geographical location was also a sensitive re-development site just outside the historic town of Chichester, meaning that the aesthetics were very important. It became clear at an early stage that the planners were keen on an integrated solar PV system, dictated by the available roof space. The aim was to blend the solar tiles into the roofs.

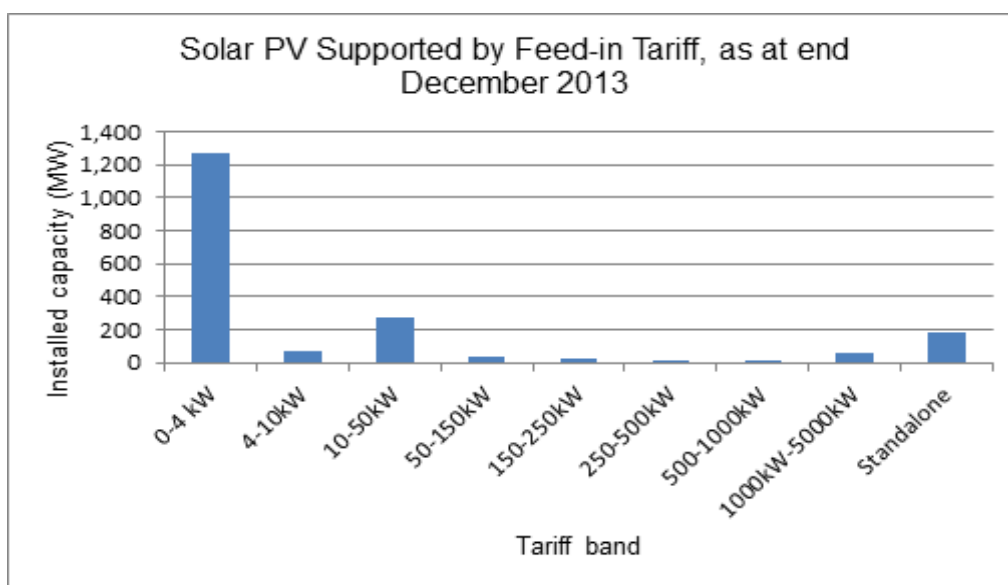
Peter Youll, Managing Director of Linden Homes Guildford, said: “The use of photovoltaics placed new demands on street layouts; these needed to be designed on east-west street orientations to maximise solar gain and made wider than usual to prevent overshadowing. Within phase one, 82 dwellings accommodate 22m<sup>2</sup> of photovoltaic tiles. All the homes with photovoltaic roof panels create surplus energy which is given back to the national grid and is credited to the homeowner’s electricity bills.”



*Image: Courtesy of Solarcentury.*

## 1.2 Commercial and industrial buildings

32. Solar PV systems for commercial and industrial use have similar benefits to those of domestic systems – lower electricity bills, protection against future electricity price rises, and a smaller carbon footprint - 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. However, growth in this market has been below its performance in other European countries, and there is potential for very significant growth in the UK. We are exploring ways to help encourage the UK's performance in this sector of the market.
33. The figure below shows cumulative deployment under the FiT for bands above 4 kWp, and shows a clear drop for systems above 50 kWp and another drop, albeit smaller, one above 250 kWp.<sup>9</sup>



34. Some of the barriers to the wider take up of solar PV by business are thought to be similar to those that prevent them from taking up energy efficiency. These include the ability to access capital, the transaction costs (management time), prioritisation of other issues, suitability of the building stock, and split incentives, primarily landlord/tenant issues. These issues can be significant for companies of any size but are likely to be particularly acute for SMEs.
35. We are committed to working with developers, financiers, and building owners and tenants to understand potential barriers to deployment and to take action where feasible and appropriate. Increasing deployment in this important sector is vital to realising our strategic ambitions for solar PV. Some sectors – retail, transport and agriculture, for example – have made some excellent progress in seizing the opportunity of generating their own electricity. Further large-scale roof-mounted projects are continuing to come forward. In February, the Minister visited the Bombardier facility near Belfast Docks to hear about the company's plans to install a 3.8 MWp solar roof, which would be the second largest in the UK. The case studies below bring to life some other recent examples.

<sup>9</sup> [www.gov.uk/government/statistical-data-sets/monthly-central-feed-in-tariff-register-statistics](http://www.gov.uk/government/statistical-data-sets/monthly-central-feed-in-tariff-register-statistics)

### Case study 3: Wheaton & Sons

JB Wheaton & Sons, a transport and warehouse company based in Somerset, has installed around 800 kWp on its roofs and another 800 kWp on waste ground between its buildings and the main London to Exeter railway line. The company continues to adapt its working practices to best suit the electricity generated from their solar installations; most of the forklift truck fleet is now electric, as are the Directors' cars that are used for local or regional business travel. The company has recently invested an additional £38,000 in an energy efficient motion detection lighting system to further reduce its energy usage. JB Wheaton & Sons generates over 60 per cent of their power this way, and on sunny days can generate more electricity than is used at their depot.



*Image: Courtesy of Solar South West Ltd.*

36. Despite these great examples, deployment in the commercial and industrial sector in the UK needs to be much stronger if it is to match that seen in others parts of Europe and if we are to achieve the UK's ambition. In many other European countries, particularly Germany, more than half of solar PV deployment is in this sector, compared to 5-20 per cent in the UK.<sup>10</sup>
37. **Ownership complications** are thought to be acting as deterrents to mid-scale roof top deployment in the UK. In Germany, for example, the legal ownership of mid-scale roof-mounted arrays is often simpler than in the UK because the array can be dismantled and moved elsewhere, for example if the business moves to new premises. Additionally, we understand that a higher proportion of commercial and industrial buildings are owner-occupied in Germany than in the UK, simplifying PV deployment and avoiding the contractual complications between landlord and tenant often experienced in the UK.

<sup>10</sup> [www.epia.org/news/publications/](http://www.epia.org/news/publications/)

38. The complexity of the **relationship between landlords and tenants**, particularly in the large retail sector has an effect on the commerciality of potential installations (e.g. where landlords incur the costs of the deployment and take the FiT payments but tenants benefit from reduced energy bills). We are working with the property sector and financiers, through the Finance Task Force, to develop measures to reduce these barriers. As part of this, **Ministers will meet with senior representatives of the retail and finance sectors in the early summer to agree a way forward, with a view to holding meetings in the future with other sectors facing similar problems.**
39. We are continuing to explore planning and other suggested obstacles to see how we can bolster the mid-size commercial market. For example, we are working with the Department for Communities and Local Government to consider whether the introduction of new permitted development rights in England would assist in removing one barrier to deployment. Currently, roofs over 50 kWp in capacity require planning permission, which can add significantly to development timescales, increasing uncertainty and therefore risk. Solar PV developers and financiers have identified this as a barrier and deployment statistics, which show a marked fall in deployment of systems above 50 kWp, would seem to bear this out. We are working across Government on proposals for allowing permitted development rights for solar panels rooftop systems up to 1 MWp. The Department for Communities and Local Government plans to consult on the introduction of the new permitted development right over the summer.
40. Solar installations larger than 50kWp applying for the FiT submit their applications through the ROO-FiT process. The amount of time that it can take to complete the application process may be another source of delay and therefore risk. We are working with Ofgem and the solar PV industry on ways to improve the process. This includes reviewing the types of guidance provided by the different bodies involved with the scheme and looking at whether the legislation can be simplified whilst maintaining the policy intent. In 2013/14, Ofgem introduced a two stage application checking process (as opposed to three stages) for straightforward applications to enable approval more swiftly. Ofgem is also producing two new guidance documents, designed to help applicants get their applications right first time, which will be published later this year, alongside a number of Ofgem hosted stakeholder events.
41. We are considering whether there is evidence to support changes to the financial support available to this sector to encourage further deployment, and whether any change would be feasible and affordable, if needed. Any amendments to financial support schemes would be considered in the broader context of the financial incentives available to solar PV installations, and the Levy Control Framework. They would also need to be consistent with the EU's State Aid rules. Proposals to amend financial incentives for solar PV would be subject to consultation.
42. **DECC will work with the Department for Communities and Local Government on extending permitted development rights in England for building-mounted solar PV to rooftop systems up to 1 MWp. CLG expects to consult on this over the summer.**
43. **DECC is considering the implications of current trends of deployment on the financial incentives available to solar PV in GB under the RO and FiT, and would consult on any proposals for amendment.**
44. **DECC will consider whether businesses that relocate to a new site should be able to take their existing installations with them and retain eligibility for the Feed-in Tariff, and depending on findings we would look to consult on changing the Feed-in Tariff scheme.**



45. **DECC will work with Ofgem and the solar industry to better understand the issues that can lead to delays, with a view to streamlining and simplifying the ROO-FiT process for all installations over 50 kWp to speed up the application process for the Feed-in Tariff.**



*In October 2013, Greg Barker MP, Minister of State for Energy and Climate Change, visited Bentley's factory in Crewe to inspect their solar roof installation.*

*The 5.1 MWp installation is the largest solar roof in the UK.*

*The 3.45 hectare roof generates up to 40 per cent of Bentley's energy requirements, reducing the factory's CO<sub>2</sub> emissions by over 2,500 tonnes per year.*

### 1.3 Public and iconic buildings

46. The Government wants to see public buildings at the forefront of the move to renewable energy. The Government itself has an ambitious programme underway to install 1 GWp of solar PV on the government estate. Scale deployment at this level would promote the benefits of solar PV more widely.
47. The first phase of this work is already well underway. The Cabinet Office, working closely with DECC, is co-ordinating a cross-government project with the intention of installing an initial 500 MWp of solar capacity. Following a meeting of Heads of Estate from across government, led by Minister Greg Barker, the Cabinet Office is working with departments to identify the most promising locations for deploying solar PV across the government estate. Sites are currently being assessed for their suitability and our expectation is that installation could start later in the summer subject to gaining any necessary approvals.
48. The Government estate has a huge range of opportunities to deploy solar PV. The Ministry of Defence, for example, with its airbases, training ranges and large sheds, owns many sites that are likely to be suitable for solar PV. There is a proposal, for example, to deploy solar PV at RAF Lyneham, a former operating airbase which is currently being converted into a training college.
49. **The Government aims to install 1 GWp solar PV generating capacity on the Government estate through a major programme led by DECC and Cabinet Office. As part of this, the Government will lead an initiative specifically targeted at England and Wales' 24,000 schools.**
50. **This year, the Government will identify the first 500 MWp of deployment and seek private finance partners to incentivise installation. As the benefits of deploying solar PV on public buildings are realised, we would expect deployment across this sector to increase substantially.**

## Schools

51. In a further initiative, the Department for Education is working on ways to improve energy efficiency across the 22,000 schools in England, to reduce their annual energy spend of £500 million. The initiative will encourage the deployment of PV on schools alongside promoting energy efficiency.
52. During 2013-14, loans totalling £10 million have been committed by Salix Finance to just over 300 schools' energy efficiency projects, with projected lifetime savings for these projects totalling just over £23 million.
53. **To support the Department for Education's energy initiative, DECC will provide clear, straightforward guidance for schools on how to install solar PV. This will outline the benefits and provide advice on: how to get started, raise funding, and a check list of key considerations.**

### Case study 4: Pendock Primary School, Worcestershire

Through the 10:10 Solar Schools project<sup>11</sup>, this small, rural primary of only 43 pupils, received a package of online and offline resources, training and support to help them crowd fund the cost of solar PV for the school roof. By combining online fundraising and social media with an organised on the ground effort, the school were able to raise £9,170 in just 18 weeks and installed 6.24 kWp of solar in April 2012. The panels are projected to bring the school additional annual revenue of over £1,000.

