

A report by Carbon Connect

# DISTRIBUTED GENERATION

FROM CINDERELLA TO CENTRE STAGE



‘There is no question that we will need significantly more distributed generation in the future, given its central role in deploying low carbon generating technologies that hold the key to meeting our carbon budgets.’

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# FOREWORD

The UK is at a critical moment in its energy history. A huge amount of our energy infrastructure needs replacing or upgrading in the next decade. We are faced with more technological options than ever before and the decisions made today could make or break our chances of meeting legally binding carbon reduction targets. These testing circumstances fall at a time of economic hardship when affordability is a heightened concern for Government, households and businesses alike. These challenges are reflected in the priorities of the Department of Energy and Climate Change which include:

*‘Reform the energy market to ensure that the UK has a diverse, safe, secure and affordable energy system and incentivise low carbon investment and deployment’*

Distributed generation has much to contribute to the three challenges of the energy ‘trilemma’ – sustainability, security and affordability. It is a gateway for the deployment of many low carbon technologies, such as wind, biomass and solar power. Its quick build times and the diversity it brings to the electricity system strengthen energy security. It also has the potential to save money, by weaning us off volatile fossil fuels, reducing wasted energy and avoiding or delaying expensive network upgrades.

Over the past two decades we have seen a growth in distributed generation, where electricity is generated from smaller units, closer to the places it is consumed. This has largely been driven by the growing popularity of renewable technologies such as wind and solar power, which lend themselves to deployment as distributed generation. Currently, around 11 per cent of the UK’s generating capacity is distributed generation and at least 55 per cent of this is renewable.

There is no question that we will need significantly more distributed generation in the future, given its central role in deploying low carbon generating technologies that hold the key to meeting our carbon budgets. The questions are instead: how can the Government unlock the full potential of distributed generation? And, how should the Government manage the corresponding network evolution?

I welcome this report for addressing these timely and important questions, and for recommending ways to tackle the systemic and institutional biases towards centralised power that have developed over the last century. We need both a healthy mix of technologies and a healthy mix of centralised power and distributed generation to fulfil our energy ambitions. Only through confronting these questions will we allow the full range of solutions to our security, sustainability and affordability challenges to compete on even terms.

I would like to thank everyone who participated in this inquiry, who generously gave their time and expertise during its course. I would also like to thank the members of the steering group for their time and hard work. I am grateful to Siemens and Covanta Energy for their sponsorship and to Andrew Robertson for compiling this report.



*Laura Sandys*

Laura Sandys MP  
Inquiry Chair

# EXECUTIVE SUMMARY

Distributed generation will play an increasingly important role in helping the Government to deliver sustainable, secure and affordable energy. Currently, distributed generation represents around 11 per cent (nine gigawatts) of the UK's generating capacity, but this number will rise as deployment of renewables and combined heat and power (CHP) increases and the UK moves towards a decarbonised power sector. Around 55 per cent (five gigawatts) of the UK's distributed generation utilises energy from renewable sources. Renewable capacity is expected to treble between 2012 and 2020 to 45 gigawatts (39 per cent of projected total capacity)<sup>1</sup>. Similarly, combined heat and power capacity, some of which is renewable, is predicted to increase by 41 per cent on 2010 levels to 8.6 gigawatts in 2020 (around seven per cent of projected total capacity)<sup>2</sup>. This demonstrates the important role of distributed generation as a gateway to the deployment of low carbon generating technologies – technologies that are essential to the UK meeting its climate change targets as part of international efforts to avoid catastrophic climate change.

## Government leadership

For too long, distributed generation has been a 'cinderella issue' – not receiving the attention from government that it needs to reach its full potential. As a result, the institutions and systems that shape the energy market have been slow to evolve and accept distributed generation as part of the family of solutions that will give us sustainable, secure and affordable energy. The regime that it faces is fragmented, biased and inefficient.

To unlock the full potential of distributed generation, the Government should put the issue centre stage, alongside other important measures such as energy efficiency, smart meters and carbon capture and storage. The remedies that this report calls for should be built upon the foundations of strong government vision and leadership. The Government should set out its vision for distributed generation, giving certainty over the role that distributed generation *will* play, rather than *could* play, in delivering its energy ambitions. Not only should the Government advocate diversity in generating technologies, but it should recognise the need for a healthier balance between centralised power and distributed generation. The recommendations in this report require action from a diverse set of actors, ranging from the market regulator to Local Planning Authorities. The Government is best placed to provide the necessary coordination and conviction and to lead by example in unlocking distributed generation's full potential.

## Recommendation 1

DECC should establish a clear vision for distributed generation.

At the end of 2011, the Department of Energy and Climate Change (DECC) set up an informal advisory group, the Distributed Energy Contact Group (DECG). The

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1 DECC (October 2012), Updated Energy & Emissions Projections 2012: Annex J

2 DECC (October 2012), Updated Energy & Emissions Projections 2012



group was tasked with identifying and removing barriers for decentralised energy, particularly with regards to the Electricity Market Reform. The formation of this group is a promising first step to recognising the important role that distributed generation will play in the near future, but this policy area must move from the fringes of the Department to centre stage.

### Recommendation 2

DECC's Distributed Energy Contact Group should be formally established with permanent representation in DECC. It should widen its focus from the Electricity Market Reform to consider all parts of the system that impact distributed generation and develop a strategy for delivering the Government's vision.

The benefits of distributed generation are understood qualitatively but not quantitatively on a regional or national scale. Some of the most important benefits are: supporting the deployment of low carbon technologies; improving system-level energy efficiency; engaging consumers in energy management; avoiding or delaying the need for costly network upgrades; and, providing new capacity in the short-term.

### Recommendation 3

DECC should develop a more detailed and quantified understanding of the benefits of distributed generation at local and national levels.

### Policy stability

The foundation of strong government leadership in supporting new technologies is predictable policy that reflects often long investment timescales and balances value for money with reducing technology costs. Policies affecting distributed generation, such as renewables support, have suffered from instability and unpredictability. This has had a wide, cumulative and long-lasting impact on investors' perceptions of risk which raises the cost of finance and diminishes the pool of viable distributed generation projects. Many of these policy changes could have been avoided or made more predictable if policies were better designed from the start.

### Recommendation 4

DECC should be clear from the start how, and under what circumstances, policy support for generators will change.

### Recommendation 5

DECC should quantitatively assess and take full account of the wide, cumulative and long-lasting impact that policy instability has on investors' assessment of risk and, consequently, the cost to consumers and taxpayers. This assessment should inform any decisions to change policy support.

### **Alignment of benefits**

Distributed generation projects contribute benefits to the local and national network, but these are not reflected in financial charges and incentives for generators. The absence of a mechanism to reflect this value prevents distributed generation from providing long-term and potentially lower-cost solutions to network constraint problems and fulfilling its potential to improve system-level energy efficiency.

### **Recommendation 6**

DECC should consult upon the local and national impact of distributed generation and mechanisms that could be introduced to measure and reflect this value, for example through adjusting Use of System Charges.

### **Institutional and systemic bias**

The UK power system and its institutions have suffered from inertia and have been slow to react to the need to adapt and serve decentralised as well as centralised power. For example, Distribution Network Operators have only just begun to consider alternatives to passive network management. Progress is beginning to be made through initiatives such as the Low Carbon Networks Fund, Smart Grids Forum and Distributed Generation Forum. These initiatives are proving effective in bringing forward ideas for better ways of working, but more focus now needs to be placed upon evaluating and implementing the best ideas and embedding them in business as usual behaviours.

### **Recommendation 7**

DECC and Ofgem should provide strong leadership to industry by acting as the architects and enablers of processes that are needed to bring about evaluation and widespread implementation of smart grid solutions being developed through initiatives such as the Low Carbon Networks Fund and Smart Grids Forum.

### **Recommendation 8**

Ofgem and Distribution Network Operators should hold Distributed Generation Forum events bi-annually and agree and publish SMART actions for Distribution Network Operators following each event. Forum events should be used for Distribution Network Operators to report progress against previously agreed actions to Ofgem and their customers.

### **Business awareness**

There is a shortage of trusted information on successful commercial and industrial applications of distributed generation. This information is typically available within businesses that have invested in generating their own electricity but there are no mechanisms for sharing this information to raise awareness and strengthen business cases in other organisations. Good practice also needs to be put in context, showing what role distributed generation has to play in a strategic approach to business energy management.

### Recommendation 9

Local Enterprise Partnerships should work with businesses to spread good practice in strategic energy management and the role of distributed generation, including case studies of successful distributed generation projects implemented by businesses in their region.

### Coordinating planning permission and grid connection

Securing planning permission and a financially viable grid connection are two key prerequisites to finalising project investment. To minimise delays and because of the uncertain timescales of these processes, planning applications and grid connection applications are often pursued in parallel. Sequencing could be made easier for developers if flexibility could be offered by Distribution Network Operators, where technically and practically feasible.

### Recommendation 10

Distribution Network Operators should consider flexible ways of developing and issuing grid connection offers to help their customers manage the scheduling uncertainty in securing planning consent for distributed generation projects.

### Community buy-in

Distributed generation developers are not always good at securing community buy-in, which can be critical in successfully navigating the planning regime. Despite being commonly perceived as a barrier by developers, recent polls have shown that community attitudes are often positive towards distributed generation. There is a shortage of information about what the Government sees as good practice in this area.

### Recommendation 11

DECC should expand its call for evidence on Community Engagement and Benefits of Onshore Wind to cover all distributed generation. The evidence should be used to publish guidance on good practice in securing community buy-in for all types of distributed generation.

### Planning guidance

The recently announced review of existing planning practice guidance is a good opportunity for the Government to emphasise the national importance of distributed generation, and therefore the weight that Local Authorities should place on the issue. Guidance is also needed to ensure that planning professionals have a comprehensive and consistent understanding of common issues relating to distributed generation.

### Recommendation 12

DCLG should ensure that updated or new planning practice guidance sends a clear and consistent message to planning professionals on the following topics, following the review of existing planning practice guidance:

- the national importance of distributed generation;
- which matters relating to distributed generation are genuinely contentious and which are not; and
- frequently raised issues such as carbon footprints, noise and house price impacts.

### Site selection

Site selection can dramatically affect the chances of a distributed generation project securing planning permission and a financially acceptable grid connection offer. There are many additional benefits to siting generating capacity intelligently so that it is close to centres of energy demand, makes best use of local energy resources and enables efficient development of connecting infrastructure.

### Recommendation 13

Local Authorities should develop closer working relationships with Distribution Network Operators and share detailed information to assess and identify areas and sites that are best suited to distributed generation.

### Recommendation 14

Local Authorities and Distribution Network Operators should develop a single portal which communicates information that will help distributed generation developers to make well-informed decisions about site selection.

### Volume of connection applications

Distribution Network Operators are overwhelmed by the number of distributed generation enquiries that they receive, which in some cases have risen by over 400 per cent in recent years. Dealing with this volume of enquiries, most of which do not result in new grid connections, is costly for Distribution Network Operators and means that the quality of service they provide is inevitably lower. Improving publicly available information about where there is spare network capacity and introducing a charging regime to discourage excessive and speculative enquiries from potential customers would help alleviate the problems.

### Recommendation 15

Ofgem should take steps to encourage Distribution Network Operators to collect and publicise information on spare network capacity at all voltage levels, prioritising higher voltages.

### Recommendation 16

DECC should take steps to introduce a charging regime for assessment and design work that discourages excessive and speculative distributed generation connection enquiries.

### Intermittency and the role of aggregators

Distributed generation is often operated by small or independent generators who face significant barriers to market because of their size and, in the case of intermittent generation, the variability of their output. Aggregators are important because they enable distributed generation operators to overcome these barriers in a financially viable way. As the Government introduces its Electricity Market Reform, there is a good opportunity to make sure that the new arrangements are consistent with an attractive market for new and existing aggregators. The Government has begun to take steps to consider this through its call for evidence on barriers to securing long-term contracts for independent renewable generation investment<sup>3</sup>.

### Recommendation 17

DECC should review the full range of factors that affect the attractiveness of the reformed UK electricity market for new and existing aggregators and consider whether actions are needed to maintain competition.

### Intermittency and energy storage

Energy storage technologies could be key in helping to enhance the benefits of distributed generation. The Government should ensure that the support it is providing in this area takes into account the potential for supporting distributed generation and that appropriate changes are made to the regulatory regime.

### Recommendation 18

DECC should dedicate some competition funds to improve the efficiency of energy storage technologies that are more suitable for distributed renewable energy operations to complement its support for grid scale storage.

### Recommendation 19

DECC should update regulations to recognise energy storage as a separate category to generation, transmission, distribution and supply, with a charging regime that is proportionate.

### Power Purchase Agreements

Power Purchase Agreements are critical for the financial viability of distributed generation as they overcome a number of problems faced by independent generators including transaction costs, risk management and creditworthiness. It is therefore

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3 DECC (July 2012), A call for evidence on barriers to securing long-term contracts for independent renewable generation investment

important that the forthcoming reform to the electricity market does not cause a hiatus in the availability of Power Purchase Agreements whilst the market adjusts.

Power Purchase Agreement providers are also in an important position to assist generators with Feed-in Tariff Contracts for Difference as, without support, generators may have difficulties in managing extra contracts and two-way cash flows with the associated collateral.

