Department of Energy & Climate Change

HM Government

Delivering UK Energy Investment: Low Carbon Energy

March 2015

Contents

Ministerial Foreword

When the Coalition Government took office in 2010, we faced an economic crisis. The task was clear. Reduce the deficit, get the public finances in order, and get the economy moving again. The fruits of our actions are beginning now to show with the deficit cut, more people in jobs than ever before and the fastest growing economy in the G7.

But it wasn't just the economy that was in crisis in 2010. It is fair to say we faced an energy crisis too. One of the gravest problems in energy we inherited was a record of historic underinvestment in energy infrastructure that, if neglected, threatened an energy security crisis, particularly in electricity supply. Many of Britain's old and polluting power stations were due to go off line and there was no concrete plan to replace them while at the same time meeting our climate change obligations to reduce harmful emissions.

The Coalition's answer to the twin economic and energy threats has been to go for green growth, increasing low-carbon generation as part of a diverse energy mix, increasingly using our own natural resources to keep jobs and investment in the country.

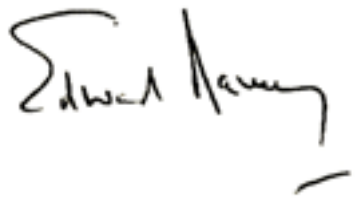
This report details how far we've come on low-carbon energy in such a short space of time. With the 2013 Energy Act, there is also now a stable long-term plan in place, supported across the political spectrum, to maintain the rapid growth we have kick-started. Electricity capacity from renewable sources has more than doubled in this Parliament. Renewable generation now provides almost a fifth

of our electricity needs, powering the equivalent of 14.5 million homes annually. And there is much more in the pipeline. We are one of the most attractive countries in the world for green growth, with almost £37bn invested in renewable energy since 2010. We lead the world in offshore wind and remain one of the world leaders in marine energy. This brings great opportunities for our businesses, for jobs, and for boosting local economies. In 2013 activity by turnover in the UK's low carbon economy was worth £122bn and supported over 460,000 jobs, and has been growing strongly.

The great thing about green energy investment and jobs is that they are not confined to London and the South East. Clean energy projects are booming in every region and country of the UK. And local communities really benefit from hosting green energy infrastructure. The onshore wind industry alone has paid out almost £8m[85] a year in community benefits on projects that have become operational since 2011. It is expected that almost £200m will be committed to local people over the life of these projects.

And it's not just renewable electricity. This paper sets out the progress we have been making in many other low-carbon areas, including low carbon electricity and low carbon heat. We have agreed key terms with the developer for the contract to build the first nuclear power station in a generation, with plans progressing for a new fleet of nuclear stations. We have launched the Renewable Heat Incentive, the world's first long-term financial support programme for renewable heat, which supports owners of renewable heat technologies in both the domestic and non-domestic sectors. On Carbon Capture and Storage the UK is a global pioneer, with our trailblazing £1bn initiative to build Europe's first commercial scale CCS plants – one for gas and one for coal. If we can cost-effectively decarbonise fossil fuel use, the benefits to the world will be beyond measure. That is why I am determined that Britain is at the forefront of green, clean energy innovation, seeking out new ways we can power our homes and businesses with reduced impact on our environment. This paper sets out our enviable record on innovation.

The lasting legacy of this Coalition Government will not be confined to rescuing the economy. We have changed Britain's energy landscape for good. The low-carbon economy that many have talked about is now within reach. There is still a long way to go, and we will need to stick to the plans we have put in place. But this Government can be proud of the clean, green energy system it has created.



Ed Davey

Executive Summary

This publication reports on progress made in low carbon energy investment in the United Kingdom. It highlights further opportunities for those interested in investing in renewable power, nuclear and carbon capture and storage, as well as renewable and low carbon heat.

It also outlines efforts taken to make low carbon technologies more efficient and commercially viable and presents live projects and the mechanisms in place to support them. For investors, the UK offers a climate of stability and confidence, and allows participation in some of the most trailblazing low-carbon projects that exist.