Crowd funding enabled the school to raise the capital needed to install solar that they own outright. In addition to that, they report that through the project they developed skills, confidence and networks that they can apply to other efforts in the future, and placed themselves in the hearts and minds of the villagers and parents. It has had the additional benefit of kick-starting energy saving measures, with the school reporting a reduction in electricity consumption of around 50 per cent in the first four months post installation - attributed to the panels and resultant behaviour change. The school are now fundraising for LED lighting.



*Images: Courtesy of Friends of Pendock School.*

<sup>11</sup> More information on the Solar Schools project is available at: [www.solarschools.org.uk](http://www.solarschools.org.uk)

## Community buildings

54. Solar PV is also being deployed sensitively on many of our most iconic buildings in the UK. For example, Bradford Cathedral (a Grade 1 listed building, built in the late medieval period) has a 9.9 kWp installation, making it the UK's first solar cathedral.

### Case study 5: Bradford Cathedral

Bradford Cathedral, a Grade I listed building, has installed a 9.9 kWp system on its south aisle roof to support the Church of England's declared aim to reduce its carbon footprint by 42 per cent by 2020. This involved the installation of 42 PV panels, completed in summer 2011. These panels are installed on the entire South Aisle roof – making it the first cathedral in the country, and possibly in the world, to generate its own power. Canon Andrew Williams, who leads the Cathedral's Eco Group, said "We were delighted to be the first cathedral to install PV cells on our roof. Whilst it would be naive of us to say that the financial benefits are not important, a key reason for doing this is to reduce our carbon footprint. The net ecological benefit of PV cells is not contested. As production increases with the high demand for panels, the carbon 'payback' time goes down. We were advised that the PV cells pay back their CO<sub>2</sub> emissions in two years in good conditions".



*Images: Courtesy of Bradford Cathedral.*

### Case Study 6: Photovoltaic noise barriers

There are other imaginative places to install solar PV such as alongside motorways.

For example, a community group representing the Chilterns and South Oxfordshire is working with the Highways Agency the opportunity to use photovoltaic noise barriers along parts of the M40 to reduce traffic noise for local residents.

*The photograph shows a similar scheme close to Verona in Italy. Image: courtesy of FAR Systems.*



## 1.4 Building-integrated PV

55. The UK has a vibrant Building Integrated PV (BIPV) sector, where the building fabric is made from solar PV materials. Technology is starting to provide us with the opportunity to install PV directly into the fabric of building glass and cladding material. These products will allow architects designing new buildings to maximise the energy generation of the fabric of the building. Costs of BIPV products have fallen at a similar rate to conventional modules, as they share the same solar cells. BIPV looks set to be an exciting area of growth.
56. The potential market for BIPV is both new build and refurbishment of existing buildings. BIPV products can be designed to match the building shapes and dimensions which will further enhance the aesthetics of solar as well as potential capacity. For example, this will allow deployment in a range of novel locations, including in the glass of skyscrapers and canopies. Solar roof tiles integrated into building roof designs will make solar PV less visible, while other products including louvres, glazed facades, atria and canopies offer other potential areas for BIPV integration. Some BIPV products can incorporate insulation, which can improve the energy efficiency of existing buildings.

### Case study 7: The Crick Building

The principle of BIPV is that PV modules are incorporated into the building envelope, substituting standard glass and other cladding materials with glass/glass laminates encapsulating PV cells within. The Francis Crick Institute is one of the latest projects designed by HOK and PLP Architects. 'The Crick' is a partnership between the Medical Research Council, Cancer Research UK and the Wellcome Trust, and three leading universities: Imperial, UCL and King's College London.

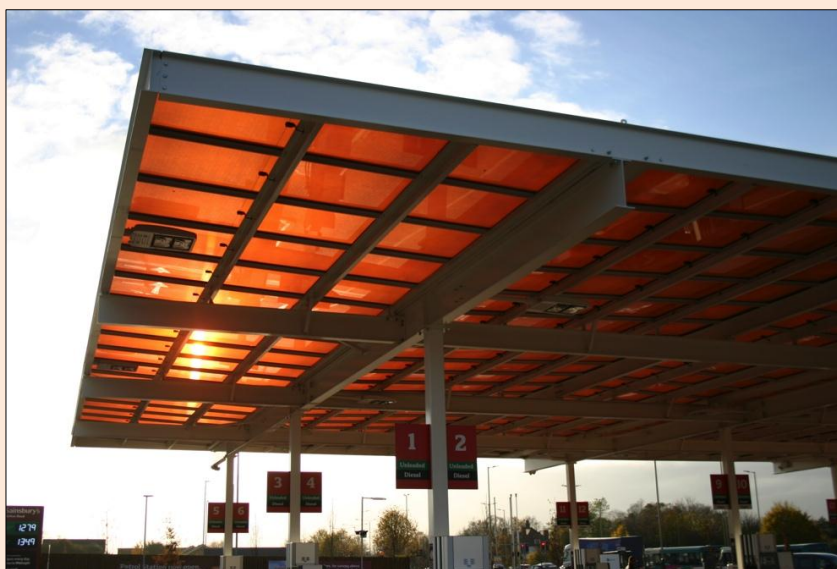
Over 800 custom built building integrated solar panels will be installed in the south-facing roof of the building to provide extra power from a renewable energy source. The panels, manufactured in the UK by specialist glass processor Romag, are expected to generate around 204,200 kWh/year and contribute towards the goal to achieve a BREEAM rating of 'excellent' for the building.



57. The market for BIPV products will provide opportunities for UK companies to develop and manufacture these products, which look to provide welcome export opportunities. BIPV also provides opportunities for next generation solar PV materials to develop (e.g. Polysolar, Oxford PV) and be brought to the market through the substantial building industry supply chain. **We are working with innovators and academia through the Solar PV Task Forces to develop an improved understanding of the technology and its supply chain, and to identify means of encouraging development.**
58. **DECC will work with the Solar PV Strategy Group, to identify how to reduce the costs of BIPV, making it more cost-effective to incorporate into new-build and include potential findings into the TINA.**

### Case study 8: Solar Glass: Petrol filling station, Leicester

The roof of this petrol station canopy in Leicestershire is constructed from solar PV glass modules as a direct replacement for the traditional corrugated metal roofing. It has a total capacity of 38 kWp and generates around 30 per cent of the accompanying petrol kiosk's electricity requirements per year.



*Image: Courtesy of Alastair Gadney at Polysolar Ltd.*

This project is one of the world's first transparent PV canopies and allows 20 per cent of natural light through to the forecourt below, thereby reducing the lighting energy requirements of the forecourt area whilst improving the aesthetic appeal of the units. Benefits for the owner are a reduction in the reliance on traditional energy sources and a commensurate carbon footprint improvement of almost 20 tonnes CO<sub>2</sub> per year. Importantly, the environmental credentials of the installation give rise to impressive figures during energy calculations (SBEM in this case).

There are significant secondary benefits for the entire construction supply chain. Since the product is a simple glass laminate sheet it is able to be treated entirely as a substitute for existing building materials. Thus, during the design phase there was minimal consideration of specialist requirements, save an allowance to hide electrical cabling. The same tradesmen who built the canopy structure also installed the glass. Specialist MCS certified electricians then finalised the installation.

## 1.5 Large-scale ground-mounted deployment

59. Over the last four years, the development of larger, usually ground-mounted, utility-scale solar PV has greatly increased both in terms of the installed capacity and the number of installations. In addition, the typical size of these installations has been increasing. The table below, which uses data taken from the Renewable Energy Planning Database (REPD)<sup>12</sup>, shows that at the end of 2011-12, there were 46 projects larger than 1 MWp operational, totalling 160 MWp of installed capacity. By the end of February this year, that number had grown to 184 projects (850 MWp) with a further 48 projects (538 MWp) expected to commission before the end of 2013-14. In addition, another 194 projects (1656 MWp) have planning permission and are awaiting construction.

**Table: Large-scale solar PV deployment in the UK**

	1-5 MWp		>5MWp <10MWp		>10MWp		Total	
	No.	Capacity MWp	No.	Capacity MWp	No.	Capacity MWp	No.	Capacity MWp
Operational: 2011/12	45	154	1	6	-	-	46	160
Operational: 2012/13	74	253	26	170	4	74	104	497
Operational: 2013/14, up to end February 2014	20	60	9	63	5	69	34	192
<b>Total operational</b>	<b>139</b>	<b>468</b>	<b>36</b>	<b>239</b>	<b>9</b>	<b>143</b>	<b>184</b>	<b>850</b>
Under construction	13	44	14	98	21	396	48	538
Awaiting construction	77	269	61	460	56	927	194	1656
<b>Total operational, under construction or awaiting construction</b>	<b>229</b>	<b>781</b>	<b>110</b>	<b>791</b>	<b>86</b>	<b>1465</b>	<b>425</b>	<b>3037</b>
<i>In planning</i>	34	112	25	189	39	848	98	1149

60. This deployment pipeline has been much stronger than anticipated in government modelling for previous reviews of the financial incentive schemes.<sup>13</sup> This has the potential to affect the financial incentives budget under the Levy Control Framework. Given the finite nature of this budget it will be necessary for the Department to continue to monitor the overall pipeline of projects, including large-scale solar PV, against our ambitions for a diverse mix of renewable technologies and achieving value for money for consumers.

<sup>12</sup> The REPD does not record if a project is ground or building-mounted but the majority are thought to be ground-mounted solar farms.

<sup>13</sup> [www.gov.uk/government/consultations/consultation-on-the-draft-electricity-market-reform-delivery](http://www.gov.uk/government/consultations/consultation-on-the-draft-electricity-market-reform-delivery)

61. All of the Government's initiatives regarding financial support need to be deliverable within the overall budget of the Levy Control Framework. The government is considering the implications of current trends of deployment on the financial incentives available to solar PV under the RO and FIT, and would consult on any proposals for amendment. We are improving our understanding of the pipeline of large-scale solar PV projects. Traditionally, energy projects require several years to move from initial planning to build, commissioning and generation. However, even large-scale PV developments can move from conception, through planning and to commissioning within 12 months.
62. Actual construction of a large-scale solar array can be completed in as little as eight weeks. This means that our usual deployment data gathering sources: the REPD, returns from Ofgem of FIT and RO accreditation, are of limited use and can return data which are several months out of date.
63. Since the Solar PV Roadmap was published, we are:
- increasing the information requested of the REPD contractor to focus more on the fast-paced nature of ground-mounted solar;
  - liaising with larger DNOs to gain a better understanding of the procedures they follow and to request anonymous preliminary data on the potential pipeline. A procedural understanding better allows us to interpret the data we receive;
  - more regularly seeking pipeline data from key solar PV stakeholders and ensuring that note is taken of future projects mentioned during stakeholder engagement. These are then factored into our pipeline monitoring;
  - monitoring data patterns and creating modelling from the findings, this will enable us to predict growth trends; and
  - discussing with Ofgem, National Grid and the DNOs how better use can be made of the information provided to them in compiling pipeline information.
64. While large-scale solar farms provide opportunities for greater generation, they can have a negative impact on the rural environment if not well-planned and well-screened. There can also be problems where local communities see no benefit but consider that they bear amenity issues. The Solar Trade Association has developed a statement of "10 Commitments" for solar farm developers (see box) which seeks to ensure that the impact of large-scale solar farms on communities, visual impact and long-term land use are minimised. In addition, the National Solar Centre is publishing two best practice guides on the development of large-scale solar farms. The first of these is on the factors that developers should consider in the design and installation of large-scale solar farms. The second is a guide to enhancing the biodiversity benefits from ground-mounted solar PV.<sup>14</sup>
65. When well-managed, solar farms could be beneficial for wildlife. However, in certain locations they could be damaging for biodiversity and ecosystems. The Solar Trade Association and National Solar Centre (NSC) are working with The National Trust, RSPB, the Bumblebee Conservation Trust and others on best practice guidance for optimising biodiversity on solar farm developments. This guidance will be available shortly on the NSC website.