#### **Recommendation 20**

DECC should work with relevant parties in the Power Purchase Agreement market to ensure that the market understands and is prepared for the introduction of Contracts for Difference in mid-2014, to prevent a hiatus in the availability of Power Purchase Agreements.

#### **Recommendation 21**

DECC should work with industry to develop an agent model where Power Purchase Agreement providers are legally able to handle the Contract for Difference cash flows on behalf of generators and, alongside this, make provisions in case of the company defaulting to ensure the generator is protected.

#### **Impacts on the transmission system**

Although not currently a barrier to the deployment of distributed generation, greater levels of deployment will have significant impacts on the operation and management of the transmission system. As distributed generation grows significantly over the coming decade, its impact upon the transmission system will also grow. This has implications for how distributed generation should be monitored and the role it plays in balancing the system.

#### **Recommendation 22**

Transmission System Operators and Distribution Network Operators should consider what information collection and sharing arrangements will be needed to manage the heightened balancing risks that more distributed generation could cause and plan their implementation.

#### **Recommendation 23**

DECC and Transmission System Operators should review arrangements to encourage and appropriately compensate distributed low carbon generation for participating in system balancing, and take steps to ensure that more distributed generation can economically participate in providing system balancing services.

# METHODOLOGY AND STEERING GROUP

Carbon Connect carried out this inquiry between February and November 2012. Masters students at Imperial College London kindly produced a scoping report which formed the basis of our early research. This scoping report was based upon a survey of businesses, interviews, desk-based research and three round-tables. Three inquiry sessions were held in Parliament, bringing together a wide range of industry representatives, civil servants and other key stakeholders. Chaired by Laura Sandys MP, these inquiry sessions were complemented by follow-up interviews with key stakeholders, the submission of written evidence, and desk-based research. A steering group of senior industry and academic representatives supported the inquiry and helped inform its direction.

The findings and recommendations in this report are those of Carbon Connect. Whilst they were informed by the steering group, witness statements heard in the steering group sessions, in-depth interviews and written submissions, they do not necessarily reflect the opinions of individual witnesses, organisations, participants or individual steering group members.

## **Inquiry Sessions**

Session I:	29 March 2012
Session II:	18 June 2012
Session III:	28 June 2012

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# 1. INTRODUCTION

## 1.1 What is distributed generation?

Distributed generation is electricity generation that is directly connected to a local distribution network or a private network, rather than to the transmission network (see Section 1.2.1 for a description of distribution and transmission networks). This often means that the electricity produced is consumed closer to the location where it was generated, reducing the need to transport power over long distances. Generating technologies that make up a significant proportion of distributed generation in the UK include solar<sup>4</sup>, wind, and combined heat and power<sup>5</sup>. The majority of distributed generation plants are under 100 megawatts in size, with many of these under ten megawatts.

In some circumstances, significant heat is produced as a by-product of distributed electricity generation, such as when biomass or gas is burned. When both heat and electricity are used, this is known as distributed energy.

This inquiry is focused on commercial and industrial business applications of distributed generation which are typically between 0.5 and 50 megawatts in size. Carbon Connect recognises and strongly supports the move to decarbonise the power sector, which underlines the importance of low carbon applications of distributed generation, such as solar, wind and biomass. However, individual generating technologies are not the focus of this inquiry and are not discussed in any detail.

## 1.2 Background to the electricity system

The electricity system is made up of three groups of assets: demand assets, supply assets and network assets. Demand assets are owned and operated by consumers, largely independently. Supply assets generate electricity and range from solar panels on the roof of a house to large nuclear power plants. Network assets carry electricity from supply assets to demand assets and are commonly referred to as ‘the grid’.

### 1.2.1 The grid

The grid can be split into two levels: the transmission network and the distribution network. The transmission network receives electricity from large power plants and moves it over long distances at high voltages to a number of distribution networks. Distribution networks carry electricity at lower voltages from the transmission network and from distributed generation plants to homes and businesses where it is consumed. Transmission Owners build and maintain the transmission network and Distribution Network Operators manage the distribution networks. Transmission System Operators are responsible for overseeing and managing the flow of electricity across the whole of the transmission network. National Grid is the Transmission System Operator for Great Britain. The UK has four Transmission Owners and 14 Distribution Network Operators each responsible for parts of the network in different areas.

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4 Solar photovoltaic

5 Both biomass and gas fired

### 1.2.2 Energy system paradigms

Electricity systems can broadly be identified as aligning to one of three paradigms: centralised, decentralised or mixed<sup>6</sup>. The centralised paradigm is characterised by a small number of large power plants supplying a network that carries electricity long distances ‘down’ the network to many dispersed consumers. The decentralised paradigm is characterised by many smaller power plants located close to the consumer demand that they serve. Under the mixed paradigm, both centralised and decentralised elements exist.

In practice, systems *predominantly* rather than *absolutely* align themselves to one of these paradigms. Distributed generation has a significant role to play in both the decentralised and mixed paradigms. The UK electricity system began in a decentralised form in the nineteenth century, developed into a centralised system in the twentieth century and is now in transition to a mixed system. The renewed importance of distributed generation this century as a gateway for low carbon technologies is a significant part of what is driving this transition.

### 1.2.3 History of the grid

The development of the grid can be summarised in three stages (Figure 1). The early system developed in a ‘chaotic’, piecemeal and decentralised manner. In the 1920s and 1930s, centralised order was imposed upon the grid which served the large, centralised fossil and nuclear fuelled power plants that came to dominate in the later twentieth century. The privatisation of the electricity markets, growth in low carbon power and move towards using ‘smart’ grid technologies seen in recent decades signals a new movement towards a more dynamic approach.

#### Figure 1: Three stages of grid history

##### Emergent dynamic chaos (decentralised)

Electricity was first generated in the UK by private companies and wealthy individuals to supply their own needs. From the 1880s onwards, public supplies of electricity became available, beginning with street lighting. This early system developed in a ‘chaotic’, piecemeal manner such that by 1918, London alone had roughly seventy electricity suppliers providing electricity at ten different frequencies and 24 different voltages.

##### Imposed static order (centralised)

To combat the inherent disorganisation and duplication of this arrangement, the Electricity Act 1926 provided for a central authority to oversee and manage a national transmission system. By 1938 the grid was fully integrated, with central control allowing power to be sent from one end of the country to the other, increasing the ability to respond to rapid demand changes or plant failures. Full nationalisation of

6 ‘Mixed’ having significant elements of both centralised and decentralised paradigms coexisting

generation and transmission followed after World War II, with around 300 supply companies amalgamated into the Central Electricity Generating Board. The Central Electricity Generating Board centrally planned and managed all generation, and power flowed 'down' the network to the end user via twelve Area Distribution Boards.

### Reform towards dynamic order (mixed)

This centrally planned monopoly ended in 1989 with the privatisation of the sector. To introduce competition to the newly created market, the Central Electricity Generating Board was split into three generation companies and a single transmission company (National Grid), with the twelve former Area Boards becoming regional electricity companies. In 2000 these regional electricity companies were separated from their distribution operations, creating regional Distribution Network Operators responsible for local distribution.

In contrast to the static order of the monopoly era, today's electricity system is composed of a multitude of actors involved in generation, distribution and supply. As more distributed generation is connected to the network, the old model of electricity flowing one-way 'down' the system is changing. Distribution networks will now adapt to manage energy flows in two directions, and must actively work with the transmission system operator to ensure the network remains balanced. A new dynamic order is gradually replacing its static predecessor, as the various parts of the system increasingly interact, in new 'smart' ways.

## 1.3 Energy 'trilemma'

There are three major challenges for the power sector: security; sustainability and affordability.

### 1.3.1 Security

The UK needs significant new investment in its electricity infrastructure to maintain secure supplies over the coming decade. How this investment is used could define our energy pathway for the next 40 years. Twenty-one per cent (19 gigawatts<sup>7</sup>) of existing generating capacity is scheduled to close by 2020 due to all but one of the UK's nuclear power stations coming to the end of its tenure by 2023 (9.4 gigawatts<sup>8</sup>) and the EU Large Combustion Plant Directive forcing the closure of many fossil-fuelled power stations by 2015 (12 gigawatts<sup>9</sup>). Taking into account plant closures and rising demand, it is estimated that 30 gigawatts of new capacity will be needed by 2020. This is thought to require investment of £75 billion in electricity generation and £35 billion in the replacement and upgrade of network infrastructure. In total, £110 billion<sup>10</sup> of investment is required between now and 2020.

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7 National Audit Office (June 2012), The government's long-term plans to deliver secure, low carbon and affordable electricity

8 National Audit Office (April 2012), The nuclear energy landscape in Great Britain

9 National Audit Office (June 2012), The government's long-term plans to deliver secure, low carbon and affordable electricity

10 Ibid.

### 1.3.2 Sustainability

Securing investment, building new capacity and upgrading the network in time are not the only challenges. The UK has legally binding targets to reduce greenhouse gas emissions by 50 per cent by 2027 and 80 per cent by 2050<sup>11</sup>. The electricity sector was responsible for 32 per cent of carbon dioxide emissions in 2011<sup>12</sup>, so reducing the carbon intensity of power generation is a vital part of meeting these targets. The Government's independent advisor on cutting carbon, the Committee on Climate Change, has said that to meet these targets the electricity sector must be 'virtually decarbonised by 2030'.

It may appear that 2030 is only relevant to our medium-term planning. However, electricity generating infrastructure has a lifespan of several decades, meaning that the £110 billion of investment decisions due to be made over the next decade will have long-lasting consequences for the carbon intensity of the sector. This 'carbon lock-in', means that our medium and long-term ambitions call for actions today.

### 1.3.3 Affordability

The final part of the equation is cost. There is a diverse mix of technologies that are vying for position in the UK's future energy mix. Each of these has a different profile of build time, carbon intensity, technological maturity and cost. The challenge is to ensure that security and carbon objectives are met whilst continuing to invest in technological development essential for meeting long-term objectives, all within a finite budget.

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11 DECC (December 2011), The Carbon Plan: Delivering our Low Carbon Future

12 DECC (July 2012), Digest of United Kingdom Energy Statistics (DUKES) for 2012: Chapter 5 - Electricity

# TOYOTA & BRITISH GAS

## CASE STUDY

<b>User</b>	Toyota
<b>Partner</b>	British Gas
<b>Location</b>	Derbyshire
<b>Technology</b>	Solar photovoltaic
<b>Capacity</b>	4.2 megawatts
<b>Annual output</b>	Not available
<b>Estimated annual financial saving</b>	£250,000
<b>Estimated annual carbon saving</b>	2,000 tCO <sub>2</sub> e
<b>Proportion of on-site demand met</b>	5 per cent
<b>Estimated project cost</b>	> £10,000,000
<b>Generation start date</b>	July 2011
<b>Delivery time (planning submission to operation)</b>	4.5 months

Notes: 1) tCO<sub>2</sub>e is tonnes of carbon dioxide equivalent

### Motivations

The solar photovoltaic project was conceived primarily to increase Toyota's use of renewable energy and thus to reduce its carbon emissions or footprint.

As one of five Toyota plants worldwide to be awarded 'Sustainable Plant' status, Toyota Motor Manufacturing UK has a wide-ranging and long-term vision to operate in a sustainable manner and exist in harmony with its surroundings. The role of a Sustainable Plant is to demonstrate environmental leadership in manufacturing, to support the goal of producing low carbon cars in a low carbon plant.

An additional objective was to create a series of smaller installations that would allow us to showcase the technology and a variety of solar photovoltaic solutions.

### Challenges and solutions

Toyota Motor Manufacturing UK, and partners British Gas, had to overcome a number of challenges to deliver the project on time. Among these were:

- Obtaining an accurate cost estimate for the required grid connection  
This proved difficult and took a considerable length of time but was critical to confirming the financial viability of the project.
- Lack of policy stability  
This had a significant and adverse impact. Soon after Toyota Motor Manufacturing UK had awarded the contract to British Gas a consultation on the Feed-in Tariffs scheme was announced. This led to a period of uncertainty and, with the outcome unknown, the project had to either be put on hold or completed within a very short time frame. This required the ground-mount

frame to be purchased from Germany rather than sourced from in the UK, as Toyota Motor Manufacturing UK had originally intended. The UK suppliers did not have the capability to produce the required quantity in the time available.

- **Planning Consent**

This was obtained without problem. However, to ensure that this was the case, Toyota Motor Manufacturing UK worked closely and proactively with a number of stakeholders including Natural England, the Derbyshire Wildlife Trust, our community liaison committee, the local flying club and the local planning officers. This ensured that Toyota Motor Manufacturing UK understood and was able to address any mitigation measures before submitting its plans for approval. Other design criteria, such as the location – out of sight and on land designated for industrial use – also helped to ensure smooth approval of the plans.

## **Benefits**

Since being installed, the solar photovoltaic installation has provided a number of benefits, the most obvious of these is financial, reducing the site's energy bill by approximately £250,000 per year. Toyota Motor Manufacturing UK also gained wide recognition of environmental leadership in both national and environmental media.

One benefit that Toyota Motor Manufacturing UK has been unable to obtain is the benefit of the carbon dioxide reduction the solar array achieves. The climate change regulations prevent Toyota Motor Manufacturing UK from claiming the carbon dioxide benefit even though the contract between British Gas and Toyota Motor Manufacturing UK is written to allow this and almost none of the electricity generated is exported to the grid. Practically, this means that neither British Gas nor Toyota Motor Manufacturing UK is able to claim the benefit of the carbon reduction.