Turnover in the UK's low carbon economy now is valued at around £122 billion and has been growing at an average rate of over 7% per year since 2010 in nominal terms. It now supports over 460,000 jobs.[1] That is around 1.5%[2] of all UK jobs, and the number employed has been increasing at an average rate of 3.8% per annum. Low carbon jobs are spread across the country, not just focused in the South-East. We estimate that since 2010 nearly £2.7 billion has been invested in renewable electricity in the North East. In Scotland, we estimate £6 billion was invested, with the Scottish renewable electricity sector now supporting 16,000 jobs.[3]

We have put in place robust mechanisms to attract investors, stimulate jobs, innovation and new developments. The Energy Act 2013 has put in place a long-term financial structure to attract investment in low-carbon generation, reduce energy use and ensure our energy security. The new mechanisms for Electricity Market Reform are now in place as is the Capacity Market to guarantee energy security and Contracts for Difference (CFDs) to boost low-carbon energy and Electricity Demand Reduction to help reduce pressure on the grid at peak times.

The CFD allocation round, concluded in February 2015, successfully allocated 27 contracts to a range of developers. These projects could power the equivalent of 1.4 million homes and could lead to the UK emitting 4.2 million fewer tonnes of CO_2 per year. The auction has driven down the costs to consumers, resulting in the capacity we've delivered costing up to £110m per year less than it would have in the absence of competition.

The Government's ambition remains to move to a competitive price discovery process for all technologies as soon as possible. Eventually, we will have a technology neutral auction in place for all low carbon generation.

To further stimulate investment in green projects, we set up the Green Investment Bank (GIB), the first of its kind in the world. Since its inception in 2012, the GIB has backed over 40 green infrastructure projects and committed more than £2 billion to the UK's green economy.[4]

As a result of these measures, the renewable energy sector has been expanding at a remarkable pace. Renewable generating capacity has grown by 165% since 2010 and now provides 18% of our electricity needs.[5]

Over **£42 billion** invested in Renewables, Nuclear and CCS since 2010 with more to come by 2020.

DECC estimates that, between 2010-2013, £45bn was invested in electricity generation and networks. Since 2010, Bloomberg New Energy Finance figures show that an estimated £37bn was invested in renewable energy generation at an average of £7 billion a year, compared to £3 billion a year in the previous parliament. 2014 was a record year with over £8bn being invested.[6]

This report details the progress made in each low carbon technology.

Offshore Wind

- The UK remains No.1 global leader in offshore wind with over 20 fully operational offshore wind farms accounting for over 4 GW capacity.
- It is estimated that the offshore wind sector attracted £9.5 billion of investment between 2010 and 2014.
- In 2013, the sector supported 13,700 jobs – an average annual increase of 8% since 2010.[7]
- In the year to Q3 2014, offshore wind provided around 3.7% of the UK's total electricity generation. By 2020 it could account for around 7-12% of our electricity generation, powering the equivalent of around 5.2 million to 9.5 million homes.[8]
- In the year to Q3 2014, offshore wind delivered 12.7 terawatt hours (TWh) of electricity onto the UK electricity network,[9] a 25% increase on a year earlier.
- UK now hosts the world's largest offshore wind farm – London Array which can generate enough energy to power the equivalent of nearly half a million UK homes.
- Our offshore wind supply chain is also growing – Siemens, in partnership with Associated British Ports, are to build an offshore wind blade manufacturing and servicing facility in the Humber region supporting up to 1,000 jobs.[10]
- On the Isle of Wight, MHI (Mitsubishi Heavy Industries) and Vestas Offshore Wind will establish an offshore wind blade factory supporting over 200 jobs.[11]

Onshore Wind

- It is estimated that the onshore wind sector attracted £7.9 billion of investment between 2010 and 2014.
- In 2013, the sector supported 19,000 jobs – an average annual increase of 10% since 2010.[7]
- In Q3 2013, onshore wind energy accounted for the largest share of renewable electricity capacity – at 35%.[12]
- In the year to 2014, onshore wind provided around 5.5% of the UK's total electricity generation. By 2020[13] it could account for 9-10% of our electricity generation, powering the equivalent of around 7 million homes.[14]

Solar PV

- The solar PV sector recorded £11.4 billion of estimated investment between 2010 and 2014.

The UK's first CFD auctions drove down the costs of renewable electricity, saving up to **£110 million** per year.