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<sup>14</sup> National Solar Centre: Best Practice For The Development Of Ground Mounted Solar PV Systems, NSC Biodiversity Appendix: [www.bre.co.uk/page.jsp?id=3202](http://www.bre.co.uk/page.jsp?id=3202)

66. The Solar PV Roadmap set out as one of its four principles that 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 and gain some form of community benefit. The National Planning Policy Framework emphasises the importance of valuing ecosystem services using tools developed by Natural England and the Environment Agency. It also stresses the importance of creating and managing specific environmentally beneficial features and undertaking mitigation or offsetting if damaging development is permitted.

### **Solar Trade Association - Solar Farms 10 Commitments**

Solar farm developers, builders or tenants who are members of the Solar Trade Association will comply with the following best practice guidance:

1. We will focus on non-agricultural land or land which is of lower agricultural quality.
2. We will be sensitive to nationally and locally protected landscapes and nature conservation areas, and we welcome opportunities to enhance the ecological value of the land.
3. We will minimise visual impact where possible and maintain appropriate screening throughout the lifetime of the project managed through a Land Management and/or Ecology plan.
4. We will engage with the community in advance of submitting a planning application.
5. We will encourage land diversification by proposing continued agricultural use or incorporating biodiversity measures within our projects.
6. We will do as much buying and employing locally as possible.
7. We will act considerately during construction, and demonstrate 'solar stewardship' of the land for the lifetime of the project.
8. We will seek the support of the local community and listen to their views and suggestions.
9. We commit to using the solar farm as an educational opportunity, where appropriate.
10. The end of the project life we will return the land to its former use.

67. These best practice initiatives are important as they help address the perception that solar farms are diverting significant amounts of land from agricultural use and domestic food production. This, alongside the effects on the landscape and communities of the rapid growth in the deployment of large-scale solar PV installations, might erode public support for the sector overall.



### Case study 9: Solar PV and biodiversity

Westmill solar farm is a 5 MWp array on the Oxfordshire-Wiltshire border which was completed in July 2011. Soon after construction a wild flower meadow was seeded beneath the array. The mix of plants delivers a long flowering season that attracts a large number of bumblebees and butterflies. The meadow is left to grow throughout the summer, providing habitat for a wide range of other invertebrates, which in turn are an abundant food source for small mammals and birds.



*Image: Courtesy of Guy Parker*

Westmill among other sites, has provided inspiration for the development of the Biodiversity Guidance for solar farms<sup>15</sup> produced by the National Solar Centre (NSC) in late 2013. The NSC's guidance draws on experience from conservation organisations, agri-environment schemes and the solar industry to provide a range of land management options that encourage wildlife while also being compatible with the generation of solar power. It is hoped that such guidance will stimulate further planning for, and investment in, biodiversity on solar farms.

68. Decisions on the granting of approval for large-scale solar PV installations (less than 50 MWp) will continue to be taken through local planning processes in accordance with local plans and any relevant material considerations, including national planning policy and practice guidance. Local planning remains the most appropriate vehicle for such decisions and ensures that the voices of the local communities in which developments are proposed are heard as part of the planning decision. The Department for Communities and Local Government, in association with DECC, published revised planning guidance for renewable energy developments in England in July 2013. This provided guidance to planners on how to assess applications for, amongst other things, large-scale, ground-mounted solar PV installations.<sup>16,17</sup> Separate planning processes are applicable in Northern Ireland, Scotland and Wales. The Planning Act (Northern Ireland) 2011 will transfer the majority of planning powers from the Planning Service to local authorities from 2015. This will include the granting of approval for large-scale solar PV. The capacity threshold for local authority approvals will shortly be the subject of consultation by the Department of Environment.

<sup>15</sup> [solar-media.s3.amazonaws.com/assets/documents/Biodiversity-for-Large-Scale-planning-of-solar-farms-in-the-UK.pdf](http://solar-media.s3.amazonaws.com/assets/documents/Biodiversity-for-Large-Scale-planning-of-solar-farms-in-the-UK.pdf)

<sup>16</sup> Written ministerial statement by Nick Boles MP on local planning 6 March 2014: [www.gov.uk/government/speeches/local-planning](http://www.gov.uk/government/speeches/local-planning)

<sup>17</sup> Planning Practice Guidance Portal: [www.planningguidance.planningportal.gov.uk](http://www.planningguidance.planningportal.gov.uk)

69. In response to Lord Taylor of Goss Moor's review of planning guidance, in March 2014 the Government launched a new accessible website bringing revised, streamlined planning guidance.<sup>18</sup> This incorporated the guidance on renewable energy (including heritage and amenity) published during last summer and making it clearer in relation to solar farms, that visual impact is a particular factor for consideration.
70. We will continue to engage with developers and other stakeholders to understand the impact of large-scale solar deployment on landscape, food production and biodiversity and consider further action if current safeguards and best practice prove inadequate.
71. **DECC will promote DCLG's planning guidance on large-scale solar farms. The guidance sets out particular considerations for solar farms, such as their visual impact, and underlines that it is important that the planning concerns of local communities are properly heard in matters that directly affect them.**
72. **DECC will continue to work with industry to promote industry best practice standards, including the STA's 10 commitments and the NSC's biodiversity guidance, to ensure deployment is sympathetic to the countryside.**
73. **DECC and Defra will work with industry to understand better the effects (both positive and negative) of solar farms on biodiversity.**

## 1.6 Ensuring timely and affordable grid access

74. Realising our ambition will require projects to be connected to the electricity grid in a timely and affordable way.
75. Concerns have been raised by developers at the time and cost it can take to connect projects to the network, particularly where wider network reinforcement is required in order to accommodate them. In response, Ofgem has taken a number of steps to help drive a more efficient, customer-focused connections service.
76. Within the current price control DPCR5 (2010-15), Ofgem introduced **Guaranteed Standards of Performance**, which required Distribution Network Operators (DNOs) to make payments to customers when they fail to issue connection quotes within specified timeframes or deliver the completed connection within an agreed timeframe. In addition it introduced a Customer Satisfaction Survey that rewards or penalises DNOs depending on how they perform against the industry average.<sup>19</sup>
77. In 2011, Ofgem established the **Distributed Generation Forum**, which annually brings together distribution network operators and developers to identify and overcome barriers to connection. As a result, DNOs developed work plans to improve the service provided. These also feature in their RIIO-ED1 Business Plans and are subject to ongoing review.
78. In addition, following publication of our Community Energy Strategy<sup>20</sup>, a new working group has been established to consider the issues facing community groups' ability to connect to the network. The group plans to report its recommendations to the Secretary of State in July 2014.<sup>21</sup>

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<sup>18</sup> Planning Practice Guidance Portal: [www.planningguidance.planningportal.gov.uk](http://www.planningguidance.planningportal.gov.uk)

<sup>19</sup> Ofgem The Broad Measure of Customer Satisfaction (BMCS): [www.ofgem.gov.uk/electricity/distribution-networks/network-price-controls/customer-service](http://www.ofgem.gov.uk/electricity/distribution-networks/network-price-controls/customer-service) and the connections Guaranteed Standards of Performance (GSOPs): [www.ofgem.gov.uk/Networks/ElecDist/QualofServ/GuarStandds/Pages/GuarStandds.aspx.pdf](http://www.ofgem.gov.uk/Networks/ElecDist/QualofServ/GuarStandds/Pages/GuarStandds.aspx.pdf).

<sup>20</sup> [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/275169/20140126Community\\_Energy\\_Strategy.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/275169/20140126Community_Energy_Strategy.pdf)

<sup>21</sup> The group, which is chaired by Ofgem, includes representatives from network companies and community groups.

79. With the introduction of RIIO-ED1 to incentivise improvements to the service provided for customers requiring a larger connection, including distributed generation, there will be a new incentive, called the **Incentive of Customer Engagement**.<sup>22</sup> DNOs will need to engage with stakeholders and use their feedback to agree a work plan and relevant targets to measure performance. Ofgem will assess performance against these targets and companies will face penalties if they fail to deliver.
80. Ofgem has included a number of elements in its RIIO-ED1 price control to help ensure that DNOs are in a position to facilitate the connection of new load or generation. DNOs are currently developing business plans to set out what **investment needs** they anticipate, ensuring all users of the network are served. Ofgem will allow the DNO to request additional funding from Ofgem once it has exceeded its allocated allowance to connect new load or generation by 20 per cent.<sup>23</sup>
81. Ofgem has also stated that it is open to DNOs submitting a case for investment ahead of need in their business plans, which appropriately shares the risk of stranded assets between themselves, connecting customers and the wider customer base. One way in which DNOs can do this is to gather a consortia of customers together who wish to connect at the same location of the network over the coming years. Through a Section 22 connection agreement, these customers can commit to paying a contribution towards the costs of the connection.
82. DNOs are in the process of preparing their expenditure plans for 2015-2023 in order for Ofgem to set their allowed revenues as part of the RIIO-ED1 Price control process. These plans include their projected estimates on take-up of low carbon technologies including solar PV and detail their proposed investment in the network. Western Power Distribution has now had its Business Plan fast-tracked, the other DNOs resubmitted their Business Plans in late March.
83. Recently, DNOs have produced detailed network hotspot maps to show where current constraints exist across the network, helping developers to identify areas of the network where a connection can be made more quickly and at lower cost. These maps can be found on the DNOs' websites.
84. While there are a number of similarities to the GB grid, the position in Northern Ireland is slightly different. The Northern Ireland Authority for Utility Regulation regulates the single DNO, Northern Ireland Electricity (NIE). A grid connection offer can only be considered once the generator has received planning permission, where appropriate. Parts of the Northern Ireland grid network are nearing capacity due to the increasing amounts of small-scale generation connecting, particularly onshore wind. This is leading to increasing connection costs and timescales and work is underway by NIE to consider how more information on grid 'hot spots' can be made accessible to generators at an early stage and prior to submitting costly planning applications. In addition to this, NIAUR has set up the 'Renewables Industry Group' to tackle the issue, including the consideration of connection to the 11 kV network for small-scale renewable generators.
85. **Ofgem will assess the RIIO-ED1 DNO Business Plans, which will include an evaluation of how the DNO's strategies for RIIO-ED1 efficiently accommodate scenarios for deployment of low carbon technologies, including solar PV, within their region. Ofgem will make a final determination on all plans by November 2014, setting the outputs that the DNOs need to deliver for their customers.**

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<sup>22</sup> Incentive on Connections Engagement (ICE) for major demand, unmetered and all DG customers: [www.ofgem.gov.uk/Networks/ElecDist/PriceCtrls/riioed1/consultations/Documents1/RIIOED1DecOverview.pdf](http://www.ofgem.gov.uk/Networks/ElecDist/PriceCtrls/riioed1/consultations/Documents1/RIIOED1DecOverview.pdf)

<sup>23</sup> If DNOs underspend their reinforcement allowance by 20 per cent, then Ofgem can potentially claw back money for customers.

86. DECC will continue to engage with industry through the Solar PV Grid Task Force to obtain an on-the-ground perspective of solar PV connection costs and waiting times, and consider whether steps can be taken to remove any barriers to deployment and speed up the process of connecting to the grid.
87. DECC will obtain grid connection data from National Grid and Distribution Network Operators to better understand the connection process, timing and the volumes of solar PV installations across the UK. This will feed into the Whole Systems Modelling project that will provide a greater understanding of the impact on grid and costs of connecting significant volumes of solar PV to the transmission and distribution network.