# 2. CURRENT PICTURE

## 2.1 The importance of distributed generation

Whilst the benefits of distributed generation are discussed in Section 3, there are two aspects of distributed generation that are fundamental to its importance for the UK's energy policy.

### 2.1.1 Decarbonisation

*'[D]istributed energy can harness a wide range of smaller-scale renewable and low-carbon energy sources, so contributing to the decarbonisation of electricity and security of supply.'*

DECC, Electricity Market Reform White Paper

The power sector must be virtually decarbonised if the UK is to meet legally binding carbon reduction targets which form part of the UK's and international community's efforts to avoid catastrophic climate change. Distributed generation is a key gateway to widespread deployment of many low carbon and resource efficient technologies, such as solar, wind, biomass and combined heat and power. To make the most of the UK's considerable solar and wind resource, and to make best use of heat produced in parallel to electricity, new generating capacity must mirror the distributed nature of solar resource, wind resource and heat demand. Making the market work better for distributed generation, will therefore help the UK to meet its carbon targets cost effectively.

### 2.1.2 Evolving electricity system

*'Without guidance from the Government, there is a risk that uncertainty over the rate of change could lead to insufficient or inappropriate investment, resulting in the network being unable to deal with future challenges.'*

DECC, Electricity Market Reform White Paper

The emergence of greater volumes of distributed generation in the past two decades and its forecast growth means that the electricity system of the future will be a hybrid of the centralised and decentralised paradigms. We have reached a critical point now where the electricity network is essentially that of a centralised system but the generating infrastructure shows an increasingly mixed portfolio of centralised and decentralised plants. There is therefore a pressing need for policy, regulation and networks to catch up and align with an increasingly mixed portfolio of generating infrastructure. If this transition is to be efficient and meet our future needs, strong leadership is required from the Government, working with, and coordinating actions across, a large and diverse sector.



## 2.2 Policy landscape

### 2.2.1 Renewables Obligation

The Renewables Obligation was introduced in Britain in April 2002<sup>13</sup>, to encourage the deployment of large scale renewable electricity generation by providing an additional revenue stream for renewable generators. Unlike the fixed payments of the Feed-in Tariffs scheme (see Section 2.2.2), the additional revenue from the Renewables Obligation is dependent upon market conditions. Electricity suppliers are obliged to purchase an annually increasing proportion of their power from renewable generators and are charged for any shortfall in meeting this obligation. Suppliers demonstrate that they have purchased renewable power by buying Renewables Obligation Certificates from renewable generators. Certificate prices fluctuate according to the obligation level, the buy-out price paid by suppliers who fall short of their obligation, and the amount of renewable electricity available. To date, the Renewables Obligation has facilitated the deployment of 13 gigawatts of capacity, approximately half of which has been onshore wind turbines<sup>14</sup>. The Renewables Obligation is scheduled to close to new generators on 31 March 2017, when a new mechanism, Feed-in Tariffs with Contracts for Difference, will replace it (see Section 2.2.5)<sup>15</sup>.

### 2.2.2 Feed-in Tariffs

Introduced in April 2010, Feed-in Tariffs (FITs) guarantee revenue for the electricity produced by low carbon generators up to five megawatts in size. The policy aims to encourage the take-up of small scale, low carbon electricity generation in parts of the domestic and non-domestic sector that have not traditionally engaged in electricity generation. The scheme rewards the owner of generating equipment with a guaranteed payment for all electricity produced, plus extra for any unused surplus that they export back to the grid. The tariffs guarantee 20 years of payments to generators and vary according to the size of the installation, with the aim of giving generators a return on investment of between four and eight per cent. Technologies supported under the policy are solar, wind, hydro, anaerobic digestion and micro combined heat and power. To date, 1.5 gigawatts of capacity has been installed under the scheme, with solar accounting for 90 per cent of this<sup>16</sup>.

### 2.2.3 Levy Exemption Certificates

Under the Climate Change Levy, non-domestic consumers are taxed for their use of mains gas, liquid gas, coal, petroleum and electricity. Introduced in 2001, the Levy aims to incentivise energy efficiency and reduce carbon emissions. Purchases of renewable electricity are exempt from the scheme, and generators of renewable electricity are able to claim Levy Exemption Certificates which can be sold to licensed electricity suppliers to validate their exemption.

### 2.2.4 License Lite

License Lite is a revised form of the electricity supply license, designed to help smaller

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13 In Northern Ireland it was introduced in 2005

14 Ofgem (March 2012), Renewables Obligation Annual Report 2010-11

15 Feed-in Tariffs with Contracts for Difference will be introduced from mid-2014

16 Ofgem (September 2012), Feed-in Tariff Installation Report

electricity generators operate as licensed suppliers on the public network. Selling directly to local customers allows larger distributed energy schemes to receive a higher rate per unit than would otherwise be received from selling direct to the larger supply companies. The standard electricity supply license places significant requirements on an applicant, resulting in disproportionately high costs for a smaller project. License Lite was proposed by the Office of Gas and Electricity Markets (Ofgem) in 2009 to remove this barrier.

### **2.2.5 Electricity Market Reform**

First proposed in July 2011, the Electricity Market Reform is a package of reforms intended to encourage investment in the UK's electricity generation infrastructure. These reforms will be phased in from 2013. There are four elements to the package:

1. Feed-in Tariffs with Contracts for Difference are long-term instruments intended to provide stable and predictable incentives for companies to invest in low-carbon generation. Contracts for Difference stabilise returns for generators at a fixed level known as the strike price. Generators receive revenue from selling their electricity into the market as under existing arrangements. In addition, when the market price is below the strike price, they also receive a top-up payment from suppliers for the additional amount. Conversely, if the market price is above the strike price, the generator must pay back the difference.
2. The Carbon Price Floor is a tax on emitting carbon dioxide. Due to begin in 2013, the floor price is intended to provide certainty over the increasing cost of carbon intensive generation and encourage investment in less carbon intensive technologies.
3. The Emissions Performance Standard will set a limit on the maximum carbon emissions allowed per unit of electricity generated by new power stations. It is principally intended to avoid the construction of new coal power plants that do not capture the majority of their carbon emissions.
4. The Capacity Mechanism will incentivise backup generation and demand response mechanisms to ensure that supply can always meet demand. Future demand will be forecast and capacity contracted several years ahead through auctions resulting in capacity agreements. Capacity providers receive steady payment for their services or face a penalty for non-delivery.

### **2.3 Deployment**

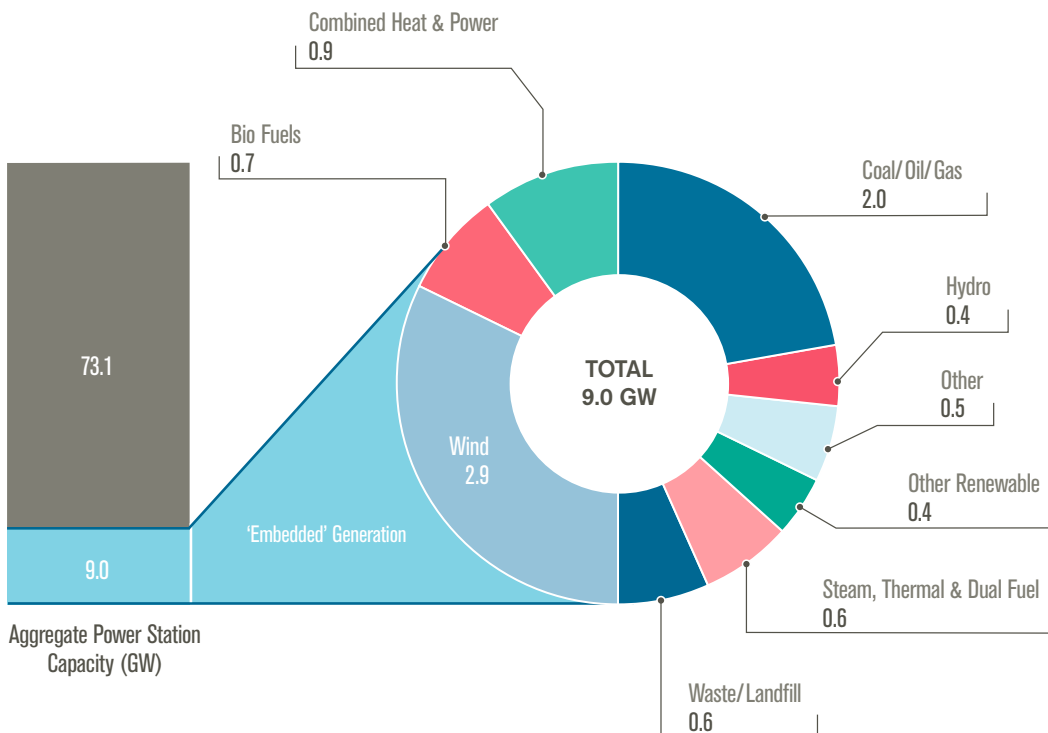
Due to inconsistencies in the way that distributed generation is defined and the broad range of technologies it can cover, it is hard to estimate the amount of installed

capacity, how much is from business and how much is low carbon. A variety of statistics is presented below that indicates the approximate proportions of the UK’s 89.1 gigawatts of installed capacity<sup>17</sup> that fall under these categories.

At the end of 2011, there was 12.3 gigawatts (13.8 per cent) of renewable electricity capacity installed and 6.1 gigawatts (6.8 per cent) of electrical capacity from good quality combined heat and power<sup>18</sup>. Around 6.2 per cent of fuel used in combined heat and power was renewable. More recent Feed-in Tariffs data indicate that of the 1.5 gigawatts (1.7 per cent) of low carbon small scale generation installed under the scheme, 30 per cent of capacity was operated by non-domestic users<sup>19</sup>.

In its 2011 Seven Year Statement, National Grid estimated there to be around nine gigawatts of what it terms ‘embedded small and medium power stations’<sup>20</sup>, equal to 11 per cent of installed capacity<sup>21</sup> (Figure 2). At least 55 per cent of this (five gigawatts) is from renewable sources. However, it recognises that its estimate of ‘embedded’ generation is very likely to be incomplete. National Grid expects there to be between 9.8 and 12.1 gigawatts of embedded generation by 2017/18, with growth rates of between 1.5 and 6.0 per cent per annum. Around half of this comes from combined heat and power and a quarter from wind power<sup>22</sup>.

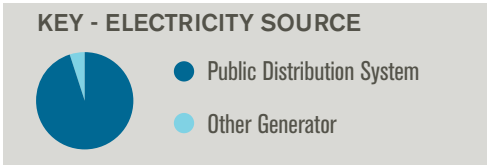
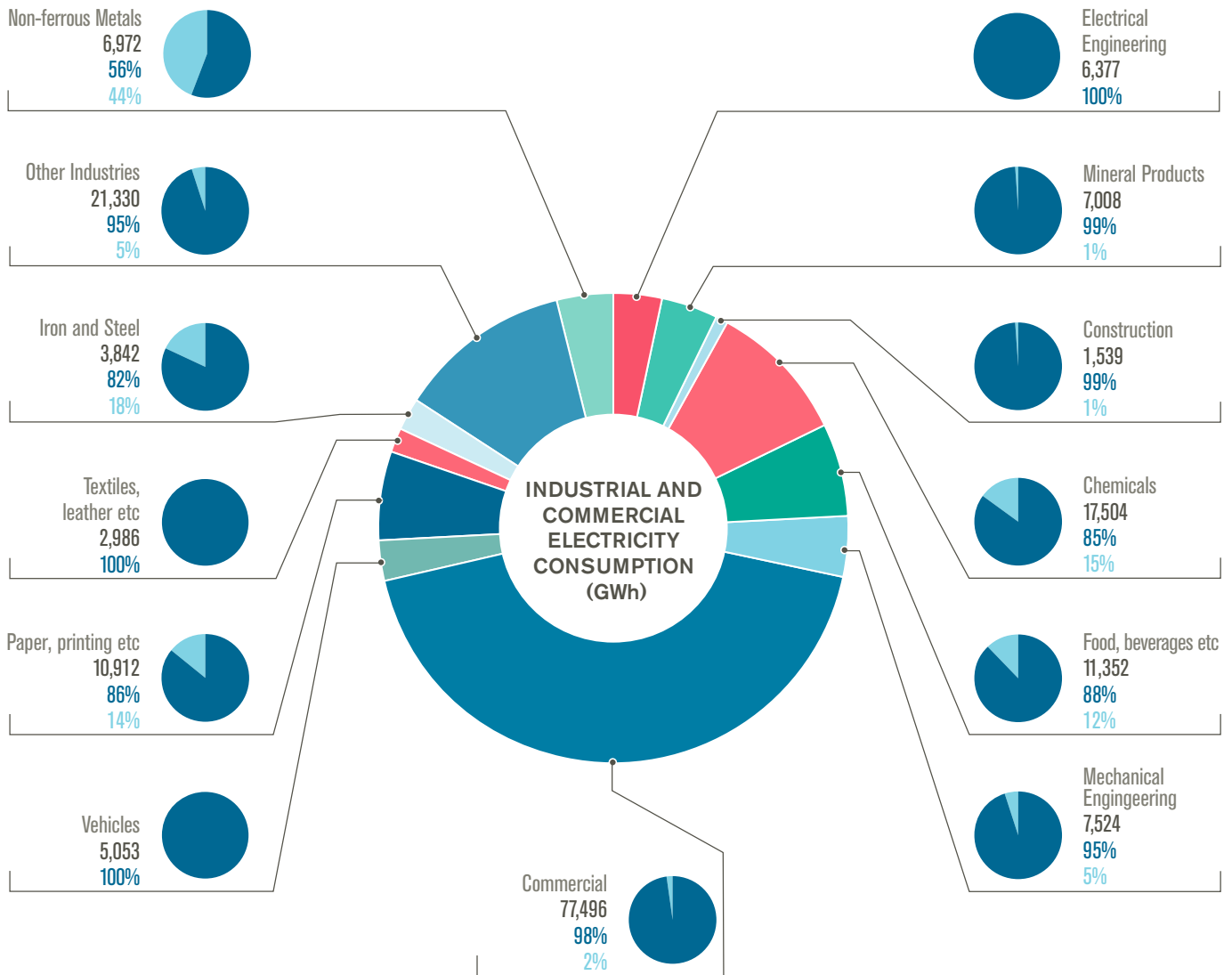
**Figure 2: Installed capacity of embedded small and medium power stations<sup>23</sup>**