- In 2013, the solar PV sector and its supply chain supported 34,400 jobs – an average annual increase of over 20% since 2010.[15]
- The UK has a total capacity of around 5 GW of electricity generated by around 650,000 PV installations.[16]
- In the year to Q3 2014, solar PV provided around 1.7% of the UK's total electricity generation. By 2020 it could account for around 3-5% of our electricity generation, powering the equivalent of around 2.5 million to 3.3 million homes.[17]
- In the lifetime of this Parliament alone, some 99% of the UK's current total solar PV has been installed.[18]

Marine Technologies

- It is estimated that marine energy technologies attracted £100m of investment between 2010 and 2014.
- In 2013, the marine technologies sector supported 3,100 jobs – an average 1.5% increase since 2010.[7]
- UK is ranked as the world's second most attractive place to invest in marine energy,[19] with theoretical potential for up to 27 GW of wave; 32 GW of tidal stream; 45 GW of tidal barrages; and 14 GW of tidal lagoons in the UK.[20]
- To seize these opportunities, we have put in place the most comprehensive wave and tidal stream energy support programme in the world, including protecting revenue support for 100 megawatts (MW) of wave and tidal stream projects.
- We have also started to explore the potential for a future lagoon programme.

Biomass and Bioenergy

- The sector attracted £8.8bn of estimated investment between 2010 and 2014.
- In 2013, Biomass and Bioenergy supported 31,700 jobs.[21]
- By the end of the third quarter of 2014, the UK had installed 4.4 GW of biomass capacity.[22]
- In the year to Q3 2014, biomass electricity provided around 6.1% of the UK's total electricity generation. By 2020 it could account for around 10-11% of our electricity generation, powering the equivalent of around 7.6 million to 8.1 million homes.[23]
- We anticipate supporting over 2 GW of biomass conversion capacity in the UK by 2020, greater than any other individual country in the EU.

Hydropower

- Hydropower attracted £300 million of estimated investment between 2010 and 2014.
- In 2013, the sector and its supply chain supported 7,400 jobs – an average increase of nearly 3% per annum since 2010.[20]
- More than 580 Feed in Tariff eligible hydro

installations with total capacity of 63 MW have been installed since 2010.[25]

- In the year to Q3 2014, hydroelectricity provided around 1.7% of the UK's total electricity generation. By 2020 it could account for around 2% of our electricity generation, powering the equivalent of around 1.3 million homes[26]

- Studies in Scotland, England and Wales indicate that there is potential of around 1–2.5 GW of small scale hydro power remaining to be exploited.[27]

Nuclear

- In October 2014 the European Commission approved the State Aid package for Hinkley Point C, bringing the first new nuclear power station in a generation an important step closer.[28]

- Estimated investment in nuclear power between 2010 and 2014 was £2.5 billion, and there are development plans for at least 11 nuclear reactors on five different sites.[29]

- In 2013, 59,000 people worked in the civil nuclear industry and its supply chain.[30]

Carbon Capture and Storage

- In 2013, the CCS sector and its supply chain supported 4,100 jobs across the UK.[31]

- We are working with industry to create a new cost-competitive CCS industry into the 2020s.[32] Our trailblazing £1 billion initiative, the CCS Commercialisation Programme, aims to launch the first commercial-scale plants in the UK – White Rose and Peterhead CCS projects – which could support more than 2,000 jobs and provide enough clean electricity to power the equivalent of 1 million homes.

- We have announced an additional £5 million funding for CCS research, development and innovation, which will be delivered though the Energy Entrepreneurs Fund and Innovation Fund.

Renewable and Low Carbon Heat

- In 2013, the wider renewable heat sector supported over 58,000 jobs.[33]

- We estimate that the domestic Renewable Heat Incentive (RHI) would drive around £3 billion of investment in new, renewable heating systems between now and 2020,[34] supporting up to 5,000 jobs by 2020.

- We estimate the non-domestic Renewable Heat Incentive (RHI) would drive around £9 billion of investment in new, renewable heating systems between now and 2020,[35] supporting up to 20,000 jobs by 2020.

- The UK government has invested £650,000 in a scheme to train domestic heating engineers to install and maintain renewable heating systems. This initiative improved the skills of nearly 850 installers.[36]

- Between now and 2020 we expect investment in renewable and natural gas-fuelled Combined Heat and Power (CHP) systems of around £5 billion.[37]

Estimated investment in low carbon electricity generation capacity between 2010-2014

Electricity generation technology	Estimated investment in electricity generation capacity 2010-2014 (2012 prices)
Onshore Wind*	£7.9bn
Offshore Wind	£9.5bn
Biomass and Bioenergy**	£8.8bn
Marine	£0.1bn
Solar PV***	£11.4bn
Hydro****	£0.3bn
Other Renewable*****	£1.7bn
Renewables Generation Capacity Investment	**£39.6bn**
Nuclear******	£ 2.5 bn
CCS	–
Renewables, Nuclear & CCS Generation Capacity Investment	**£42.1bn**