## 2. Realising ambition through innovation

88. The high levels of solar PV we wish to see deployed, particularly on domestic rooftops and mid-size roofs, will require breakthroughs in innovation, cost reduction, grid solutions, and financing solutions, in order to be realised. Technology innovation is key to cost reduction and to deploying significantly greater levels of solar PV and to minimise costs for bill-payers; as well as delivering genuine carbon reductions and helping meet the UK's target of 15 per cent of final consumption from renewable energy by 2020.
89. Innovation is vital in enabling us to realise our ambitions for solar PV through progress in the following areas:
- Cost reduction through innovation
  - Innovative financing solutions
  - Balancing the system through innovation
  - Carbon emissions reduction through innovation.

### 2.1 Realising cost reduction through innovation

90. Solar PV technology has experienced radical innovation and radical cost reductions: since the beginning of the decade, the costs of solar PV have fallen by over 50 per cent.<sup>24</sup>
91. The main cost reduction drivers have been improvements to the device, manufacturing and production, and the benefit of the transfer of knowledge from the already mature semiconductor industry into solar PV.<sup>25</sup> The PV module *price* (which is a result of a combination of production costs and profit) is only part of the whole PV system, including balance of system (BoS) costs.<sup>26</sup> There has been some reduction in BoS costs through the combined effect of system design modifications such as reducing the number of parts, improved integration of PV modules, improved mounting systems and standardisation of components.

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<sup>24</sup> Cambridge Economic Policy Associates Ltd and Parsons Brinckerhoff (2011) Updates to the Feed-in Tariff Model Documentation of Changes for solar PV Consultation:

[www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/48136/2174-cepa-paper.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48136/2174-cepa-paper.pdf) and Parsons Brinckerhoff (2012) Solar PV Cost Update:

[www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/43083/5381-solar-pv-cost-update.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43083/5381-solar-pv-cost-update.pdf)

<sup>25</sup> [ukerc.rl.ac.uk/UCAT/cgi-bin/ucate\\_query.pl](http://ukerc.rl.ac.uk/UCAT/cgi-bin/ucate_query.pl).

<sup>26</sup> All other costs associated with installation and financing including mounting materials, racking, inverters, cables and wiring, metering, installation labour, financing, contractual costs and permitting.

92. Supply and demand for solar PV is also now global in nature, and with Europe's share of the global market reduced by 20 per cent<sup>27</sup>, the current market is dominated by China and Asia-Pacific supplying around 70 per cent of global PV.<sup>28</sup> It is thought that the industry manufacturing strategies and market imbalances associated with high global market growth are likely to have been a stronger influence on the recent falls in PV module prices than that of the underlying efficiencies of production costs.<sup>29</sup>
93. There continue to be opportunities to gain further cost reductions both through enhancements in the cell efficiency (the quantity of radiated light converted into usable electric power)<sup>30</sup>, and through improvements to the BoS components, which are now the main share of capital costs.<sup>31</sup> Innovation in inverter technology, standardisation, and materials efficiency of structural components, offer opportunities for cost reduction.<sup>32</sup> A key factor influencing the BoS costs is whether the PV system is installed to a new building or retrofitted: system costs are usually lower for new-builds.<sup>33</sup>
94. So far, the PV sector has been dominated by one technology (c-Si) and one product (the flat photovoltaic module). This has triggered significant cost reductions in manufacturing but not a major change in the way in which the PV technology can be deployed and used.<sup>34</sup> That step change could be harnessed through innovation of new technologies and improving integration to UK grid and the development of associated technologies. That said, crystalline silicon (c-Si) is expected to remain the top PV technology in the coming years.<sup>35</sup>
95. The UK, together with more established countries' PV markets such as Germany, Italy or the US, could see a differentiated opportunity to that of China and Asia-Pacific countries to develop innovative products (e.g. BIPV; thin film, and printable organic PV).<sup>36</sup> The UK has well-established research and development activity on a range of photovoltaic technologies and applications, which are predominately focussed on next generation technologies.<sup>37</sup> This may provide a comparative advantage.

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<sup>27</sup> European Photovoltaic Institute Association (EPIA) (2013) Global Market Outlook for Photovoltaics 2013-2017: [www.epia.org/fileadmin/user\\_upload/Publications/GMO\\_2013\\_-\\_Final\\_PDF.pdf](http://www.epia.org/fileadmin/user_upload/Publications/GMO_2013_-_Final_PDF.pdf)

<sup>28</sup> *ibid*

<sup>29</sup> Candelise, C. Winkler, M. Gross, R. (2013) The dynamics of solar PV costs and prices as a challenge for technology forecasting, in *Renewable and Sustainable Energy Reviews* 26, p96–107.

<sup>30</sup> Marigo, N. Candelise, C (2013) What is behind the recent dramatic reductions in Photovoltaic prices? The role of China. *Economia e Politica Industriale - Journal of Industrial and Business Economics* 2013 vol. 40 (3): 5-41.

<sup>31</sup> Rocky Mountain Institute (2010) Achieving low-cost solar PV: Industry workshop recommendations for Near-term balance of system cost reductions. [www.rmi.org/Content/Files/BOSReport.pdf](http://www.rmi.org/Content/Files/BOSReport.pdf)

<sup>32</sup> Rocky Mountain Institute (2010) Achieving low-cost solar PV: Industry workshop recommendations for Near-term balance of system cost reductions: [www.rmi.org/Content/Files/BOSReport.pdf](http://www.rmi.org/Content/Files/BOSReport.pdf)

<sup>33</sup> Nelson, J. Gambhir, A. Ekins-Daukes, N (2014) *Solar Power for CO2 Mitigation*. Imperial College: Grantham Institute for Climate Change:

[www.workspace.imperial.ac.uk/climatechange/Public/pdfs/Briefing%20Papers/Solar%20power%20for%20CO2%20mitigation%20-%20Grantham%20BP%2011.pdf](http://www.workspace.imperial.ac.uk/climatechange/Public/pdfs/Briefing%20Papers/Solar%20power%20for%20CO2%20mitigation%20-%20Grantham%20BP%2011.pdf)

<sup>34</sup> Marigo, N. Candelise, C (2013) What is behind the recent dramatic reductions in Photovoltaic prices? The role of China. *Economia e Politica Industriale - Journal of Industrial and Business Economics* 2013 vol. 40 (3): 5-41.

<sup>35</sup> European Photovoltaic Institute Association (EPIA) (2013) Global Market Outlook for Photovoltaics 2013-2017: [www.epia.org/fileadmin/user\\_upload/Publications/GMO\\_2013\\_-\\_Final\\_PDF.pdf](http://www.epia.org/fileadmin/user_upload/Publications/GMO_2013_-_Final_PDF.pdf)

<sup>36</sup> Marigo, N. Candelise, C (2013) What is behind the recent dramatic reductions in Photovoltaic prices? The role of China. *Economia e Politica Industriale - Journal of Industrial and Business Economics* 2013 vol. 40 (3): 5-41.

<sup>37</sup> [www.gov.uk/government/publications/uk-solar-pv-strategy-part-1-roadmap-to-a-brighter-future](http://www.gov.uk/government/publications/uk-solar-pv-strategy-part-1-roadmap-to-a-brighter-future)

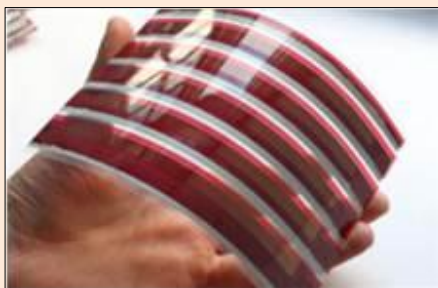
96. The UK has significant, specific strengths in solar research and innovation which could contribute to future economic growth. Our research activities, particularly on third generation photovoltaics were recognised as world-leading by the International Review of Energy Research.<sup>38</sup> These next generation PV, excitonic technologies – including both dye-sensitised cells and organic and hybrid PV – are all growing research areas in the UK and the UK recently introduced the first assembly line for flexible excitonic cells.<sup>39</sup>
97. The UK is also home to several start-up companies operating in third generation PV which have spun from universities, for example: Oxford Photovoltaics Ltd is a spin out from the University of Oxford who are focussing on BIPV (see case study box); whilst Eight19, with technology initially developed at Cambridge University, are developing and manufacturing solar cells based on printed plastic which benefit from high throughput and cheap production processes.

### Case study 10: SPECIFIC Innovation and Knowledge Centre - Buildings as Power Stations

The Sustainable Product Engineering Centre for Innovative Functional Industrial Coatings (SPECIFIC) at Swansea University is funded for five years by the Engineering and Physical Sciences Research Council (EPSRC), the Technology Strategy Board and the Welsh Government. SPECIFIC is one of seven Innovation and Knowledge Centres with the aim of commercialising emerging technologies through creating early stage critical mass in an area of disruptive technology.

Working with industrial partners including Tata Steel, BASF and NSG Group, SPECIFIC aims to develop functional coated steel and glass products that will transform the roofs and walls of buildings into surfaces that will generate, store and release energy. The ambition for these products is to generate over one third of the UK's total target renewable energy by 2020; reducing CO2 output by 6 million tonnes per year and creating new jobs in high-value manufacturing.

Recently, SPECIFIC won further funding as part of the consortium for the Photovoltaic Technology based on Earth Abundant Materials (PVTEAM) project led by the University of Bristol. PVTEAM aims to replace costly, toxic and scarce elements in solar cells with new active materials based on abundant and cost effective elements that will be safer and environmentally sustainable. The development and implementation of processes compatible with large-scale manufacturing in the UK will be based at SPECIFIC, which will oversee designing scale-up strategies and preparing techno-economic assessment.



<sup>38</sup> Research Councils UK (2010-2012) Review of Energy: [www.rcuk.ac.uk/Publications/reports/Pages/Energy2010.aspx](http://www.rcuk.ac.uk/Publications/reports/Pages/Energy2010.aspx)

<sup>39</sup> SPECIFIC (2012): [www.specific.eu.com/capabilities/pilot](http://www.specific.eu.com/capabilities/pilot)

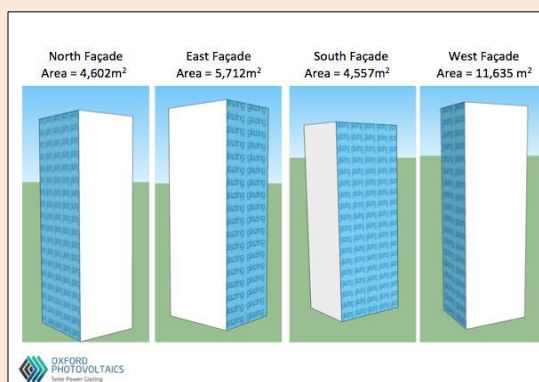
98. Our strong academic and innovation expertise and our research strengths provide a platform for the UK to build on. There are opportunities to export those skills and knowledge and, if exploited effectively, that expertise could provide the potential to create and export world-leading commercial technologies.
99. DECC will work with the Skills Funding Agency and the Solar PV Strategy Group to encourage the PV sector to maximise the opportunities for skills development across all aspects of the supply chain. We would like to see options for apprenticeships as well as studying at higher and further education level.



### Case study 11: Thin Film Perovskite Solar Glass PV

Oxford PV has pioneered the development of perovskite thin film solar cells, which can be printed directly onto architectural glass to produce transparent or opaque coatings. This glass can be integrated into unitised facades for the construction of tall glass buildings.

In lab conditions the solar cell efficiency of 17 per cent has been reported for opaque cells. For application into a 50 per cent transparent glass IGU, a module efficiency of 5 per cent is assumed.