Notes: 1) GW is gigawatts

17 DECC (July 2012), Digest of United Kingdom Energy Statistics (DUKES) for 2012: Chapter 5 - Electricity  
 18 DECC (September 2012), Combined Heat and Power in Scotland, Wales, Northern Ireland and the regions of England in 2011  
 19 Ofgem (September 2012), Feed-in Tariff Installation Report  
 20 Power stations with a registered capacity up to 100 megawatts in NGET’s Transmission Area, 30 megawatts in SPT’s Transmission Area and 10 megawatts in SHETL’s Transmission Area  
 21 National Grid identified aggregate power station capacity to be 82.1 gigawatts in 2010/11  
 22 National Grid (May 2011), Seven Year Statement  
 23 National Grid (May 2011), Seven Year Statement – Table 4.1

Figure 3: Consumption and sourcing of electricity by Industry and Commerce



Notes: 1) GWh is gigawatt hours

Companies that produce electricity, but whose main business activity is not electricity generation, referred to as ‘other generation’ in UK energy statistics<sup>24</sup>, accounted for 7.4 gigawatts (8.3 per cent) of installed capacity at the end of 2011. Of this, 2.6 gigawatts was from renewable sources<sup>25</sup>. The majority, if not all, of capacity listed as ‘other generation’ will fall under this report’s definition of distributed generation. Figure 3 shows the electricity consumption of various industrial and commercial sectors in 2011 and the split between electricity sourced from other generators (likely to be self-generated) and electricity sourced from the grid. It shows that distributed generation has already been adopted across many sectors but that there is huge variation in take-up between sectors. It also suggests that there is significant potential for further deployment.

## 2.4 Current policies and actions

### 2.4.1 The Department of Energy and Climate Change (DECC)

In its Electricity Market Reform White Paper<sup>26</sup>, DECC stated that distributed energy and local generation could have a much greater role to play in the future energy system and that the Government recognises the need to put in place the conditions to unlock its potential. To unlock the full potential of distributed generation, the Government should put the issue centre stage, alongside other important measures such as energy efficiency, smart meters and carbon capture and storage. The remedies that this report calls for should be built upon the foundations of strong government vision and leadership. The Government should set out its vision for distributed generation, giving certainty over the role that distributed generation *will* play, rather than *could* play, in delivering its energy ambitions. Not only should the Government advocate diversity in generating technologies, but it should recognise the need for a healthier balance between centralised power and distributed generation. The recommendations in this report require action from a diverse set of actors, ranging from the market regulator to Local Planning Authorities. The Government is best placed to provide the necessary coordination and conviction and to lead by example in unlocking distributed generation’s full potential.

#### Recommendation 1

DECC should establish a clear vision for distributed generation.

At the end of 2011, DECC set up an informal advisory group, the Distributed Energy Contact Group (DECG). The group, chaired by Greg Barker MP, has representation from academia, trade bodies, the public sector, the distributed energy industry and officials from the Department itself.

The formation of this group is a promising first step to recognising the important role that distributed generation will play in the near future, but this policy area must move

24 ‘Other generators’ are companies that produce electricity as part of their manufacturing or other commercial activities, but whose main business is not electricity generation. ‘Other generators’ also covers generation by energy services companies at power stations on an industrial or commercial site where the main purpose is the supply of electricity to that site, even if the energy service company is a subsidiary of a major power producer

25 DECC (July 2012), Digest of United Kingdom Energy Statistics (DUKES) for 2012: Chapter 5 - Electricity

26 DECC (July 2011), Planning our electric future: a White Paper for secure, affordable and low-carbon electricity

from the fringes of the Department to centre stage.

The Distributed Energy Contact Group's tasks<sup>27</sup> are:

1. to build upon the framework contained in the White Paper by helping the Government identify the full potential of decentralised energy to support the objectives of the Electricity Market Review; and,
2. to help the Government identify the barriers to decentralised energy delivering its full potential and the measures necessary to remove the barriers.

To date, the group's work has focused on the first of these tasks and only narrow consideration has been given to the second<sup>28</sup>.

## **Recommendation 2**

DECC's Distributed Energy Contact Group should be formally established with permanent representation in DECC. It should widen its focus from the Electricity Market Reform to consider all parts of the system that impact distributed generation and develop a strategy for delivering the Government's vision.

### **2.4.2 The Office of the Gas and Electricity Markets (Ofgem)**

Ofgem sees distributed generation as an important and growing area of work and its remit includes ensuring that the development of distributed generation is not unfairly treated by the way networks are operated and regulated.

Since 2011, Ofgem has hosted annual Distributed Generation Forums where Distribution Network Operators and their distributed generation customers discuss the process of securing a distribution network connection. This is explored further in Section 4. The Innovation Funding Incentive and Low Carbon Networks Fund, both administered by Ofgem, have supported innovative work by Distribution Network Operators including trials of new ways to manage distributed generation. This is discussed further in Section 4. Finally, the new price control framework, RIIO<sup>29</sup>, which will first be implemented in 2015, is expected to reward Distribution Network Operators that cater for the needs of distributed generation, for example by incentivising customer satisfaction and strategic network investments.

### **2.4.3 The Energy Networks Association**

The Energy Networks Association represents all Distribution Network Operators and acts as a strategic focus and channel of communication for the industry. It acknowledges that the UK's target of sourcing 15 per cent of energy from renewables by 2020 implies substantial growth in distributed generation and investment in the

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<sup>27</sup> [http://www.decc.gov.uk/en/content/cms/meeting\\_energy/heat\\_strategy/decg/decg.aspx](http://www.decc.gov.uk/en/content/cms/meeting_energy/heat_strategy/decg/decg.aspx)

<sup>28</sup> DECC (various), Minutes to DECG meetings on 28 November 2011, 2 February 2012 and 13 June 2012

<sup>29</sup> RIIO stands for Revenue = Incentives + Innovation + Outputs; ED1 is the first electricity distribution price control review under the RIIO model

network infrastructure. It states that stakeholders are concerned about the likelihood of meeting the Government's targets because of reasons including delays in obtaining planning consent and the current regulatory framework, both addressed in this report.

*'The Distribution Network Operators believe that the introduction of the correct commercial and regulatory framework is the single most important factor [for] how network operators can support the Government's target for renewable and energy efficient generation.'*

– Energy Networks Association<sup>†</sup>

Following requirements made by Ofgem, the Energy Networks Association – along with its members – produced user-friendly common guidelines and application forms for distributed generation developers and owners looking to secure a network connection. This has been welcomed by the industry, although some feel that they could go further and standardise the application process itself. However, this risks making the process less flexible and restricting Distribution Network Operators from offering a tailored service which many customers also want to see happen. This issue is discussed further in Section 4.

# 3. BENEFITS OF DISTRIBUTED GENERATION

The benefits of distributed generation are understood qualitatively, but not well quantified at a regional or national scale. Part of the problem is the lack of a common definition for distributed generation, but several benefits are also contingent on other factors such as site selection, technology choice and future development of supply and demand profiles. What is more certain however, is that distributed generation is a gateway to deployment, development and cost reduction for many low carbon technologies that are essential for the UK to meet its climate change targets.

## 3.1 Ten benefits of commercial and industrial scale distributed generation

### 1. Lower carbon emissions

Distributed generation is a gateway to deployment for many low carbon generation technologies. At least 55 per cent of the embedded small and medium plants identified by National Grid in 2011 were renewable<sup>31</sup>. A supportive regime for distributed generation will become increasingly critical as carbon budgets apply greater downward pressure on power sector emissions and costs for low carbon generation technologies fall, leading to higher deployment rates.

### 2. Reduced transmission and distribution losses

Distributed generation can avoid transmission and distribution losses if located near to centres of demand, reducing the distance that power is transported. System losses can account for up to around three per cent of demand<sup>32</sup>.

### 3. Short build time

Distributed generation plants can be built quickly and could therefore play an important role in supplying some of the 30 gigawatts of new generating capacity needed this decade.

### 4. Security and diversity of supply

More distributed generation means a more diverse electricity system, in both the range of different technologies and the number of separate power plants. This lowers the reliance of the UK electricity system on a small number of large power plants, therefore improving energy security. Energy security is predicted to weaken significantly over the coming decade. Ofgem recently predicted that the UK's de-rated capacity margin<sup>33</sup> will fall from around 14 per cent in 2012/13 to 4 per cent in 2015/16<sup>34</sup>.

### 5. New sources of investment

By 2020, the UK needs to have seen £110 billion of investment in electricity infrastructure<sup>35</sup>. The Feed-in Tariffs scheme has shown that significant appetite for investment in energy generation can be stimulated from 'non-traditional' sources if the right market conditions are created. Attracting investment from 'alternative' sources, such as non-energy-related businesses, will relieve pressure from utility companies' balance sheets and help the UK to secure the investment it needs to keep the lights on.

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31 National Grid (May 2011), Seven Year Statement 2011 – Table 4.1

32 National Grid (May 2011), Seven Year Statement 2011 – Table 7.4

33 De-rated capacity margin is defined as the excess of available generation capacity over demand

34 Ofgem (October 2012), Energy Capacity Assessment

35 DECC (July 2011), Planning our electric future: a White Paper for secure, affordable and low-carbon electricity



## 6. Engaging consumers with energy

Owning or operating distributed generation can be an important tool in engaging businesses in their energy use<sup>36</sup>. This is an important step in businesses managing the risk of rising energy prices and raising their awareness of measures such as energy efficiency.

## 7. Avoid or delay the need for network upgrades

When well sited, distributed generation plant can alleviate network constraints, avoiding or delaying the need for costly network upgrades. This saves money for consumers who face rising energy prices over the coming decade.

## 8. Value for money

The scale of plant that industrial and commercial businesses adopt provides better value for money than domestic and micro-scale which has been heavily backed by the Government through Feed-in Tariffs. This was recognised by DECC in its Electricity Market Reform White Paper:

*‘The economies of scale and efficiencies of the larger [distributed energy] installations in commercial and industrial sectors means they can provide additional benefits over domestic installations.’*

– DECC, Electricity Market Reform White Paper

## 9. Future role for system balancing

Ensuring that electricity supply always meets demand is expected to become more challenging as the UK decarbonises its power sector. Distributed generation currently does not play a role in balancing the transmission system because its total capacity is still relatively low and distribution networks are not smart enough. Both these factors are expected to change, making it possible for distributed generation to contribute towards future system balancing challenges. When combined with heat generation, distributed generation is a substitute for the generation of heat from electricity, therefore also contributing to electricity demand management<sup>37</sup>.

In addition, there is the potential for distributed generation to participate in system balancing in future distribution networks through providing ancillary services such as curtailment and voltage control services (discussed in the Case Study on page 36).

## 10. Improved resource efficiency

When by-product heat is usefully utilised, such as in a combined heat and power system, plant efficiency can be up to 80 per cent compared to around 50 per cent for modern gas plants and around 40 per cent for coal fired plants<sup>38</sup>.

### Recommendation 3

DECC should develop a more detailed and quantified understanding of the benefits of distributed generation at local and national levels.

36 Ibid.

37 Ibid.

38 [http://www.chpa.co.uk/what-is-chp\\_15](http://www.chpa.co.uk/what-is-chp_15)

# TATA STEEL & SITA

## CASE STUDY

<b>User</b>	<b>TATA Steel</b>
<b>Project partner</b>	<b>SITA</b>
<b>Location</b>	<b>Scunthorpe</b>
<b>Technology</b>	<b>Landfill Gas</b>
<b>Electrical capacity</b>	<b>1 megawatt</b>
<b>Annual electrical output</b>	<b>7.5 gigawatt hours</b>
<b>Estimated annual financial saving</b>	<b>£150,000</b>
<b>Estimated annual carbon saving</b>	<b>4,000 tCO<sub>2</sub>e</b>
<b>Proportion of on-site demand met</b>	<b>&lt;1 per cent</b>
<b>Estimated project cost</b>	<b>£1,200,000</b>
<b>Generation start date</b>	<b>February 2011</b>
<b>Delivery time (planning submission to operation)</b>	<b>9 months</b>

### Motivations

The close geographical proximity of the SITA landfill and the TATA Steel works lent itself to a distributed generation scheme. SITA has a specific objective to maximise landfill gas recovery and associated generation across its portfolio and is always looking for innovative projects with strategic partners. TATA Steel has a strategic aim to reduce its exposure to external energy markets and continually looks for innovative, value-adding energy solutions.