Source: DECC estimates based on EMR Delivery Plan and updated modelling. Investment figures are derived from capacity deployment rates, construction costs and assumptions over the length of construction and cost phasing. As such, both past and future estimated investment figures are subject to change when underlying assumptions or data are revised to reflect updated evidence:

* Including large scale onshore wind, but excluding Scottish Islands onshore wind

** Including dedicated biomass, biomass conversions, bioliquids, energy from waste, anaerobic digestion (including small scale), advanced conversion technologies, landfill and sewage gas (including CHP variations of any of these technologies)

*** Including large and small scale solar PV

**** Including large and small scale hydro technologies

***** Including Scottish Islands onshore wind, small scale onshore wind, and geothermal (including CHP)

****** 2010-2014 investment estimate includes the purchase of Horizon Nuclear Power by GE Hitachi, the purchase of the Moorside site by NuGen and expenditures in the period relating to the development of Hinkley Point C.

Energy projects account for around **60%** of the UK's infrastructure pipeline.

Introduction

In July 2014, the Government published the first ever comprehensive assessment of energy investment in the UK 'Delivering UK Energy Investment[38]'. It was a detailed look ahead at the investment challenge in the years and decades to come. In January, we published a supplementary report which took an in-depth look into investment in energy networks.[39]

This third investment report focuses on low carbon technologies in power generation and heat, including renewable energy sources. It looks at relatively mature technologies which are already being commercially deployed, those that are yet to be deployed commercially at scale in the UK, such as carbon capture and storage, and at what the Government is doing to support these and other innovative emerging technologies.

The report captures the Government's record of achievement, highlights the progress made in low carbon energy since 'Delivering UK Energy Investment' was published last year, and points to the way forward and the scale of the investment opportunity that still remains.

The need for investment in low-carbon energy

Investment in energy infrastructure is critical for the UK's energy security. In 2010, around a fifth of the UK's power-stations were earmarked for closure by the end of the decade because they were too old or too polluting. Energy projects currently account for nearly 60% of the UK's total infrastructure project pipeline, totalling nearly £275 billion.[40]

At the same time, we also need to meet our legal obligations as set out in the Climate Change Act 2008 to reduce the harmful gases that contribute to climate change. The Government announced the UK had met its first carbon budget, covering 2008–2012, with Greenhouse Gas emissions in 2012 23.6% lower than 1990 base year levels.[41] We are also now on track to meet the even more demanding reductions required to meet the second and third carbon budgets. The EU's 2030 new energy and climate package, based on the UK's proposed blueprint, commits Member States to cut domestic greenhouse gas emissions by at least 40% by 2030. This includes EU-wide targets for renewable energy and improvements in energy efficiency, both of 27%, which are non-binding on Member States.

Energy investment and decarbonisation represent a huge economic opportunity for the UK jobs market and energy investment has been a key part of the Government's strategy to boost economic growth and create jobs.

Government action

Since 2010, the Government has driven energy investment in order to meet the three objectives of energy security, economic growth, and decarbonisation.

Green Investment Bank

In 2012, the UK Government set up the Green Investment Bank, the first of its kind in the world. With an initial capitalisation of £3.8 billion, the Green Investment Bank aims to accelerate the UK's transition to a green economy by backing green projects in specific sectors in the UK, primarily offshore wind, energy efficiency, waste and bioenergy. The Green Investment Bank has supported over 40 green infrastructure projects and committed more than £2 billion to the UK's green economy into transactions worth over £7 billion.[42]

Energy Act 2013

The Energy Act 2013 represents the most radical reform of Britain's energy landscape since privatisation. The Act puts in place the long-term legal and financial framework required to create a secure, affordable and diverse energy mix, with the proportion derived from low-carbon sources increasing over time to help meet the UK's Carbon Budgets and EU targets. It has the potential to support up to 250,000 jobs[43] in low carbon electricity by 2020.

Contracts for Difference (CfDs) replace the Renewables Obligation as the primary mechanism to attract investment in low-carbon generation. CfDs are available to a wider range of low-carbon technologies than the previous system including nuclear power and carbon capture and storage. They provide investors with a stable return over the time of the contract and allow Government to progressively reduce subsidy levels over time as technology matures and costs come down.