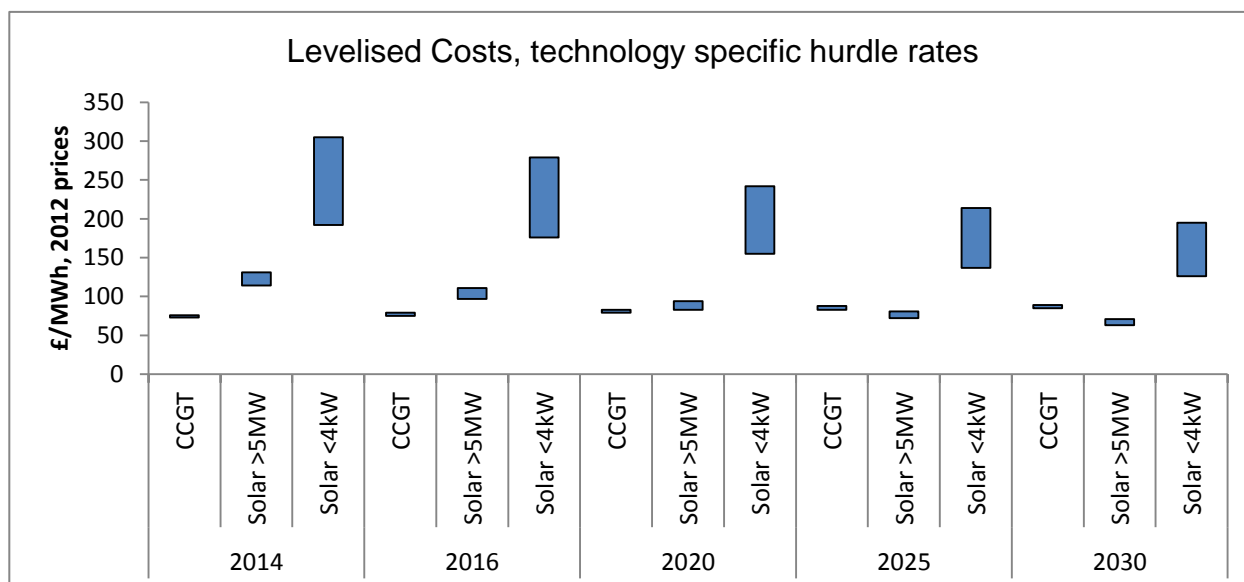
A new tall commercial building planned for construction completion in the next three to four years has been modelled. The building is designed to exceed the 2010 building regulations Part L by 25 per cent. The total glass facade area will be 26,500m<sup>2</sup>. With 19,900m<sup>2</sup> of coated vision glass and 6,600m<sup>2</sup> of coated spandrels the building becomes a 1.7 MWp vertical solar farm. This would generate 714 MWhr/year which is estimated to be 26 per cent of the building's regulated consumption.

To explore that potential, the members of the Low Carbon Innovation Co-ordination Group (LCICG) have begun the process of developing a Technology Innovation Needs Assessment (TINA) for Solar PV technologies with the aim of publishing the report by early 2015. The TINA methodology has been applied to range of technologies<sup>40</sup> and provides a shared evidence base to inform LCICG investment decisions. The TINAs consider the principal components of a given technology and identify the key innovation needs in the short- and medium-term necessary to meet our long-term objectives. Each TINA includes an assessment of: the value of the technology and the innovation in meeting emissions and other energy policy targets at lowest cost; the value of the technology and the innovation in aiding UK economic growth; and the case for UK public-sector support, including a review of international and private-sector activity and a consideration of market failures. The development of a TINA for Solar PV will provide insights into the UK comparative strengths in solar PV innovation and will help LCICG members and UK researchers and innovators prioritise future investments in Solar PV research and development.

<sup>40</sup> LCICG Technology Innovation Needs Assessment:  
[www.lowcarboninnovation.co.uk/working\\_together/technology\\_focus\\_areas/overview/](http://www.lowcarboninnovation.co.uk/working_together/technology_focus_areas/overview/)

100. **The Low Carbon Innovation Co-ordination Group will report in early 2015 on a Technology Innovation Needs Assessment (TINA) for Solar PV technologies that will identify the key innovation needs in the short-term and medium-term necessary to meet our long-term objectives.**
101. **DECC encourages the solar PV sector to take up opportunities through the third phase of the Energy Entrepreneurs Fund, that launched a further £10m of available funding in January 2014.**
102. Given this scope for innovation and cost reduction, we expect costs (and price of modules) for solar PV to fall much faster than for other key renewable energy technologies. Central cost reduction trajectories (in levelised costs terms<sup>41</sup>) are set out below for solar PV (domestic and large-scale).<sup>42</sup> There is a progressive levelised cost reduction trajectory assumed in the period out to 2030, reflecting the advancements made in technology development and supply chains, indicating a reduction in levelised costs of around 20 per cent by 2020. If this rate of cost reduction continued into the 2020s, solar PV would be competitive in levelised costs terms with other large-scale generation technologies such as CCGT by 2025.<sup>43</sup>

**Estimated levelised cost comparison of electricity generation technologies<sup>44</sup>**



<sup>41</sup> Discounted average cost over the lifetime of the plant per MWh of electricity generated.

<sup>42</sup> Assessment based on Table 13, DECC (2013) Electricity Generation Costs 2013:

[www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/223940/DECC\\_Electricity\\_Generation\\_Costs\\_for\\_publication\\_-\\_24\\_07\\_13.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223940/DECC_Electricity_Generation_Costs_for_publication_-_24_07_13.pdf)

<sup>43</sup> Assessment based on Table 13, DECC (2013) Electricity Generation Costs 2013:

[www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/223940/DECC\\_Electricity\\_Generation\\_Costs\\_for\\_publication\\_-\\_24\\_07\\_13.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223940/DECC_Electricity_Generation_Costs_for_publication_-_24_07_13.pdf)

<sup>44</sup> DECC (2013) Electricity Generation Costs 2013:

[www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/223940/DECC\\_Electricity\\_Generation\\_Costs\\_for\\_publication\\_-\\_24\\_07\\_13.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223940/DECC_Electricity_Generation_Costs_for_publication_-_24_07_13.pdf) The hurdle rate for small-scale solar (8% pre-tax, real) is the mid-point of the hurdle rate range for domestic investors assumed in modelling for Phase 2A of the FITs Comprehensive Review Government response (4.5%-11.5%). For more details see: [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/43080/5391-impact-assessment-government-response-to-consulta.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43080/5391-impact-assessment-government-response-to-consulta.pdf)

103. Although forecasts have generally been accurate about the downward trend of PV costs, there still lies some considerable uncertainty about the exact level of cost reduction the sector will experience or by when, and even small changes can affect long-term estimates of cost reductions.<sup>45</sup> Industry commentators expect that the current market consolidation will ease, which will allow manufacturers to once again cover their production costs at the current low prices.<sup>46</sup> An industry-wide recovery is expected and some industry reports suggest the global solar industry is already on the rebound and accelerating.<sup>47</sup> Current cost uncertainty is also as a result of European Commission anti-dumping and anti-subsidy cases (see case study box).
104. We will commission the Solar PV Strategy Group, over the next six months, to report on opportunities for solar PV cost reduction across the supply chain and deployment; with the particular aim of highlighting areas to reduce installed costs for solar PV to domestic and commercial/industrial customers, and how soon different markets will achieve grid parity. We will also continue to monitor solar PV cost reduction.

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<sup>45</sup> UKERC (2013) Presenting the Future An assessment of future costs estimation methodologies in the electricity generation sector: [www.ukerc.ac.uk/support/article3514-Are-we-getting-better-at-predicting-future-electricity-generation-costs](http://www.ukerc.ac.uk/support/article3514-Are-we-getting-better-at-predicting-future-electricity-generation-costs)

<sup>46</sup> Fraunhofer Institute for Solar Energy Systems (2013) Levelised cost of electricity renewable energy technologies: [www.ise.fraunhofer.de/en/publications/veroeffentlichungen-pdf-dateien-en/studien-und-konzeptpapiere/study-levelized-cost-of-electricity-renewable-energies.pdf](http://www.ise.fraunhofer.de/en/publications/veroeffentlichungen-pdf-dateien-en/studien-und-konzeptpapiere/study-levelized-cost-of-electricity-renewable-energies.pdf)

<sup>47</sup> IHS (2014) White Paper Top Ten solar Predictions 2014: [www.ihs.com/info/sc/a/solar-predictions-2014.aspx](http://www.ihs.com/info/sc/a/solar-predictions-2014.aspx)

### Case study 12: The impact of the Chinese anti-dumping and anti-subsidy case

In the second half of 2012, in response to a complaint by a group of European manufacturers, the European Commission launched investigations into whether the Chinese manufacturers had benefited from dumping or subsidies (“unfair” trade practices) and had inflicted material injury on European manufacturers as a result. The Commission concluded that there had been dumping which had caused material injury. It published proposals for significant import duties for Chinese solar products imported to Europe. However, these proposals were accompanied by public messaging from the Commission that they would be prepared to consider a negotiated undertaking with Chinese exporters which would go some way to minimising the disruption to the EU solar market. The Commission subsequently negotiated such undertakings with some Chinese exporters. This approach was supported by a majority of Member States, including the UK.

In December 2013, the Commission published Regulations<sup>48</sup> imposing definitive anti-dumping and countervailing (anti-subsidy) duties as well as a Commission Decision<sup>49</sup> confirming the acceptance of the price undertakings which would apply to a limited quantity of imports. These decisions entered into force on 6 December 2013 for a period of two years ending in December 2015.

In the weeks following the introduction of these measures, the solar PV sector in the UK raised concerns that the increased costs imposed through the minimum price would act as a break on solar deployment at all scales in the UK. However, there has been no clear evidence of a significant effect on deployment rates, especially at domestic and utility scale. On that basis it is presumed that any additional costs arising from the anti-dumping measures have been absorbed within project margins. However, we will continue to review costs and deployment rates on this basis.

## 2.2 Novel financial solutions

105. The Minister has spoken on several occasions about his desire to see the wider deployment of distributed energy technologies, such as solar PV, create a fundamental shift in the make-up of the UK energy mix. Solar PV, particularly at domestic level and on businesses, will play a key role in creating a new “prosumer” base – the move “from the Big 6 to the Big 60,000” – where consumers of electricity are also its producers. There can be beneficial synergies from the installation of self-generation technologies and smart metering equipment in the domestic setting. A greater awareness of and personal attachment to the nature of energy generation and usage can encourage consumers to reduce their own consumption. The principle of combining demand response, demand reduction technologies and decentralised energy generation (known collectively as the “D3 agenda”) underpin our approach to policies across energy efficiency, demand-side reduction, public awareness of energy usage and distributed energy.

<sup>48</sup> COUNCIL IMPLEMENTING REGULATION (EU) No 1238/2013 of 2 December 2013, imposing a definitive anti-dumping duty and collecting definitively the provisional duty imposed on imports of crystalline silicon photovoltaic modules and key components (i.e. cells) originating in or consigned from the People's Republic of China COUNCIL IMPLEMENTING REGULATION (EU) No 1239/2013 of 2 December 2013 imposing a definitive countervailing duty on imports of crystalline silicon photovoltaic modules and key components (i.e. cells) originating in or consigned from the People's Republic of China (2013/707/EU).

<sup>49</sup> COMMISSION IMPLEMENTING DECISION of 4 December 2013 confirming the acceptance of an undertaking offered in connection with the anti-dumping and anti-subsidy proceedings concerning imports of crystalline silicon photovoltaic modules and key components (i.e. cells) originating in or consigned from the People's Republic of China for the period of application of definitive measures (2013/707/EU).