### Challenges and solutions

The only specific challenge with the project was ensuring that the generation scheme met the tight electrical controls required by the TATA network. Both parties worked together in a constructive and focused manner to deliver a project on a rapid timeframe.

### Benefits

SITA have benefited from a reduced electrical connection cost due to the close proximity of the connection point to the TATA network.

# 4. BARRIERS AND SOLUTIONS

To unlock the benefits of distributed generation, the systems and institutions that make up and influence our energy system need to realign. What has grown to serve the interests of a centralised and largely fossil-fuel based power system must now be re-optimised to serve a diverse, low carbon and smart power system. A significant part of this change involves levelling the playing field for distributed generation. Strong government leadership is critical to see these changes take place swiftly and efficiently.

## 4.1 Policy stability

The foundation of strong government leadership in supporting new technologies is predictable policy that reflects often long investment timescales. Policy instability and unpredictability heighten investment risk and decrease investors' willingness to finance projects. The UK policy support landscape for low carbon power technologies, which make up a considerable portion of distribution generation, has suffered from instability for some time (Figure 4).

The Feed-in Tariffs scheme has shown that if policy changes are not transparent and predictable, the resulting damage to market confidence can be significant. In October 2011, earlier than planned, DECC published a consultation on cuts to the Feed-in Tariffs rates for smaller solar installations<sup>39</sup>. The process and methodology for changing tariff rates that DECC established at the start of the Feed-in Tariffs scheme was not sufficiently transparent and predictable. The early consultation and subsequent cut in solar tariff rates had a severe impact on industry confidence in policy stability.

*'To facilitate the investment in renewables that the country needs, investors need to have confidence in a stable and predictable commercial environment for those investments. The scale and pace of the changes [to solar power Feed-in Tariffs] now proposed was a 'shock' for the industry and the suddenness of their introduction has damaged investor confidence across the whole energy sector. This damage would not have occurred if the Government had recognised the unsustainable rate of the expansion of solar installations at an earlier date, something which ought to have been identified by Ministers and officials sooner...'*

– Energy and Climate Change Select Committee<sup>40</sup>

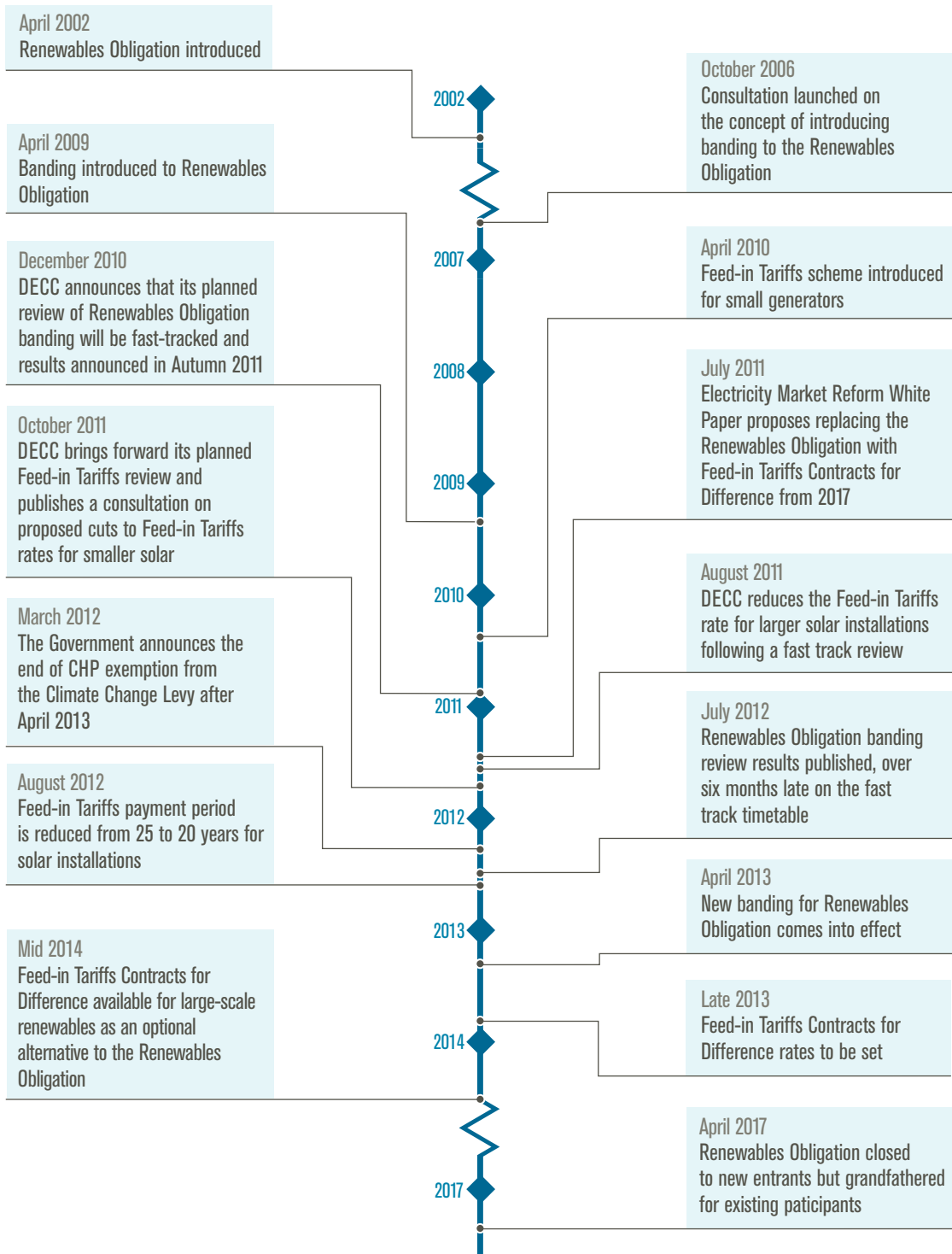
The Renewables Obligation, introduced in 2002<sup>41</sup>, has also suffered from instability. In April 2009, 'banding' was introduced which tailored the level of support to the cost of the different renewable technologies. The need for banding could have been anticipated at the beginning of the scheme and provisions for it built into the policy from the start. In December 2010, DECC announced that its planned review of banding rates would be brought forward, with new bands confirmed in Autumn 2011 to provide earlier certainty for investors. This conversely resulted in additional uncertainty and loss of trust from investors because the new rates did not materialise until July 2012, over half a year late on the fast track timetable.

39 DECC (October 2011), Feed-in tariffs scheme: consultation on Comprehensive Review Phase 1 – tariffs for solar PV

40 Energy and Climate Change Select Committee (December 2011), Ninth Report – Solar Power Feed-in Tariffs – Volume I

41 The Renewables Obligation was introduced in 2002 for England, Wales and Scotland. It was introduced in 2005 for Northern Ireland

**Figure 4: Instability and uncertainty in support for low carbon power technologies**



The phasing out of the Renewables Obligation and phasing in of Feed-in Tariffs with Contracts for Difference is a further policy change that is heightening uncertainty and risk for investors. This is not a criticism of the reforms themselves, which are discussed in later sections.

#### Recommendation 4

DECC should be clear from the start how, and under what circumstances, policy support for generators will change.

#### Recommendation 5

DECC should quantitatively assess and take full account of the wide, cumulative and long-lasting impact that policy instability has on investors' assessment of risk and, consequently, the cost to consumers and taxpayers. This assessment should inform any decisions to change policy support.

### 4.2 Alignment of benefits

Distributed generation projects contribute benefits to the local and national networks, but these are not reflected in financial charges and incentives for generators. For example, siting distributed generation in areas of the network that are served by frequently constrained lines<sup>42</sup> can reduce costs incurred by the system and network operators by: reducing the need for system balancing; eliminating the need for network reinforcements; or delaying the need for network reinforcements. The absence of a mechanism to reflect this value prevents distributed generation from providing long-term and potentially lower cost solutions to network constraint problems.

Similarly, placement of distributed generation close to centres of demand can reduce system losses<sup>43</sup> because power is transported over shorter distances. This improves the overall efficiency of the network, however there is no mechanism to reflect financially the impact of generators on system losses.

#### Recommendation 6

DECC should consult upon the local and national impact of distributed generation and mechanisms that could be introduced to measure and reflect this value, for example through adjusting Use of System Charges.

### 4.3 Institutional and systemic bias

The UK power system and its institutions have suffered from inertia and have been slow to react to the need to adapt and serve decentralised as well as centralised power. For example, ancillary grid services are biased against participation from variable generation such as wind. And, Distribution Network Operators have only just begun

42 Network constraints are 'bottlenecks' on transmission or distribution networks where the capacity of a particular network branch is insufficient to carry all the power needed

43 System losses can be up to around three per cent of peak demand. Source: National Grid (May 2011), Seven Year Statement 2011 – Table 7.4

# LOW CARBON NETWORKS FUND: FLEXIBLE PLUG AND PLAY

## CASE STUDY

### Led by UK Power Networks

Flexible Plug and Play is a Low Carbon Networks Fund project, led by UK Power Networks, that is trialling a number of innovative technical and commercial solutions for the connection of distributed generation to distribution networks.

The fundamental objective of the project is to identify and demonstrate commercial, regulatory and technical solutions to allow better network connections for distributed generation, specifically renewable generation. Better in this context means that connection is cheaper and faster. To achieve this, the project will trial a wide range of smart technologies and services that could help Distribution Network Operators to manage their networks actively. Two such services that will be piloted are curtailment and voltage control. Generators are likely to benefit from these services through flexible connection options and lower overall charges.

### Curtailment Services

Generator curtailment occurs when a generator is temporarily prevented from generating as desired and must reduce output below its current capacity, to some lower limit or possibly to zero. One common use of curtailment is to ensure that the flows along different branches of the network remain within safe and secure limits.

Curtailment can be financially beneficial for distributed generation developers seeking a grid connection if it avoids the need for expensive network reinforcement upgrades or speeds up the process of securing a grid connection.

The primary barrier to implementing curtailment services between Distribution Network Operators and generators are the commercial arrangements. The project will pilot curtailment services with distributed generation plant that have agreed to participate in the project.

### Voltage Control Services

Distribution Network Operators have an obligation to control the voltage at each customer's point of connection, to keep it within statutory limits. Connecting distributed generation to the network can sometimes make it more difficult for Distribution Network Operators to fulfil their voltage control obligations.

Some types of distributed generation are connected to the network via equipment that has the capability of improving 'power quality' which can help Distribution Network Operators control voltage. This equipment could be used more widely by all types of distributed generation at little additional cost to provide voltage control services to Distribution Network Operators.

One of the principle barriers to implementing this technology is the commercial and contractual arrangements. Through piloting voltage control services, this project will test commercial and contractual arrangements.

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to consider alternatives to passive network management. Progress is starting to be made, such as through the Smart Grids Forum, the Low Carbon Networks Fund and Distributed Generation Forum. These initiatives are proving effective in bringing forward ideas for better ways of working, but more focus now needs to be placed upon evaluating and implementing the best ideas and embedding them in business as usual behaviours.

Government's involvement may not be direct, but there is an opportunity for it to provide leadership by acting as architect and enabler of the processes that are needed to bring about widespread implementation. For example, Ofgem should work with the Energy Networks Association and its members to ensure that the learning from Low Carbon Networks Fund projects is evaluated, shared and turned into action and widespread implementation as early as possible to take full advantage of the new extended price control framework starting in 2015 (RIIO-ED1<sup>44</sup>).

#### Recommendation 7

DECC and Ofgem should provide strong leadership to industry by acting as the architects and enablers of processes that are needed to bring about evaluation and widespread implementation of smart grid solutions being developed through initiatives such as the Low Carbon Networks Fund and Smart Grids Forum.

The Distributed Generation Forum is an event run annually by Ofgem for Distribution Network Operators and distributed generation customers to discuss progress and issues with connecting to the grid. All parties have found it an effective way of communicating and discussing issues. However, there is scope to improve its effectiveness through more frequent meetings and using the Forum to agree SMART<sup>45</sup> action points for Distribution Network Operators.

#### Recommendation 8

Ofgem and Distribution Network Operators should hold Distributed Generation Forum events bi-annually and agree and publish SMART actions for Distribution Network Operators following each event. Forum events should be used for Distribution Network Operators to report progress against previously agreed actions to Ofgem and their customers.

### 4.4 Business awareness

There is a shortage of trusted information on successful commercial and industrial applications of distributed generation. This information is typically available within businesses that have invested in generating their own electricity but there are no mechanisms for sharing this information to raise awareness and strengthen business cases in other organisations. Good practice also needs to be put in context, showing

44 RIIO stands for Revenue = Incentives + Innovation + Outputs; ED1 is the first electricity distribution price control review under the RIIO model

45 SMART actions are: Specific, Measurable, Attainable, Relevant and Timely

what role distributed generation has to play in a strategic approach to business energy management.