Ahead of the first competitive auctions for Contracts for Difference, State Aid approval was granted for five offshore wind projects awarded investment contracts under the Final Investment Decision for Renewables Enabling process. Similarly, State aid approval was awarded to MGT Teeside's Renewable Energy Project – a dedicated biomass plant with Combined Heat and Power (CHP). The European Commission also approved the Hinkley Point C State aid case, an important step in moving forward in the construction of the first new nuclear power station in the UK for a generation.

In February 2015 the first Contracts for Difference, worth over £315m, were awarded under the enduring regime to renewables developers. These projects could provide enough power for the equivalent of 1.4 million homes, and could lead to the UK emitting 4.2 million fewer tonnes of CO_2 per year.

Community Energy

The proliferation of new renewable technologies mean small scale energy projects – making energy for the community, in the community – are now increasingly viable as business propositions. Large scale generation will clearly continue to play a significant role in meeting our energy needs, but our vision is of a future market no longer dominated

Between 2014 and 2020, we could need to invest up to **£100 billion** in the electricity system alone.[44]

by a small number of large energy companies and traditional business models.

The Government's first Community Energy Strategy[45] lays out the details of the role that communities can play in helping to meet energy and climate change challenges and helps put in place a framework of financial and business support. There are now over 5,000 community energy groups active in generating, managing, purchasing and reducing energy. It is estimated, that community share offers alone have raised over £35m since 2012.[46] DECC's two Community Energy Fund's worth £25m are now dispersing funds to both urban and rural based projects.

Investment

With the focus the Government has placed on renewing energy infrastructure, the UK has become an attractive global destination for low-carbon energy investment. For the third year running the UK has invested more in clean energy than any other country in Europe. The UK is rated as one of the best places in the world to invest in renewable energy. We lead the world in offshore wind and remain one of the world leaders in marine energy.[47] This has helped to drive record levels of investment. In 2014, UK's share in renewable energy investment in EU was 30%.

This bucks the trend across the rest of Europe where investment has fallen overall by 64% since 2010, compared to an increase of 42% in the UK.[48] Renewable heat consumption increased by 40% between 2010 and 2013. This is an increase in renewables' share of overall heat consumption from 1.9% to 2.8%.[49]

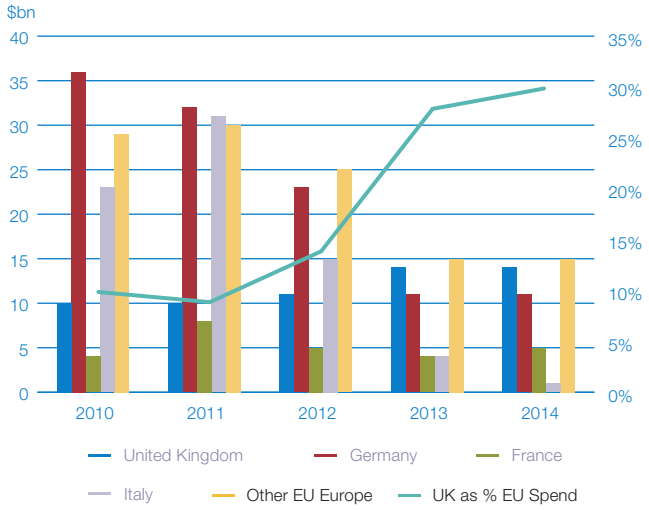
Between 2010-2013, DECC estimates that £45bn was invested in electricity generation and networks. While for the period 2010-2014, Bloomberg New Energy Finance estimates £37bn invested in renewable energy generation, more than double the amount invested in the previous parliament. 2014 was a record year with over £8bn being invested.

As a whole, turnover in the UK's low carbon economy now is valued at around £122 billion and has been growing at an average rate of over 7% per year in nominal terms. It now supports over 460,000 jobs.[50] That is around 1.5%[51] of all UK jobs, and the number employed has been increasing at an average rate of 3.8% per annum.

Low carbon jobs are spread across the country, not just focused in the South-East. We estimate that since 2010 £2.7 billion has been invested in renewable electricity in the North East. In Scotland, we estimate £6 billion was invested, with the Scottish renewable electricity sector now supporting nearly 16,000 jobs.[52]

We estimate future investment in renewable electricity generation capacity between 2015 and 2020 of up to £45bn, rising to up to £60bn including Nuclear and CCS. The reforms now in place as part of the Energy Act 2013 are designed to continue the success we have enjoyed since 2010, and meet investment requirements.