106. Innovation in financing is a further aspect of realising our ambition. The solar industry and financial institutes have been working closely to develop viable and novel financial solutions. These solutions are tailor made to each case and projects and are available from a number of different sources:
107. The solar industry and financial institutes have been working closely to develop viable financial solutions. These solutions are tailor made to each case and projects and are available from a number of different sources:
- **Crowd funding.** Linking up communities and individuals with renewable energy projects make it possible for everyone to share in the benefits of clean energy production.
  - **Green Deal Finance.** Consumers can use Green Deal finance to help meet the costs of installing solar PV on their property and receive the Feed-in Tariff (FiT) as well. The amount they can finance through the Green Deal will depend on how much the home is expected to save on its electricity bill. However Feed-in Tariff payments (generation and export tariffs) cannot be included in this calculation.
  - **Power Purchase Agreement (PPA) or ESCO.** Where a third party company, an Energy Supply Company (ESCO) pays for the solar installation and retains ownership, and sells electricity back to customer at a discounted rate. This will not eliminate customer's energy bills, but it can offer significant reductions.
  - **Lease finance.** A solar lease is much like a car lease and can be a Hire Purchase agreement, or a Finance Lease. Someone else owns the equipment, and the customer pays a monthly fee to lease it until the end of the agreement. A solar lease differs from a solar power purchase agreement (PPA) in that the customer is leasing the equipment, whereas with a PPA, they are paying for the electricity the panels produce. Leases can have either fixed, escalating, or de-escalating monthly payments over the lifetime of the agreement, which currently can be up to five years. In a sense, they are very similar agreements, in that someone else owns and maintains the system. But there can be much lower electricity bills from a clean, renewable source of energy. Like a PPA, the advantage of a solar lease is that instead of making a large upfront investment in solar panels, the customer can get started with little to no upfront investment.
  - **Non-Debt Operating Lease.** True operating leases offer a flexible method of acquiring solar installations. The customer effectively makes monthly repayments to a finance company over three periods. The first period is usually between three and seven years where the financier is able to recoup up to 90 per cent of the capital cost of the equipment. There is then a secondary term on the lease, usually a further three to five years where the repayments drop significantly to allow the financier to recoup the remaining 10 per cent of the capital cost before a tertiary period of peppercorn rentals of a nominal amount. The customer can choose to terminate the agreement at the end of the primary or secondary terms, or at any point after. The customer is able to be the recipient of all the energy that is produced, as well as directly receiving Feed-in Tariffs and Export Tariffs where eligible. Monthly payments are usually tailored to match the customer's energy savings and exports, and aim to have a zero up-front cost for the installation. A key element of the operating lease is that in accounting terms it is not classed as debt funding i.e. it is financed through normal expenditure account in the same way customer's current electricity bills are paid. Non-debt funding has no effect on other credit lines such as the bank, and allows the customer access to future funding should they need.

- **Home Equity Solar Loans.** Some home equity loan products are beginning to take into account the value the solar energy system adds to the customer's home into their cumulative loan to value ratio calculations. This means more people would qualify for a loan with these products. A solar system which saves on energy bills and generates income can add value to the property. For example, if a solar system saves the home owner £1,000 a year in energy, and generates £2,500 a year in additional income, it adds £50,000 to the value of the home. Some lenders are beginning to lend against the future value of the property.
  - **Contract Hire.** Contract Hire is very similar to a lease rental scheme on a car. Monthly payments are made to a third party financier for a period of 3-10 years with a 'balloon payment' at the end of the primary term.
  - **Small commercial utility finance.** This is suitable for commercial rooftop energy projects whereby the roof owner has shares in the utility company created to own the asset. The tenant buys the energy required to run their business from the utility company created by the investor and the roof owner.
  - **Community energy projects.** There are many different forms of community energy, including both wholly and partly community owned developments. One example is based on the ESCO or PPA agreement described above. The key difference is that the shareholders in the ESCO are local communities, individuals and local associations. A group can get together and purchase shares in a newly formed business (the ESCO) which then purchases the solar installation and sells the energy at a discounted rate to the shareholders. Sometimes, the installer of the solar PV also takes a share in the ESCO. The ongoing benefit is that the shareholders each take a share of the long term profits of the ESCO, as well as saving on their electricity bills.
108. The Government published its Community Energy Strategy in January 2014, which set out a bold vision for scaling up this sector.<sup>50</sup> This included a commitment from the renewables industry to facilitate a substantial increase in the ownership of new, commercial, onshore renewables developments – and this includes solar PV developments. A Shared Ownership Taskforce, including representatives from the renewables industry and the community energy sector, is considering how to achieve this. Furthermore, a Community Energy Finance Roundtable has been set up to explore issues that are limiting access to, and/or availability of, finance for community energy projects and to develop and propose appropriate solutions. Conclusions and recommendations of each will be reported to the Secretary of State for Energy and Climate Change and the Minister for Civil Society this summer.
109. As indicated in the Community Energy Strategy, the Government is considering an increase in the FIT capacity ceiling for community projects from 5 to 10 MWp and looking into how we might improve our guidance and change our policy to enable community groups to combine grants with FiTs and RHI, in a manner consistent with EU State Aid rules. Any changes would be within the overall context of the need for financial support to be deliverable within the overall budget of the Levy Control Framework.
110. As the costs of solar PV come down and new financing options become available, installing solar PV is likely to become a viable option for increasing numbers of households, businesses, communities and organisations.
111. **DECC will work with the Green Investment Bank (GIB) to explore the scope to support solar PV as part of commercial energy efficiency projects in the UK using GIB funding.**

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<sup>50</sup> [www.gov.uk/government/news/power-to-the-people-government-boost-to-community-energy](http://www.gov.uk/government/news/power-to-the-people-government-boost-to-community-energy)

## 2.3 Managing system integration through innovation

112. With significant increases in solar PV deployment, it is necessary to manage its integration into the electricity system and market. Last year, National Grid published analysis confirming that 10 GWp of non-controllable solar PV in Great Britain can be accommodated without significantly changing operational practices, but that above this level would make managing the grid significantly more challenging and costly.<sup>51</sup> We will need to be innovative both in terms of technology and operational and market incentives, to meet this challenge.
113. The Solar PV Roadmap committed us to work with partners to explore measures and technological advances to manage grid systems balancing as levels of solar PV are increased. Since then we have been working with the Electricity Networks Association (ENA), National Grid and Distribution Network Operators (DNOs) to explore what can be done to integrate more than 10 GWp of solar PV without significantly increasing costs. Workshops have been held and we have worked with stakeholders to put in place methods to better understand the volume of PV connection coming forward and to give a clearer picture of likely connections out to 2020. This project is part of a wider programme to analyse the whole energy system in the UK improving our understanding of the changing nature of our grid system, its resilience and how we can best manage grid systems balancing in the future.
114. There are four key system challenges for connecting solar PV to the grid. First, there is limited spare connection capacity, with most capacity at suitable sites already assigned to developers, whether or not projects have progressed.<sup>52</sup> Secondly, solar can lead to voltage level increases, when generation is high and demand is low, and this could result in network assets tripping and damage to electrical equipment. Thirdly, PV does not provide inertia, a property which affects the frequency control capability of the system: as low carbon generation replaces conventional fossil fuelled generation, the overall system inertia<sup>53</sup> reduces because conventional plant has rotating mass which provides inertia to the system, whilst solar PV does not. As a result there is a greater impact in the balancing of supply and demand, requiring additional measures.<sup>54</sup> This can have local effects as well as system-wide ones. Fourthly, uncontrolled renewable generation can exceed minimum demand and it is not currently possible to turn off most solar PV. Electricity market incentives and action by National Grid should mean that other generation reduces its output to as solar PV increases. This is likely to have a cost, particularly if the point is reached when the only generation remaining on the system is that which must run.
115. DECC's work with National Grid and the DNOs is considering solutions to these challenges, and these are likely to require a combination of changes to the network, the system and electricity market. The roll-out of these solutions differs by technology and for the most part, the deployment of large-scale storage technologies and electricity interconnection have longer innovation and or construction lead times and are therefore further away from roll-out than the other solutions. These other solutions (as discussed in more detail below) include demand side response, smart grid, active network management, smart inverters and small-scale battery storage which are technologies that are more readily available and we will see increasingly greater integration, cost reduction and roll-out in the period to 2020 and beyond, which may start to help manage these challenges.

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<sup>51</sup> National Grid (2013) Solar PV Assessing the Impact of Minimum Demand: [www.nationalgrid.com/corporate/About+Us/futureofenergy/](http://www.nationalgrid.com/corporate/About+Us/futureofenergy/)

<sup>52</sup> REPD data sourced 26 February 2014: [www.restats.decc.gov.uk/app/reporting/decc/monthlyextract](http://www.restats.decc.gov.uk/app/reporting/decc/monthlyextract).

<sup>53</sup> Inertia is the stored rotating energy in the system.

<sup>54</sup> A requirement for additional energy to contain the frequency within the required upper and lower limits and a reduction in the overall dynamic stability of the system: [www.ofgem.gov.uk/electricity/wholesale-market/market-efficiency-review-and-reform/electricity-balancing-significant-code-review](http://www.ofgem.gov.uk/electricity/wholesale-market/market-efficiency-review-and-reform/electricity-balancing-significant-code-review)

116. Electricity market incentives drive the balancing of supply and demand, so should be able to encourage a reduction in output from controllable solar PV and other generation types when output from solar PV is high.<sup>55</sup> National Grid has made an assessment of how the various approaches might work with different types of solar owners.<sup>56</sup>
117. A first step in reducing the size of the challenge would be encouraging solar PV deployment where there is existing connection capacity and local demand – in particular through increasing deployment at mid- to large-scale industrial rooftop solar. **Demand side response** could also reduce the scale of the challenge, by encouraging domestic customers to match use of electricity to times of high solar output. As more of our energy demand is electrified this potential increases. There are also benefits for the customer and anecdotal evidence suggests many solar PV owners do this.
118. The development of **smart grids**, facilitated by the nationwide roll-out of smart meters in the period to 2020, will strengthen the network operators' ability to integrate distributed generation (or new demand) into the network at lower cost. Smart grids provide real-time information which can be used to control the network. This can help DNOs manage the network in a way that avoids, reduces or defers the need for conventional network reinforcement by maximising the use of network infrastructure. In February, the Smart Grid Forum<sup>57</sup> published a Smart Grid Vision and Routemap to develop common vision for smart grid development in Great Britain, communicate the wide-ranging benefits associated with developing smart and provide a framework to progress in addressing the challenges to deployment. Ofgem has introduced a £500m Low Carbon Network Fund<sup>58</sup>, which provides support for network companies to trial new smart technologies and innovative commercial solutions in order to develop smarter grids and consider how to address the technical challenges that increasing levels of distributed generation presents.
119. In **active network management** (ANM) systems real time data from the network is used to automatically inform operational decisions. An ANM system monitors the state of the network and on the occasions when no other action was possible to maintain supply, would curtail the output of generators signed up to non-firm connection arrangements. Whilst a relatively new development, the adoption of ANM systems have the potential to enable significant amounts of additional capacity to be introduced without reinforcing the network. DNOs have begun rolling-out such systems in locations where they are a lower cost solution to standard reinforcement.
120. **Smart inverters** have greater functionality to perform specific automated grid balancing functions, for example, automatically reducing solar output in response to rising system frequency when generation exceeds minimum demand. The technology is available, but development of the Distribution Code further is likely to be needed in order to take this option forward. An alternative approach is for smart meters to provide a communication channel.