Local Enterprise Partnerships are well placed to facilitate and lead this work on a regional basis. They should utilise their connections and knowledge of local business to spread good practice, helping to strengthen the resilience and sustainability of the local economy, whilst potentially attracting new inward investment.

#### **Recommendation 9**

Local Enterprise Partnerships should work with businesses to spread good practice in strategic energy management and the role of distributed generation, including case studies of successful distributed generation projects implemented by businesses in their region.

#### **4.5 Coordinating planning permission and grid connection**

Securing planning permission and a financially viable grid connection are two key prerequisites to finalising project investment. Developers need to have planning permission before they can financially commit by accepting a grid connection offer. To minimise delays and because of the uncertain timescales of these processes, planning applications and grid connection applications are often pursued in parallel. Problems can arise when grid connection offers are received before planning permission is granted because these offers are time-limited to anything from one to six months (at the discretion of each Distribution Network Operator). Grid connection offers can sometimes expire before planning permission is secured and then applications have to be resubmitted and reprocessed, leading to further costs for Distribution Network Operators and delays for developers.

#### **Recommendation 10**

Distribution Network Operators should consider flexible ways of developing and issuing grid connection offers to help their customers manage the scheduling uncertainty in securing planning consent for distributed generation projects.

#### **4.6 Planning permission**

Distributed generation developers find getting planning permission difficult. There are a variety of reasons why this is and ways in which gaining planning permission could be supported.



# BRITISH SUGAR

## CASE STUDY

User	British Sugar
Project partner	None
Location	Wissington
Technology	CHP
Electrical capacity	70 megawatts
Annual electrical output	501 gigawatt hours
Estimated annual financial saving	20 per cent
Estimated annual carbon saving	101,500 tCO <sub>2</sub> e
Proportion of on-site demand met	100 per cent
Estimated project cost	Not available
Generation start date	July 1998
Delivery time (planning submission to operation)	23 months

Notes: 1) tCO<sub>2</sub>e is tonnes of carbon dioxide equivalent

British Sugar's Wissington site is the largest sugar beet factory in the world. The factory can best be described as a bio-refinery because on the same site it produces annually 420,000 tonnes of sugar products, up to 55,000 tonnes of Bioethanol, 140,000 tonnes of animal feed and many other products. Heat recovery greatly reduces the carbon footprint of the refinery. The factory is adjacent to the UK's largest single tomato glasshouse which uses considerable volumes of low-grade heat and carbon dioxide from the factory's combined heat and power (CHP) plant to help grow around 140 million tomatoes each year.

At the heart of this truly sustainable approach to manufacturing is a highly efficient, 70 megawatt capacity, combined heat and power plant. This meets all the steam and electricity needs of the site's operations and is able to export some 50 megawatts of additional, low-carbon electricity back to the local network; enough power to meet the energy needs of 120,000 people. The performance of the combined heat and power plant itself is augmented by the addition of a water injection system which can boost output from the gas turbine particularly during warm weather.

### 4.6.1 Community buy-in

*'We need a far better process of community engagement to make sure all concerns are properly listened to'*

– Caroline Lucas MP (*The Guardian*, 1 November 2012)

Distributed generation developers are not always good at securing community buy-in. There is a shortage of information about what the Government sees as good practice in this area. Community buy-in should not be an insurmountable barrier as a recent poll<sup>46</sup> found that a majority of respondents wanted to see more energy coming from solar power and wind farms – two of the frontrunner technologies for distributed generation (Figure 5). In another recent poll<sup>47</sup> more respondents said that they were likely to support a wind turbine being erected in their locality, than responded either unlikely or indifferent (Figure 6).

The Government should expand its call for evidence on community engagement from onshore wind to all distributed generation. The evidence should be used to publish guidance that sets out what steps can be taken, when and by whom to stand the best chance of bringing forward projects that balance the needs of local communities with national ambitions. It should include models for providing financial benefits to communities.

#### Recommendation 11

DECC should expand its call for evidence on Community Engagement and Benefits of Onshore Wind to cover all distributed generation. The evidence should be used to publish guidance on good practice in securing community buy-in for all types of distributed generation.

### 4.6.2 Planning guidance

Local Planning Authorities and Planning Committees do not always have a strong understanding of the issues surrounding distributed generation. In particular there is a need for a clear and consistent understanding of:

- the national importance of distributed generation;
- which matters are genuinely contentious and which are not; and
- frequently raised issues such as carbon footprints, noise and house price impacts.

Guidance from government on these topics would allow quicker and better-informed decisions to be made about planning and consent, and in some cases avoid duplication.

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46 ICM Research (October 2012), poll prepared on behalf of Co-operative Group Consumer Insight

47 YouGov (October 2012), poll for *The Sunday Times*

Figure 5: Percentage of respondents wanting the UK to use more of each energy generation technology

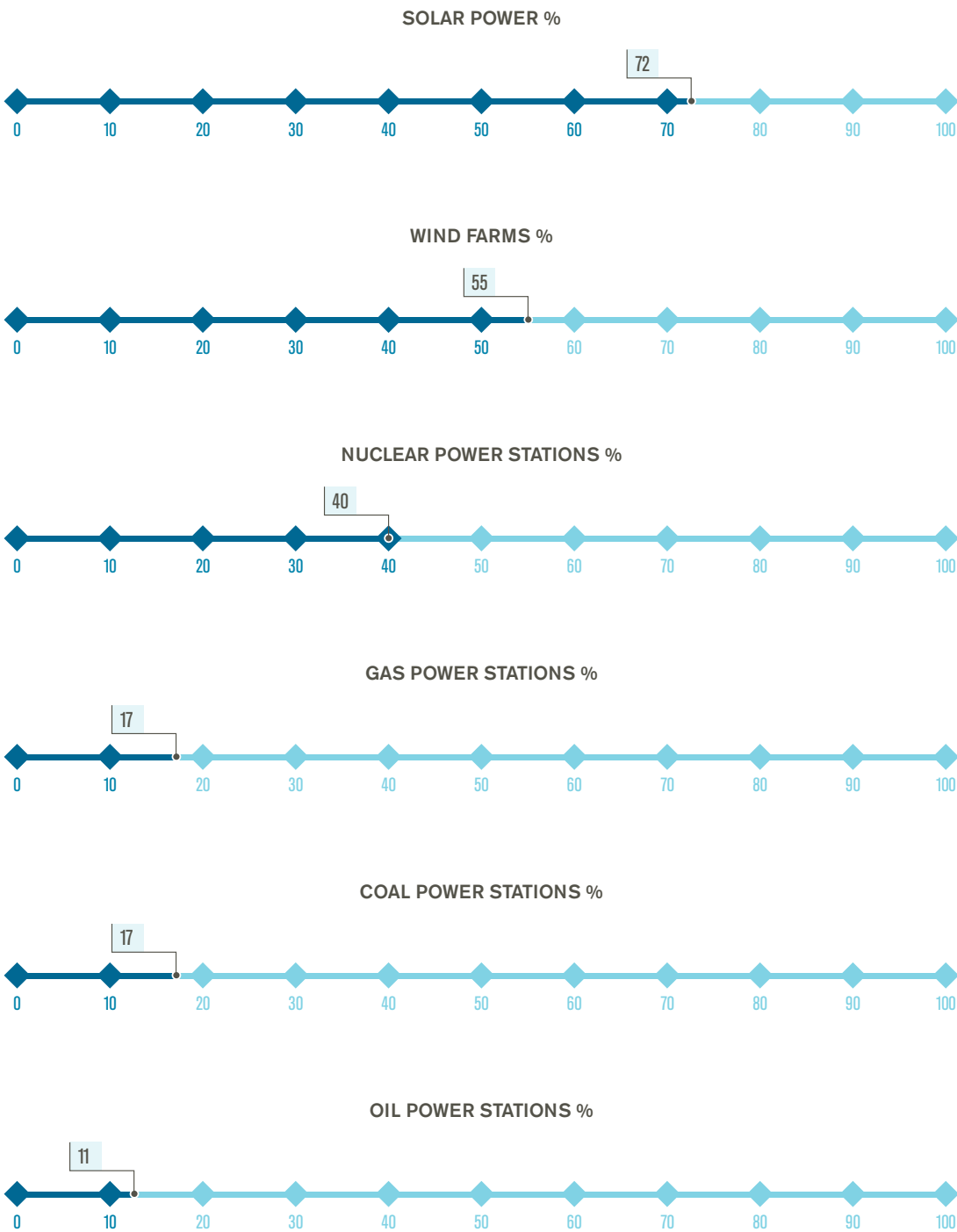
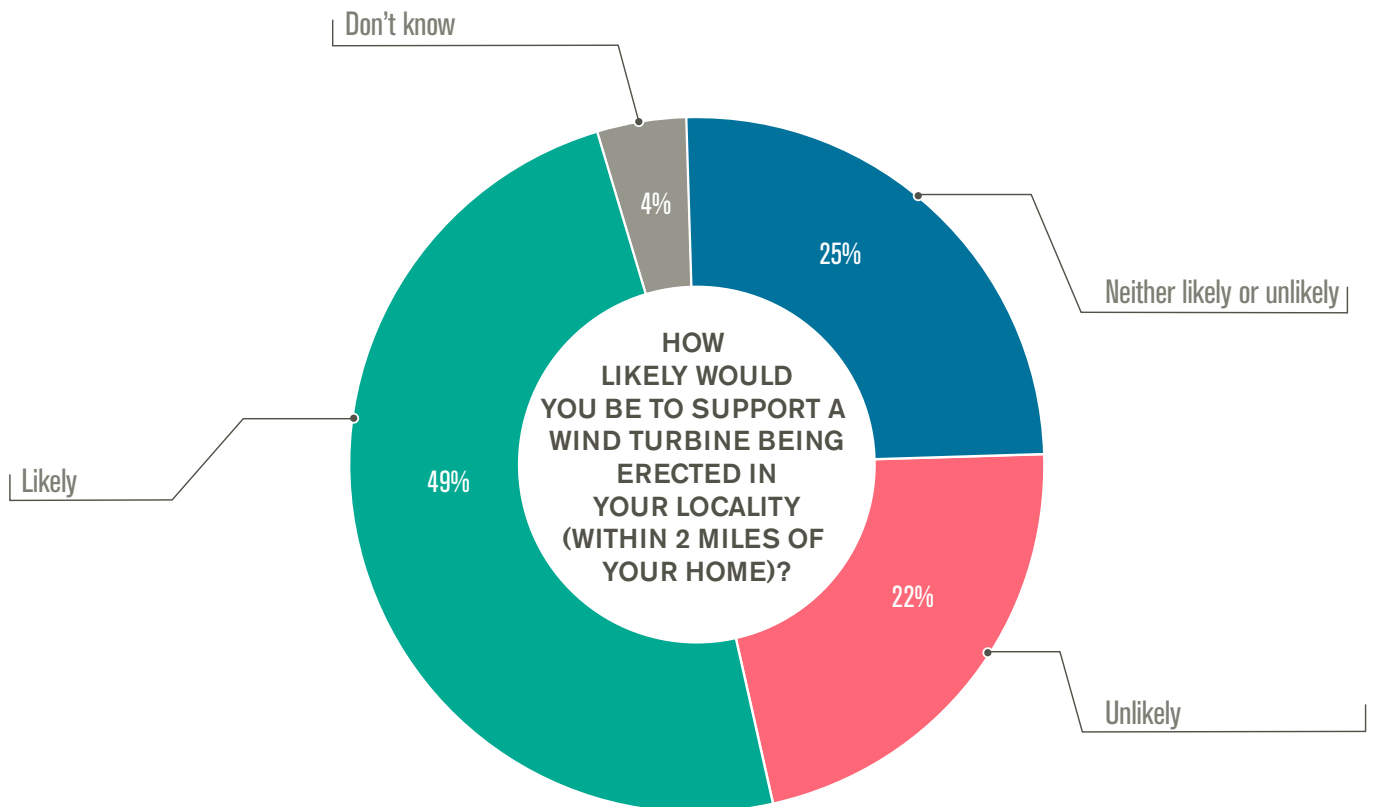


Figure 6: Poll on support for local wind turbines



**Recommendation 12**

DCLG should ensure that updated or new planning practice guidance sends a clear and consistent message to planning professionals on the following topics, following the review of existing planning practice guidance:

- the national importance of distributed generation;
- which matters relating to distributed generation are genuinely contentious and which are not; and
- frequently raised issues such as carbon footprints, noise and house price impacts.

**4.6.3 Site selection**

Site selection can dramatically affect the chances of a project securing planning permission and a financially acceptable grid connection offer. There are many additional benefits, including financial, to siting generating capacity intelligently so that it is close to centres of energy demand, makes best use of local energy resources and

enables efficient development of connecting infrastructure. Despite this, limited effort is put into a 'systems based' approach to planning generating capacity or providing information to distributed generation developers to enable them to make intelligent decisions about site selection. The current piecemeal approach will invariably lead to suboptimal solutions, giving rise to higher overall network reinforcement and connection costs. There are a variety of actions that the Government, Local Authorities and Distribution Network Operators can take to improve the situation.