EU renewable energy investment with UK as % of EU spend



Source: Bloomberg New Energy Finance[14]

New-build renewable energy finance (New investment excluding R&D)

$m	2014	% change on 2013	
China	80,232	33%	↑
United States	34,912	8%	↑
Japan	34,250	11%	↑
United Kingdom	13,887	3%	↑
Germany	11,351	4%	↑
Canada	8,014	35%	↑
Africa (exc. N Africa)	7,216	22%	↑
India	7,144	13%	↑
Brazil	6,851	109%	↑
Middle East & North Africa	5,351	108%	↑

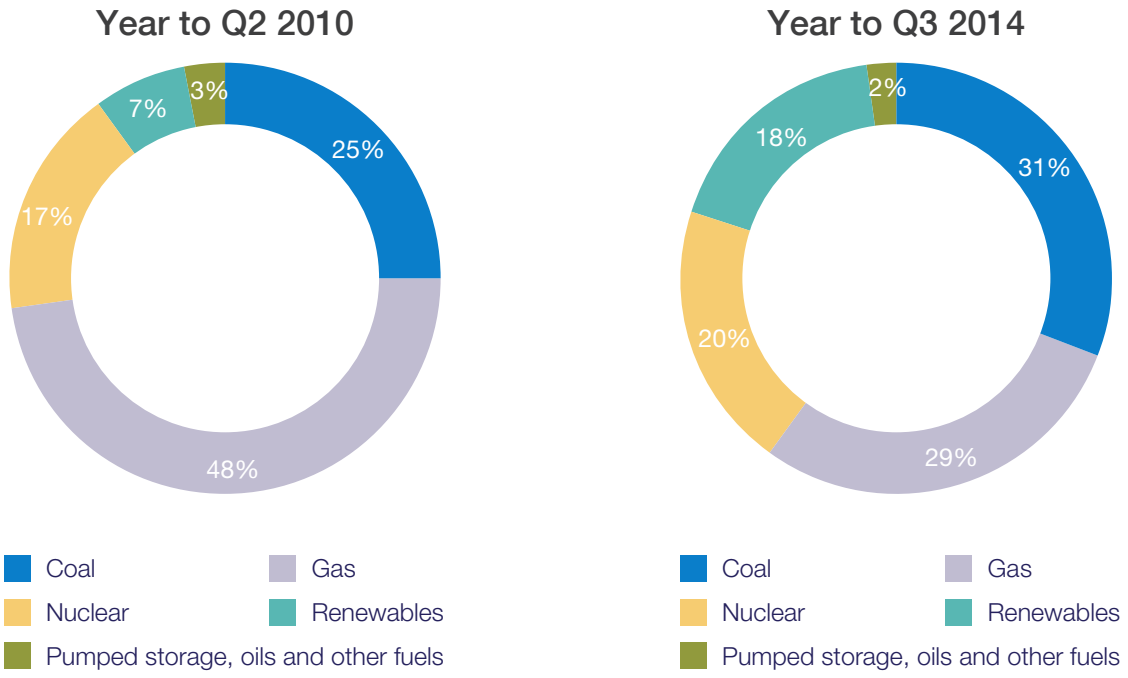
Source: Bloomberg New Energy Finance[53]

This level of investment is having a profound effect on the UK's energy mix.

In the year to 2014 Q3, we generated 129 TWh of low carbon electricity, 43% more than in the year to 2010 Q2.[54] In the same period, the UK generated 61.4 terawatt hours of renewable electricity, representing an increase in the share of renewable electricity in overall generation from 6.4% in the year to 2010 Q2 to more than 18% in the year to 2014 Q3. Renewables' highest quarterly share was 19.5% in 2014 Q1.

The figure on page 15 shows how the UK's generation mix has been de-carbonised between the year to Q2 2010 and the year to Q3 2014, with the share of low carbon electricity in total generation increasing from 24% to 38%.

UK electricity generation mix



Source: Energy Trends, December 2014

Cost Reduction

Affordability is key to decarbonisation. The Levy Control Framework (LCF) enables the Government to control the costs of supporting low carbon electricity paid for through consumers' energy bills and reflects the importance Government places both on delivering low carbon electricity generation, and keeping consumer bills affordable. The LCF sets annual limits on the projected costs of all DECC's low carbon electricity levy-funded schemes until 2020/21. The annual cap rises to £7.6 billion (in 2011/12 prices) in 2020/21, a level which will enable us to cost-effectively meet our low carbon and renewables ambitions.