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<sup>55</sup> It is anticipated that Ofgem's Electricity Balancing Significant Code Review should help sharpen these incentives: [www.ofgem.gov.uk/electricity/wholesale-market/market-efficiency-review-and-reform/electricity-balancing-significant-code-review](http://www.ofgem.gov.uk/electricity/wholesale-market/market-efficiency-review-and-reform/electricity-balancing-significant-code-review)

<sup>56</sup> National Grid Solar PV Briefing Note 2014: [www.2.nationalgrid.com/UK/industry-information/future-of-energy](http://www.2.nationalgrid.com/UK/industry-information/future-of-energy)

<sup>57</sup> The Smart Grid Forum, an industry group co-chaired by DECC and Ofgem established in 2011 to explore the benefits of developing a smart grid, and to consider what actions is necessary to remove any obstacles to: [www.ofgem.gov.uk/electricity/distribution-networks/forums-seminars-and-working-groups/decc-and-ofgem-smart-grid-forum](http://www.ofgem.gov.uk/electricity/distribution-networks/forums-seminars-and-working-groups/decc-and-ofgem-smart-grid-forum)

<sup>58</sup> The new RIIO-ED1 Price Control will also include incentives to ensure that network companies drive innovation and the adoption of smart technologies and see the LCN Fund replaced by a new Network Innovation Allowance and Network Innovation Competition.



121. **Energy Storage** would allow for generation to be stored until it is required. Small-scale battery storage systems enable households to manage their electricity requirements, and costs are declining. Larger scale energy storage technologies (e.g. pumped hydro; compressed and liquid air energy storage; hydrogen storage) have high capital costs and the newer technologies are not yet commercially available. These are not likely to be an immediate solution for large-scale grid systems balancing but significant current innovation investment in these areas is expected to reduce costs to make them viable for future deployment.
122. Energy storage has been highlighted as a key technology by the Low Carbon Innovation Coordination Group in its Strategic Framework.<sup>59</sup> DECC is currently supporting energy storage research through two innovation competitions, with a combined budget of up to £20m.<sup>60</sup> Both these competitions are directly relevant to the deployment of solar PV in the home or in small-scale commercial settings. Our Energy Storage Technology Demonstration Competition has awarded a contract of £1.3m to Moixa Technology Ltd to install and demonstrate its small battery-based storage unit in about 300 homes across the UK (see case study). Under the Energy Storage Component Research and Feasibility Study Scheme, we have awarded a grant of £396,000 to Sharp Laboratories of Europe Ltd to develop and scale up a new battery technology for residential and community energy storage systems, particularly for use coupled with PV renewable energy generation.
123. **DECC is supporting energy storage research through two innovation competitions, with a combined budget of up to £20m.**

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<sup>59</sup> Published on 13 February 2014:

[www.lowcarboninnovation.co.uk/working\\_together/strategic\\_framework/overview/](http://www.lowcarboninnovation.co.uk/working_together/strategic_framework/overview/)

<sup>60</sup> [www.gov.uk/innovation-funding-for-low-carbon-technologies-opportunities-for-bidders#closed-schemes-still-current](http://www.gov.uk/innovation-funding-for-low-carbon-technologies-opportunities-for-bidders#closed-schemes-still-current)

### Case Study 13: MASLOW Home Storage

MASLOW is a smart energy storage system for solar. It improves self-generation by storing excess solar or charging at night, to reduce energy use at peak times.

MASLOW is being installed in 300 homes in 2014 as part of a DECC Energy Storage Demonstrator pilot, showing impact of storing power from local or remote renewables on reducing peak demand, and providing storage as a service for grid balancing.

A house scale 2.3 kWp PV array, charging 7 kWh of battery storage in MASLOW units has been installed at Arcola Theatre in Dalston, London as a showcase. The MASLOW units power DC LED lighting and electronics throughout the building.

MASLOW Storage system helps PV deliver resilience for end users, greater efficiency in connected DC Lighting/Electronics, reduced peak energy use delivering lower energy and carbon costs. MASLOW storage systems can also be aggregated and managed as grid-scale battery resources. This reduces local network upgrade costs to accommodate renewables, and helps wider system balancing and peak reduction.

Storage can also make smaller PV installations (e.g. <1 kWp) viable in city and urban properties by allowing wall or window-mounted solar to be connected into MASLOW battery units, to store energy for powering lighting and electronics during peak evening hours, or to power home offices.



*Images: Courtesy of Moixa Technology Ltd & Arcola Theatre*

124. **Electricity interconnection** can support integration of intermittent sources of energy and the associated system balancing. It can also help provide ancillary services such as frequency response. The Government is highly committed to increasing electricity interconnection capacity and in December 2013 published a policy statement, “More interconnection: improving energy security and lowering bills”, which outlined steps being taken to increase our capacity. We supported around 6GW of UK interconnection European Projects of Common Interest in the 2013 Union List. These projects have various target operational dates, ranging from late 2016 into the early 2020s.

### Case study 14: PV 2025 Research

EPSRC is funding a £1million research project to understand and predict what influence solar PV will have on our electricity system in the long term. The PV2025 project aims to answer a number of questions relating to solar PV across the UK and how geography, legislation and social factors might impact on the costs and benefits to UK. Led by Loughborough University's Centre for Renewable Energy Systems Technology (CREST), other project partners include Imperial College London, E.ON and BlueSky International Ltd.

The PV2025 project considers solar PV energy production in the national context looking at how PV system configuration or regional differences in environmental conditions impact upon factors such as energy generation and the infrastructure required to effectively distribute this energy; and with the overarching research question 'How can we maximise the benefits and limit the costs for UK Plc while having a vibrant PV market?'. PV2025 is split into four topical work packages each addressing key aspects of PV in the UK and the tools developed during the project will be made available for general use.

## 2.4 Innovation delivering carbon reductions

125. Innovation can also help to secure further carbon reductions from solar PV. As set out in the Solar PV Roadmap,<sup>61</sup> the lifecycle of the dominant silicon-based PV has several stages, with the raw material extraction and manufacturing phases being the most significant in terms of emissions. These phases are energy intensive and the balance of system manufacture (inverter, installation, mounting structures) requires the production of steel, aluminium and other metals.<sup>62,63, 64.</sup>
126. Phase 1 of the Roadmap identified wide variations in estimates of the carbon intensity of solar photovoltaic electricity and committed us to undertaking further work to understand the life-cycle emissions that apply to solar PV deployment in the UK; particularly in relation to the current markets from which solar panels are sourced.
127. New research<sup>65</sup> has shown that power generated by solar panels manufactured using an electricity grid mix similar to the UK's, but deployed in southern Europe<sup>66</sup>, can incur between 15-38 gCO<sub>2</sub>/kWh as life cycle emissions, depending on the type of solar PV technology used.<sup>67,68</sup> These values may double for manufacture using a grid mix typical of China rather than Europe.<sup>69, 70, 71</sup>

<sup>61</sup> [www.gov.uk/government/publications/uk-solar-pv-strategy-part-1-roadmap-to-a-brighter-future](http://www.gov.uk/government/publications/uk-solar-pv-strategy-part-1-roadmap-to-a-brighter-future)

<sup>62</sup> The Commission on Climate Change, Ricardo- AEA (2013) Current and Future Lifecycle Emission of key low carbon technologies and alternatives: [www.theccc.org.uk/wp-content/uploads/2013/09/Ricardo-AEA-lifecycle-emissions-low-carbon-technologies-April-2013.pdf](http://www.theccc.org.uk/wp-content/uploads/2013/09/Ricardo-AEA-lifecycle-emissions-low-carbon-technologies-April-2013.pdf)

<sup>63</sup> NREL (2012) Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics: [www.nrel.gov/docs/fy13osti/56487.pdf](http://www.nrel.gov/docs/fy13osti/56487.pdf)

<sup>64</sup> Alsema, E. A. and de Wild-Scholten, M. J. (2006). Environmental impacts of crystalline silicon photovoltaic module production. Paper presented at the 13th CIRP International Conference on Life Cycle Engineering, Belgium.

<sup>65</sup> de Wild Scholten, M.J. (2013) Energy payback time and carbon footprint of commercial photovoltaic systems. Solar Energy Materials & Solar Cells 119 (2013) 296–305.

<sup>66</sup> Based on irradiance of 1700 kWh/m<sup>2</sup>/yr.

<sup>67</sup> Crystalline silicon (c-Si) systems at 38 gCO<sub>2</sub>/kWh, multi crystalline silicon (m-cSi) at 27g CO<sub>2</sub>/kWh, and Cadmium Telluride (CdTe) at 15g CO<sub>2</sub>/kWh.

<sup>68</sup> de Wild Scholten, M.J. (2013) Energy payback time and carbon footprint of commercial photovoltaic systems. Solar Energy Materials & Solar Cells 119 (2013) 296–305.

<sup>69</sup> Grantham Institute (2014) Nelson, J. Gambhir, A. Ekins-Daukes, N (2014) Solar Power for CO<sub>2</sub> Mitigation. Imperial College: Grantham Institute for Climate Change.

128. Studies typically give impacts for PV deployed in Europe. In the table below we show the scaled calculations for solar PV deployed in the UK with its lower irradiation levels than Europe.<sup>72</sup> The lowest UK carbon impacts would be seen from cadmium telluride PV produced in Europe and deployed in the sunny south-west of England: 21 gCO<sub>2</sub>e/kWh. For crystalline silicon PV produced in China with its coal-dominated generation, and deployed in the relatively less sunny UK Midlands, the carbon impact rises to 149 gCO<sub>2</sub>e/kWh.<sup>73</sup>

**Table: UK Solar PV Carbon Footprint**

UK Location & Irradiance	Carbon intensity versus PV technology and manufacturing locations (gCO <sub>2</sub> e/kWh)					
	(based on typical grid mix for UK and China as shown below)					
	cSi (UK)	cSi (China)	m-cSi (UK)	m-cSi (China)	CdTe (UK)	CdTe (China)
Midlands (925kWh/m <sup>2</sup> /yr)	<b>70</b>	<b>149</b>	<b>50</b>	<b>90</b>	<b>28</b>	<b>37</b>
South West England (1200kWh/m <sup>2</sup> /yr)	<b>54</b>	<b>115</b>	<b>38</b>	<b>70</b>	<b>21</b>	<b>28</b>

129. Overall, the total direct and indirect carbon footprint for UK solar PV is still much smaller than that for typical gas powered plant. The average fuel-only direct and indirect emissions from fossil fuelled combined cycle gas turbine in the UK is around 440 gCO<sub>2</sub>e/kWh<sup>74</sup> excluding other life cycle components whilst the carbon footprint for onshore and offshore wind power has a range of 3–28 gCO<sub>2</sub>e/kWh.<sup>75</sup>

130. The solar PV emissions ‘payback time’ depends on the lifetime of the solar modules and the solar resource at where the panels are deployed. The lifetime of c-Si solar modules is typically around 30 years, while modules manufactured today take between two and four years to produce the energy used in manufacture, depending on levels of solar radiation.<sup>76</sup>

<sup>70</sup> Crystalline silicon (c-Si) systems at 81 gCO<sub>2</sub>/kWh, multi crystalline silicon (m-cSi) at 49g CO<sub>2</sub>/kWh, and Cadmium Telluride (CdTe) at 20g CO<sub>2</sub>/kWh.

<sup>71</sup> de Wild Scholten, M.J. (2013) Energy payback time and carbon footprint of commercial photovoltaic systems. Solar Energy Materials & Solar Cells 119 (2013) 296–305.

<sup>72</sup> Based on de Wild Scholten, M.J. (2013) Energy payback time and carbon footprint of commercial photovoltaic systems. Solar Energy Materials & Solar Cells 119 (2013) 296–305.

<sup>73</sup> It is also worth noting that all the figures in the table exclude delivery to site, installation, operation, maintenance and end-of-life phases which would be bespoke to each deployment. It does also not include the recognition that solar PV reduces grid transmission losses.