#### 4.6.3.1 Highlight the importance of distributed generation

Local Authorities vary in the extent to which they proactively assess and specifically identify appropriate areas and sites for distributed generation developments. There is therefore a variable level of information that is easily accessible for developers to make well-informed decisions about site selection. Local Authorities would place more significance on assessing and clearly identifying areas and sites that are likely to be suitable for distributed generation developments if they receive stronger signals from the Government about the national importance of distributed generation. The National Planning Policy Framework, published in March 2012<sup>48</sup>, is helpful in emphasising the importance of low carbon power and the role that distributed generation can play, but more should be done to highlight its importance. In October 2012, the Department for Communities and Local Government (DCLG) announced a review of planning practice guidance chaired by Lord Taylor of Goss Moor<sup>49</sup>. This review and the subsequent work on new guidance is an opportunity for the Government to communicate the importance of distributed generation (see Recommendation 12).

#### 4.6.3.2 Identify suitable areas and sites

Local Authorities and Distribution Network Operators are well placed to assess and identify areas and sites that are best suited to distributed generation. In doing this, Local Authorities should develop closer working relationships with Distribution Network Operators:

- to ensure that preferred sites for distributed generation developments identified in Local Plans are consistent with capacity available on local electricity networks;
- so that Local Plans can take into account where distributed generation would be most beneficial from a network perspective, for example, where it can relieve network constraints; and
- so that Distribution Network Operators can have more certainty over likely future developments that their network will have to serve and can make better-informed strategic investment decisions.

### Recommendation 13

Local Authorities should develop closer working relationships with Distribution Network Operators and share detailed information to assess and identify areas and sites that are best suited to distributed generation.

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48 DCLG, (March 2012), National Planning Policy Framework

49 <http://www.communities.gov.uk/newsstories/newsroom/2236539>

#### 4.6.3.3 Communicate to potential developers

As well as assessing and identifying the best locations for distributed generation, Local Authorities and Distribution Network Operators should develop a single portal which presents information on:

- specific locations identified in Local Plans as most and least likely to be suitable for distributed generation;
- which locations have spare network capacity and how much; and
- resource mapping, such as mapping of wind speeds, solar intensity or local waste and biomass resources.

The information currently available to distributed generation developers is not easily interpreted by non-experts. A simpler tool, such as an online planning tool, would allow this information to be more easily accessible by those who need it.

#### **Recommendation 14**

Local Authorities and Distribution Network Operators should develop a single portal which communicates information that will help distributed generation developers to make well-informed decisions about site selection.

### 4.7 Volume of connection applications

To secure a grid connection, generators must first submit a connection application form with technical details to their Distribution Network Operator. The Distribution Network Operator then has up to three months to provide a formal connection offer and price quotation.

Distribution Network Operators are overwhelmed by the number of distributed generation enquiries that they receive, which in some cases has risen by over 400 per cent in recent years. The number of enquires that result in new connections is typically no higher than 15 per cent, and is often much lower. Distributed generation connection enquiries do not attract an administration fee and so some developers submit multiple 'speculative' enquiries. There appear to be two reasons for this:

1. There is a lack of publicly available information about where there is spare network capacity; and
2. It does not cost developers to submit multiple distributed generation connection enquiries.

Dealing with this volume of enquiries, particularly when such a large proportion does not result in new connections, is costly for Distribution Network Operators and means that the quality of service they provide is inevitably lower. Reducing the number of

distributed generation enquiries would therefore have significant benefits for both customers and Distribution Network Operators. For example, Distribution Network Operators would be more able to provide a tailored and flexible service, which is something often sought by distributed generation customers and will become more important as smart technologies offer a greater number of connection options.

Ofgem should take steps to encourage Distribution Network Operators to collect and publicise information on spare network capacity at all voltage levels, prioritising higher voltages. DECC should introduce a charging regime that discourages excessive speculative distributed generation connection enquiries. These actions will not only help to reduce the number of applications, but money raised from connection application fees can be used to support the resources required for Distribution Network Operators to collect and publicise information on spare network capacity. Some of the measures that Ofgem is proposing to introduce under RIIO-ED1 in 2015 will begin to address these problems, but actions should be taken before then to address the issue over the next three years.

#### **Recommendation 15**

Ofgem should take steps to encourage Distribution Network Operators to collect and publicise information on spare network capacity at all voltage levels, prioritising higher voltages.

#### **Recommendation 16**

DECC should take steps to introduce a charging regime for assessment and design work that discourages excessive and speculative distributed generation connection enquiries.

Implementing these recommendations could be cost neutral if they result in fewer and better-informed distributed generation applications and therefore reduce processing costs. Additional funding from introducing charges for assessment and design work could also strengthen the financial case for these recommendations.

### **4.8 Intermittency and the role of aggregators**

Distributed generation is often operated by independent generators with small or single holdings of generation plant. Independent generators can face problems if their plant is intermittent, such as is the case for wind and solar power. The variation in output has two sources: seasonal variation in weather and random variation in weather.

Seasonal variability can cause cash flow and operational inefficiencies for independent generators. Whereas random variability often means that power is sold at a discounted price because a risk premium is charged by the party buying the power.

Variability from these two sources can be reduced by aggregators. Aggregators act as a middleman between generators and buyers in the wholesale electricity market. They buy power from generators and sell it on the wholesale market. By buying power from

a carefully balanced portfolio of many different generators, aggregators can overcome the problems of variability and pass on the benefits to each individual generator in their portfolio.

The impact of aggregation is demonstrated in two examples below. The first shows how the relatively predictable patterns in variable output from wind and solar plants form a more stable output when aggregated over an extended period (a year). The second example demonstrates that holding a portfolio of projects diversifies risks of random variation over shorter time periods (a week).

#### **4.8.1 Aggregation of solar and wind projects over one year**

The output from solar plants in the UK peaks during the summer months whilst falling to a minimum during the winter. Wind power follows an approximately inverse pattern, peaking in the winter and falling to its lowest during the summer. Whilst there may be significant fluctuations in output on a day-to-day basis, this pattern of output is more reliable at a monthly level.

If added together, the combined output of solar and wind plants over the year forms a far more stable output than each on its own. In this example below (Figure 7), the variability of the individual wind and solar plants is 47 per cent<sup>50</sup>, whereas the variability of the aggregated output is only 11 per cent. This extra stability provides operational and financial benefits to the aggregator which can then be passed on to each individual project in the aggregator's portfolio. These benefits would otherwise be inaccessible to independent generators.

#### **4.8.2 Aggregation of many intermittent generators over a week**

Patterns of weather are not wholly predictable and in this sense are random. This causes the output of wind and solar plants to vary on an hourly and daily basis in a way that can only be forecast in the short-term. The negative impact of this random variation can be reduced by aggregators that hold portfolios of many intermittent generating plants.

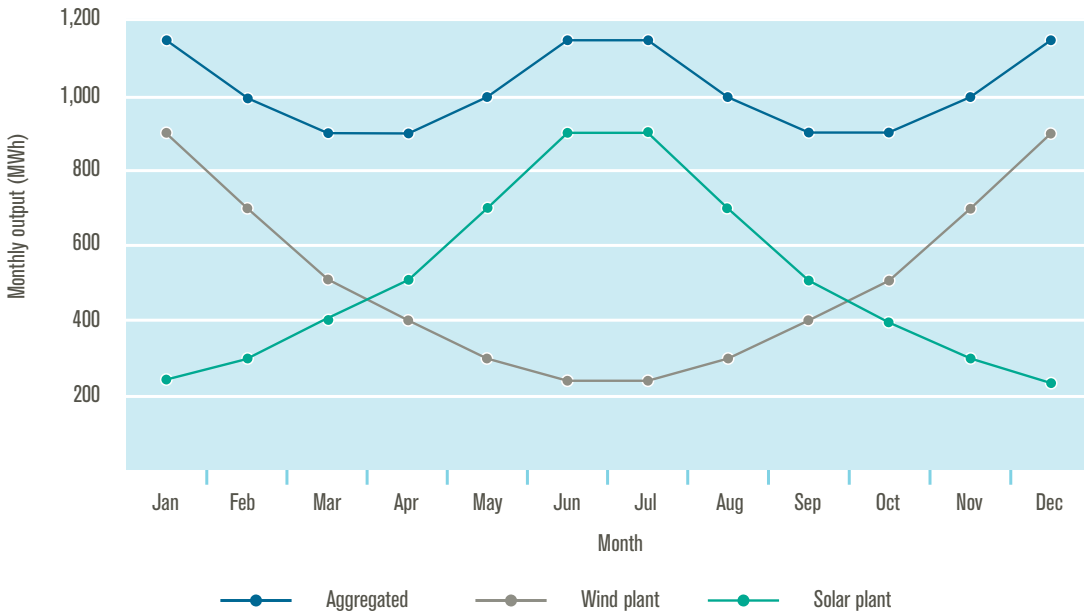
In the example below (Figure 8), ten intermittent distributed generation plants have power outputs that vary randomly between 10 and 50 megawatt hours each day. This could, for example, represent plants in ten different locations. Individually, the output of the plants has an average variability of 42 per cent. If the same ten plants were held as a portfolio by an aggregator, this variability would be reduced to just 12 per cent. As above (Section 4.8.1), the benefits of reducing variability can be passed on by the aggregator to each of the generators in its portfolio.

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<sup>50</sup> Variability is measured throughout as relative standard deviation which is:  $100 * (\text{standard deviation} / \text{mean output})$ . In Figure 7, output is monthly output. In Figure 8, output is daily output



**Figure 7: Reduction of variability in an aggregated portfolio of solar and wind projects**



Notes: 1) Aggregated output is equal to solar plant output plus wind plant output  
 2) MWh is megawatt hours

Distributed generation is often operated by small or independent generators that face significant barriers to market because of their size and, in the case of intermittent generation, the variability of their output. Aggregators are important because they enable distributed generation operators to overcome these barriers in a financially viable way. As the Government introduces its Electricity Market Reform, there is a good opportunity to make sure that the new arrangements are consistent with an attractive market for new and existing aggregators. The Government has begun to take steps to consider this through its call for evidence on barriers to securing long-term contracts for independent renewable generation investment<sup>51</sup>.

**Recommendation 17**

DECC should review the full range of factors that affect the attractiveness of the reformed UK electricity market for new and existing aggregators and consider whether actions are needed to maintain competition.

51 DECC (July 2012), A call for evidence on barriers to securing long-term contracts for independent renewable generation investment

**Figure 8: Example of risk diversification in an aggregated portfolio of ten plants with a variable output**

	Daily output (MWh)							Variability <sup>52</sup>
	Mon	Tue	Wed	Thu	Fri	Sat	Sun	
I	24	12	42	33	41	33	34	33%
II	31	24	33	17	29	13	22	31%
III	49	43	13	32	11	37	49	47%
IV	49	18	39	20	37	48	26	38%
V	12	26	19	13	39	19	40	48%
VI	18	33	42	16	19	17	13	47%
VII	13	13	14	45	21	11	29	59%
VIII	23	16	36	27	38	28	15	34%
IX	29	31	38	15	14	11	27	43%
X	25	10	35	46	50	30	49	42%
<b>Aggregated</b>	<b>273</b>	<b>226</b>	<b>311</b>	<b>264</b>	<b>299</b>	<b>247</b>	<b>304</b>	<b>12%</b>

Notes: 1) Aggregated output is equal to the sum of the ten distributed generation plant outputs  
 2) The output of each plant was set randomly between 10 and 50 megawatt hours each day  
 3) MWh is megawatt hours

### 4.9 Intermittency and energy storage

One solution to managing the variability of some forms of distributed generation is energy storage. Being able to store energy in times of plenty and release it to the grid at times of high demand can help smooth peaks and troughs in energy supply and lower the costs of system balancing. As the proportion of intermittent energy generation increases in the UK’s energy mix, additional measures, such as energy storage, will be needed to maintain a safe and efficient balance between supply and demand.

There are many technical solutions to energy storage, for example: pumped hydro-electricity, hydrogen fuel cells, batteries and flywheels. Support for these energy storage technologies has been limited. According to the National Grid<sup>53</sup> there is little storage capability on the UK network, the principal capacity being approximately 2,800 megawatts of pumped hydro-electricity storage, which can store approximately 27,000 megawatt hours (2.5 per cent of daily average electricity production). Initial estimates suggest that the reserve requirement will rise from just under 4,000 megawatts at 2011 levels to 8,000 megawatts in 2025 if wind power provides 30 per cent of our electricity capacity.

52 Variability is measured throughout as relative standard deviation which is:  $100 * (\text{standard deviation} / \text{mean output})$ . In Figure 7, output is monthly output. In Figure 8, output is daily output  
 53 National Grid (June 2011), Operating the Electricity Transmission Networks in 2020

In October 2012, DECC launched two energy storage competitions, one for large scale energy storage demonstration projects and the other for research and feasibility studies into storage systems and their components. Both offer support for developing grid scale energy storage technologies. Some of these grid scale technologies may be transferable to distributed generation scale systems however, there are a number of energy storage technologies, such as flywheels, that are better suited to distributed generation that may be overlooked.

#### **Recommendation 18**

DECC should dedicate some competition funds to improve the efficiency of energy storage technologies that are more suitable for distributed renewable energy operations to complement its support for grid scale storage.

Technological development is not the only ingredient required to see energy storage play a greater role in supporting distributed generation. Regulation also needs updating to reflect the combined demand and supply services that energy storage operators can offer. Existing regulation means that operators pay charges both as a demand customer when filling storage and as a generator when releasing storage. This means that energy storage operators would currently face disproportionately high costs, discouraging investment.