<sup>74</sup> Turconi, R et al (2013) Life Cycle Assessment of electricity generation technologies: Overview, Comparability and limitations, Renewable and Sustainable Energy Reviews 28: 555 - 565.

<sup>75</sup> *ibid.*

<sup>76</sup> de Wild Scholten, M.J. (2013) Energy payback time and carbon footprint of commercial photovoltaic systems. Solar Energy Materials & Solar Cells 119 (2013) 296–305.

131. Some PV technologies have a lower carbon footprint than others. Savings could be achieved if thin-film PV were used in place of the dominant crystalline silicon (c-Si).<sup>77</sup> Printable PV technology such as Organic PV (which is not yet commercially viable) could also provide extremely rapid emissions reductions even for module lifetimes of only five years.<sup>78</sup> The research confirms that the mitigation potential of solar PV varies considerably according to the materials and processes used.<sup>79</sup>
132. Innovation can lead to reductions in carbon during manufacture. For example, using PV technology that is wafer thin reduces the amount of silicon wasted in manufacture and reduces the carbon payback time, for c-Si, in the UK from approximately four years to 11 months (assuming 925kWh/m<sup>2</sup>). Using printable PV and thin film PV technologies could reduce carbon payback time to matter of weeks.<sup>80</sup>
133. Efforts to reduce the lifecycle carbon footprint of solar PV technology are supported by accreditation schemes (for example through BSI PAS 2050:2011 Standard or the Carbon Trust Footprint and Carbon Trust) and we would encourage UK companies within the industry to adopt accreditation.
134. **DECC will work with the Solar PV Innovation Task Force to encourage UK companies within the industry to adopt carbon lifecycle accreditation and to identify ways of reducing the carbon footprint of the UK Solar PV supply chain.**

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<sup>77</sup> Grantham Institute (2014) Nelson, J. Gambhir, A. Ekins-Daukes, N (2014) Solar Power for CO<sub>2</sub> Mitigation. Imperial College: Grantham Institute for Climate Change:  
[www.workspace.imperial.ac.uk/climatechange/Public/pdfs/Briefing%20Papers/Solar%20power%20for%20CO2%20mitigation%20-%20Grantham%20BP%2011.pdf](http://www.workspace.imperial.ac.uk/climatechange/Public/pdfs/Briefing%20Papers/Solar%20power%20for%20CO2%20mitigation%20-%20Grantham%20BP%2011.pdf)

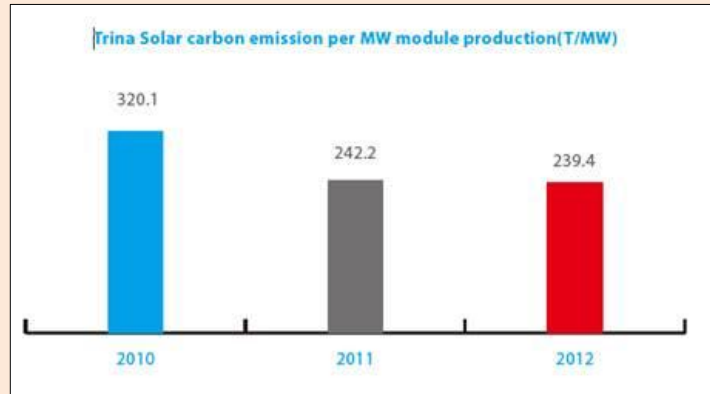
<sup>78</sup> Ibid.

<sup>79</sup> Ibid.

<sup>80</sup> Ibid.

### Case study 15: Trina Solar's partnership with BSI

In 2012, Trina Solar obtained the Carbon Footprint Verification for the company's solar PV modules from British Standards Institution (BSI) based on the requirements of the PAS 2050:2011 standard. BSI verified the greenhouse gas emissions during the whole life cycle including acquisition of raw materials, processing activities phase and packaging phase.



The verification allows Trina Solar to identify further opportunities to reduce greenhouse gas emissions in the processes of product design and module manufacturing. Projects undertaken to reduce carbon impact include reducing the consumption of electricity in 2013 per MW by 64 per cent compared to 2009. Subsequently, in June 2013, Trina Solar received ISO14064 greenhouse gas verification by BSI. Trina Solar's emissions per MW module in 2012 were reduced by 2.8 tonnes CO<sub>2</sub>e/MW compared to 2011. BSI's assessment services support Trina's ongoing environmental impact assessment and climate protection through the full PV module life cycle.

## 3. Jobs and growth

135. The Solar PV Roadmap noted the importance of solar PV not just for the contribution it can make to decarbonisation and security of supply but also the contribution it can make to UK economic growth.
136. There is a thriving installation sector in the UK and some manufacturing capacity, particularly in innovative and building integrated PV. The rapid growth in the sector means that the long-term jobs and investment potential is difficult to predict with certainty but industry estimates indicate that it has the potential to support tens of thousands of jobs (including within the dedicated solar PV and wider construction sectors that are focussed on solar PV installation and deployment).
137. We have been working with the sector and the National Solar Centre to develop more-reliable methodologies to measure jobs and investment.

### Case study 16: SunSolar Energy

SunSolar Energy started manufacturing standard 60 and 72 cell modules in Oldbury, near Birmingham earlier this year. Annual production capacity of 35 MW initially will increase to 75 MW and then 135 MW by 2015.



*Image: Courtesy of SunSolar Ltd UK.*

The facility will support over 100 new jobs in manufacturing, research and development, support, sales and marketing, administration and logistics.

138. DECC commissioned the National Solar Centre to develop a methodology for and to conduct an initial analysis of UK employment numbers and investment in the solar PV industry.<sup>81</sup> This methodology is based on calculating the number of jobs required to provide existing deployment, and is therefore very sensitive to our knowledge of the pipeline.
139. The analysis is preliminary and our understanding of jobs and investment will need to be improved in coming months. The NSC data is quoted here to indicate the scale of jobs in solar PV in the UK, but it must be noted that considerable work is required before this data can be regarded as definitive. The analysis divides the information between large-scale solar farms and building-mounted deployment. Because there are more regular data, the jobs and investment figures are more accurate for building-mounted deployment than for solar fields. It will, however, become more accurate as we improve our understanding of large-scale deployment as described above.
140. According to the NSC analysis, there were between approximately 11,700 and 14,000 direct and indirect jobs supported in the solar PV industry in UK as of the end of 2013.<sup>82</sup> At the top end of the NSC estimate, there are currently approximately 10,500 jobs in building-mounted deployment of solar PV, based on current FiT figures of approximately 521 MWp per year, of whom the bulk are installers (approximately 5,700) and developers (approximately 1,500). The same analysis estimates approximately 3,500 jobs in solar farm deployment assuming deployment of approximately 510 MWp. Of these, most are installers and developers as before, but at roughly equal numbers of approximately 680 and 1,400 each respectively.
141. Estimates of future jobs statistics are very strongly dependent on our estimate of the future jobs pipeline. The NSC analysis indicates that for a given installed capacity, greater jobs numbers are associated with building-mounted PV.
142. With BIPV coming through, as a specialist product more likely to be made in the UK, the jobs component could be substantial. Conventional PV systems have supply chains that are heavily dependent on imported product from outside the UK. The major contribution to the UK supply chain is through development, installation and maintenance. However, BIPV is currently more likely to be manufactured in UK through companies such as Romag, Kingspan and others. The high technology BIPV exemplified by the glass and façade products under development by Oxford PV and Polysolar is yet to be industrialised in the mainstream, and there is therefore a significant opportunity to encourage the growth of a strong UK industrial base.
143. The NSC study quoted above represents preliminary estimates, and we will continue to work with NSC to improve our understanding of the jobs and investment situation in the UK PV industry.
144. **DECC will encourage the industry to open up employment in the sector to greater numbers of women.**
145. Solar PV deployment continues to grow globally. Figures published in March 2014 by the European Photovoltaic Industry Association (EPIA) suggest that over 37 GWp worth of solar capacity was installed worldwide during 2013. The majority of deployment took place in China, Japan and the United States. EPIA's estimates stated that 11.3 GWp was deployed in China, 6.9 GWp in Japan and 4.8 GWp in the United States. This contrasts with the relative slow-down in deployment elsewhere in the EU where Germany deployed 3.3 GWp of solar PV (compared to 7.6 GWp the previous year).

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<sup>81</sup> UK Solar PV Employment Initial Assessment, National Solar Centre, Feb 2014.

<sup>82</sup> Based on assumed additional number of jobs for spare capacity in companies. High end estimate assumes 20% spare capacity.



146. Industry commentators have predicted an even higher global demand for solar PV for 2014 with NPD SolarBuzz predicting deployment of up to 49 GW.<sup>83</sup> Other commentators have predicted similar levels of deployment: for example, IHS has predicted global installations in the range of 40 to 45 GW.<sup>84</sup>
147. This continuing growth globally not only suggests that module prices can be driven down further but it also presents export opportunities for UK solar PV companies. The expansion of the solar PV sector in the UK has led to the generation of significant levels of expertise in terms of the design and deployment of solar PV systems. This is in addition to the innovative solar PV products being developed in the UK. DECC will continue to work actively with UKTI, overseas posts and the sector to promote this expertise overseas and to ensure that UK benefits from export opportunities.
148. To encourage greater investment in UK from abroad and to encourage UK overseas exports, we will continue to support UKTI and FCO led trade missions, such as the ministerially led trade visit to Saudi Arabia in November 2013, and the Minister's Statement to the West African conference on Off-Grid energy in February 2014.
149. We will also continue to encourage overseas investment, such as the upcoming work with FCO and the BPVA to promote deployment of solar PV in the UK Overseas Territories. Indeed, international engagement has a range of important functions, including information exchange and promotion of best practice. We will continue to work with FCO and UKTI to determine a way ahead for international activity on solar PV.

#### Case study 17: Trade Mission to Saudi Arabia

Saudi Arabia, better known as the world's largest oil exporter or around 10 million barrels per day also has ambitious targets of generating a total of 54 GWp of energy from renewable resources by 2032, almost 80 per cent of which is designated to come from solar power, with the remainder coming from a mix of wind, geothermal, and waste-to-energy resources.

A critical path to unlocking commercial opportunities for UK companies within these projects is the careful development and maintenance of relationships with key decision makers. In Saudi Arabia this often means dealing with the ruling Royal Family and the support of UK Minister's is often critical in demonstrating government support and commitment in pursuit of UK commercial business interests.

The visit by Greg Barker in November 2013 allied to that of a visiting renewable energy trade delegation of 19 companies was a good example of public diplomacy combining with UK commercial interests to open doors and access often denied to other delegations, in this case to the King Abdullah City for Atomic and Renewable Energy. The result of this combination was an open dialogue and a free flow and exchange of information.

For UK companies to be successful in overseas markets it takes more than one visit, they need to show a demonstration of commitment to the market over a number of visits. It is here that diplomacy supported by activities such as the Prosperity Agenda and Ministerial visits can play an important role in maintaining key relationships to promoting UK interests and in leading the line with trade delegations.

<sup>83</sup> [www.solarbuzz.com](http://www.solarbuzz.com)

<sup>84</sup> [www.ihs.com/industry/renewable-energy/index.aspx](http://www.ihs.com/industry/renewable-energy/index.aspx)

150. **DECC will work with industry to exploit opportunities to export British solar products, expertise, and innovation through a programme of trade missions, working closely with UKTI, BIS, and the FCO.**
151. **DECC will continue to encourage overseas investment, such as in support of our commitment to establish renewable energy workshops for the Governments of the Overseas Territories.**
152. **DECC will increase collaboration with BIS and UKTI to attract inward foreign investment to support domestic R&D, innovation and manufacturing.**

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Department of Energy & Climate Change  
3 Whitehall Place  
London SW1A 2AW  
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