#### **Recommendation 19**

DECC should update regulations to recognise energy storage as a separate category to generation, transmission, distribution and supply, with a charging regime that is proportionate.

### **4.10 Power Purchase Agreements**

Power Purchase Agreements are contracts that generators use to sell their electricity to another party, such as a supplier or an aggregator. They normally specify the quantity of power being sold, the time for delivery of that power and the price paid for it, and they often span many years of generating.

#### **4.10.1 Importance of Power Purchase Agreements**

Power Purchase Agreements are critical for the financial viability of distributed generation as they overcome a number of problems faced by independent generators which are described below.

##### **4.10.1.1 Transaction costs**

Generators that do not have large quantities of power to sell find that the transaction fees for selling power in small quantities are disproportionately expensive. This means that the net revenue they receive per unit sold is lower than for other larger generators.

Selling electricity through a Power Purchase Agreement rather than directly to the wholesale market avoids these transaction costs.

#### 4.10.1.2 Hedging

The price of electricity that generators can sell their electricity for on the wholesale market varies. Generators want to protect themselves from the risk of low market price when they come to sell their electricity. To do this, they can hedge the market by trading various contracts to buy and sell electricity. These contracts are only available for certain quantities of electricity called 'clip sizes'. Commonly traded clip sizes are often larger than those required by small generators, so distributed generation operators cannot hedge their exposure to price risk. Generating electricity therefore becomes an activity that is beyond the risk appetite of the business. Fixing a price for electricity in a fixed-price Power Purchase Agreement eliminates the generator's exposure to price risk and removes the need for hedging.

#### 4.10.1.3 Expertise

Electricity generation is not always the primary business activity for operators of distributed generation. In these circumstances, businesses can lack the dedicated expertise to actively trade in the wholesale markets. Selling electricity through a Power Purchase Agreement rather than directly to the wholesale market requires less expertise and dedicated resource.

#### 4.10.1.4 Creditworthiness

A Power Purchase Agreement gives far greater certainty over a generator's revenues and is an important contract for securing project finance at an acceptable cost. The fixed price, guaranteed off-take and specified time period set out in a Power Purchase Agreement demonstrate a generator's credit-worthiness and helps to make a project bankable.

### 4.10.2 Power Purchase Agreements and Electricity Market Reform

The introduction of Feed-in Tariffs with Contracts for Difference, as part of the Electricity Market Reform, will change the Power Purchase Agreement market. Fixed-price Power Purchase Agreements are likely to become less popular and variable-price Power Purchase Agreements more popular. This is because the Feed-in Tariffs with Contracts for Difference regime will entitle generators to receive variable top-up payments for power sold which vary in an approximately opposite manner to the prevailing wholesale market price. The combined revenues from a variable-price Power Purchase Agreement and top-up Contracts for Difference payments will create a relatively stable and predictable net income, as each revenue stream will vary in an approximately opposite manner.

Because Power Purchase Agreements are critical for distributed generation, it is important that the reform to the electricity market does not cause a hiatus in their

availability whilst the market adjusts. The Government is well placed to take action, ensuring that this does not happen and that the relevant players in the Power Purchase Agreement market are well prepared for the ensuing market reforms.

#### Recommendation 20

DECC should work with relevant parties in the Power Purchase Agreement market to ensure that the market understands and is prepared for the introduction of Contracts for Difference in mid-2014, to prevent a hiatus in the availability of Power Purchase Agreements.

Power Purchase Agreement providers are also in an important position to assist generators with Feed-in Tariff Contracts for Difference as, without support, generators may have difficulties managing extra contracts and two-way cash flows with the associated collateral.

#### Recommendation 21

DECC should work with industry to develop an agent model where Power Purchase Agreement providers are legally able to handle the Contract for Difference cash flows on behalf of generators and, alongside this, make provisions in case of the company defaulting to ensure the generator is protected.

### 4.11 Impacts on the transmission system

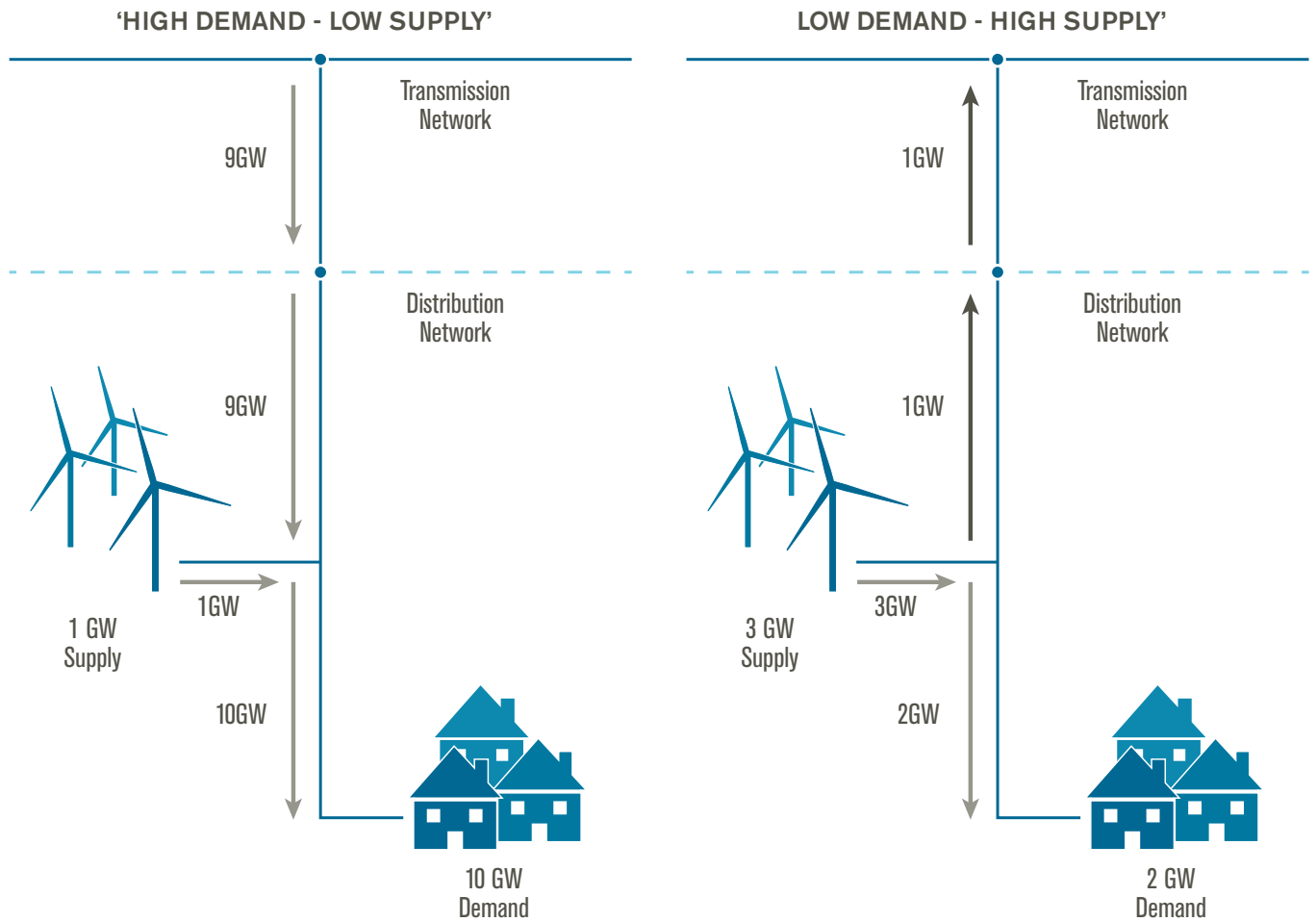
Although not currently a barrier to the deployment of distributed generation, greater levels of deployment will have significant impacts on the operation and management of the transmission system. Despite being connected at the distribution network level, 'below' the transmission network, distributed generation can have significant knock-on impacts upon flows over the transmission network (Figure 9).

As distributed generation grows significantly over the coming decade, its impact upon the transmission system will also grow. This has implications for how distributed generation should be monitored and the role it plays in balancing the system.

#### 4.11.1 System monitoring

The transmission system operator currently has limited visibility of what generating capacity is connected to distribution networks, what this capacity is generating and when. As the level of distributed generation increases over the coming decades, all parties responsible for network management will need better information of this sort to manage the heightened challenges of operating the networks effectively. Transmission System Operators and Distribution Network Operators should consider what information collection and sharing arrangement will be needed and plan their implementation.

**Figure 9: Distributed Generation impact on transmission system flows**



Notes: 1) GW is gigawatts

**4.11.2 System balancing**

As distributed generation grows, it is predicted that greater efforts could be required to balance the system. It will therefore become more important that generation embedded on the distribution network actively participates in system balancing through the balancing mechanism. Existing system balancing arrangements were largely designed with centralised fossil fuel plants in mind. These arrangements need revisiting to encourage and appropriately compensate distributed low carbon generation for participating in system balancing.

One example of sub-optimal balancing arrangements is the compensation methodology for curtailment<sup>54</sup>. Compensation for curtailment uses a methodology based upon the operating costs and revenues of fossil fuel plants which dominated the power sector when the arrangements were legislated. Using this as a basis for compensation will not be appropriate for a system with significant distributed low carbon generation, such as wind power, because of the different operating cost and revenue structures of these technologies.

#### **Recommendation 22**

Transmission System Operators and Distribution Network Operators should consider what information collection and sharing arrangements will be needed to manage the heightened balancing risks that more distributed generation could cause and plan their implementation.

#### **Recommendation 23**

DECC and Transmission System Operators should review arrangements to encourage and appropriately compensate distributed low carbon generation for participating in system balancing, and take steps to ensure that more distributed generation can economically participate in providing system balancing services.

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<sup>54</sup> Curtailment is a service provided by generators whereby they reduce their generating output in return for a fee upon instruction from the system operator. It is a service called upon by the system operator to aid system balancing

# GLOSSARY

## **Aggregator**

A business that acts as a mediator between generators and the wholesale electricity markets by purchasing electricity from a variety of sources and trading it on the wholesale electricity markets.

## **Carbon dioxide equivalent (CO<sub>2</sub>e)**

A measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential, by converting amounts of other gases to the equivalent amount of carbon dioxide.

## **Centralised energy**

Energy produced by, usually, large generating plant connected to the transmission network.

## **Climate Change Levy (CCL)**

A tax on the use of energy in industry, commerce and the public sector. Revenue raised is recycled back to business through a 0.3 per cent cut in employers' national insurance contributions, as well as through energy efficiency improvement programs.

## **Combined heat and power (CHP)**

The combined production of useable heat and power (electricity) in one single process or plant.

## **Decentralised energy**

Energy produced at or near the point of use, irrespective of size or technology used. Generating plant may or may not be connected to a wider transmission grid.

## **Distributed energy**

Energy produced by generating plant located close to the point of use.

## **Distributed generation**

Electricity generating plant that is connected to a distribution or private network rather than a transmission network.

## **Distribution network**

An electricity network that connects end-users to the higher-voltage national transmission network. There are fourteen distribution networks in the UK, carrying lower voltage supplies to individual end users.

## **Distribution Network Operator (DNO)**

A business that owns, operates and maintains a distribution network.

## **Embedded generation**

See distributed generation.

## **Energy**

In general 'energy' refers to electricity and heat together, whilst 'generation' is reserved for electricity only (also referred to as 'power'). The terms 'distributed', 'embedded' and 'decentralised' are often used interchangeably, but this inquiry uses 'distributed'.



### **Gigawatt (GW)**

A unit of power equal to one billion watts.

### **Gigawatt hour (GWh)**

A unit of energy equivalent to one billion watts expended for one hour.

### **Greenhouse gases (GHGs)**

Gases covered by the Kyoto Protocol: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF<sub>6</sub>).

### **Levy Exemption Certificates (LECs)**

Electronic certificates awarded to generators of renewable electricity. These are sold to energy suppliers who use them to prove that they have purchased enough renewable electricity to equal their sales to non-domestic users (who do not pay the Climate Change Levy for purchases of renewable energy).

### **Megawatt (MW)**

A unit of power equal to one million watts.

### **Megawatt hour (MWh)**

A unit of energy equivalent to one million watts expended for one hour.

### **Power Purchase Agreements (PPAs)**

A contract between a producer (typically a generating plant) and a purchaser of electricity.

### **Solar photovoltaic (Solar)**

A method of generating electrical power by converting solar radiation into direct electrical current, using semiconductors (usually silicon) that exhibit the photovoltaic effect.

### **System losses (transmission and distribution)**

The difference between the quantity of energy entering the network and that leaving it. Energy is lost in transmission due to resistance in cables, wires, transformers and faulty equipment.

### **Transmission network**

An electricity network which interconnects power stations and substations, typically over long distances.

# ABOUT CARBON CONNECT

Carbon Connect is the independent forum that facilitates discussion and debate between business, government and parliament to bring about a low carbon transformation underpinned by sustainable energy.

For our members we provide an events and research programme that is progressive, independent and affordable. As well as benefitting from our own independent analysis, members engage in a lively dialogue with government, parliament and other leading businesses. Together, we discuss and debate the opportunities and challenges presented by a low carbon transformation underpinned by sustainable energy.

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