The cost of many forms of renewable energy is dropping. Subsidies for new large-scale onshore wind projects were reduced by 10% in 2013, reflecting evidence of falling costs. On offshore wind, the recent Cost Reduction Monitoring Framework report shows costs of electricity generated falling by over 10% in the last 2 years. In the first CfD auction in Feb 2015, offshore wind contracts were awarded

In the year to Q3 2014, we generated 129 TWh of low carbon electricity, 43% more than in the year to Q2 2010[55]

at up to 18% below the published strike price. Bloomberg New Energy Finance estimates the costs of Solar PV have been cut in half since 2010.

The Contracts for Difference system sees support rates continuing to fall to the next decade and beyond, delivering increasing value for money for consumers.

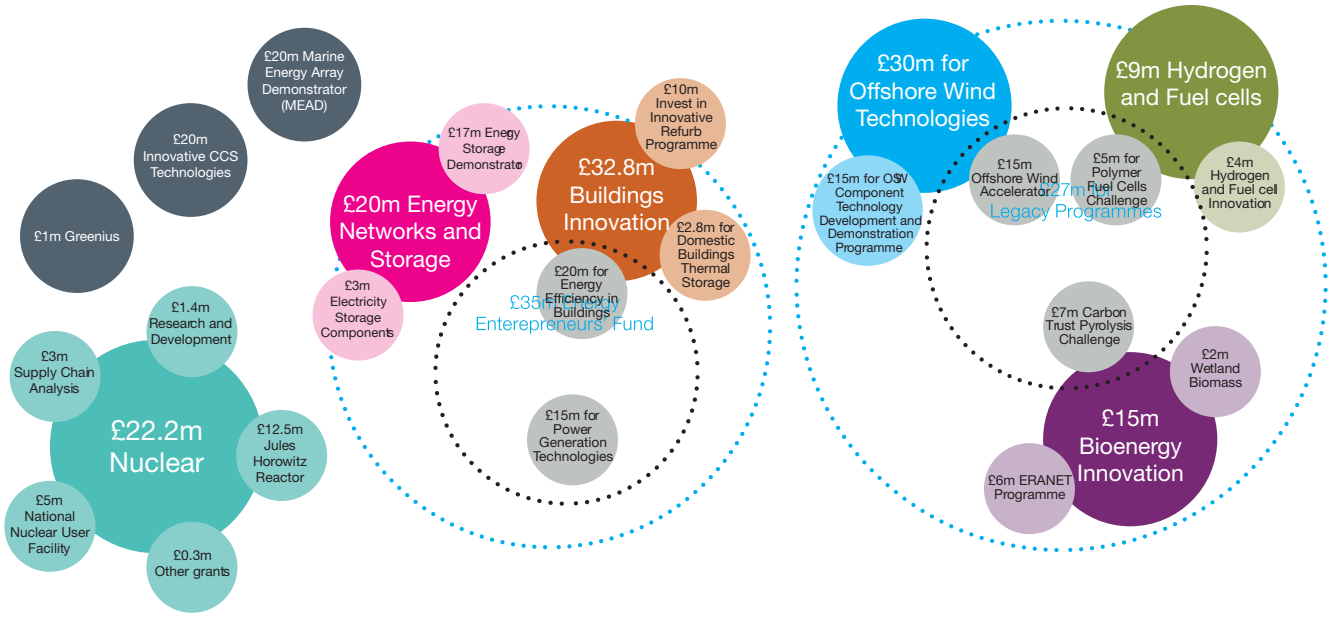
Drive to innovate

Innovation is vital if we are to develop the technologies that will underpin our transition to a low carbon economy, and make it affordable and deliverable.

DECC's innovation programme of up to £185 million will have enabled around 200 companies to develop low carbon technologies from 2011–2015. These have focused on reducing the cost of energy generation and improving energy efficiency in our homes and workplaces to meet greenhouse gas reduction targets.

This complements wider support for innovative low carbon technologies, worth over £1 billion, led by other public-backed agencies, including the Research Councils UK[56] as well as opportunities at the European level from Horizon 2020; the largest ever European Union Research and Innovation fund with almost €6 billion of funding available for energy projects up to 2020.

DECC's allocated spend of up to £185m on low carbon energy technologies for 2011 to 2015



Jobs and Investment in Low Carbon Energy

Low Carbon Energy Employment in 2013

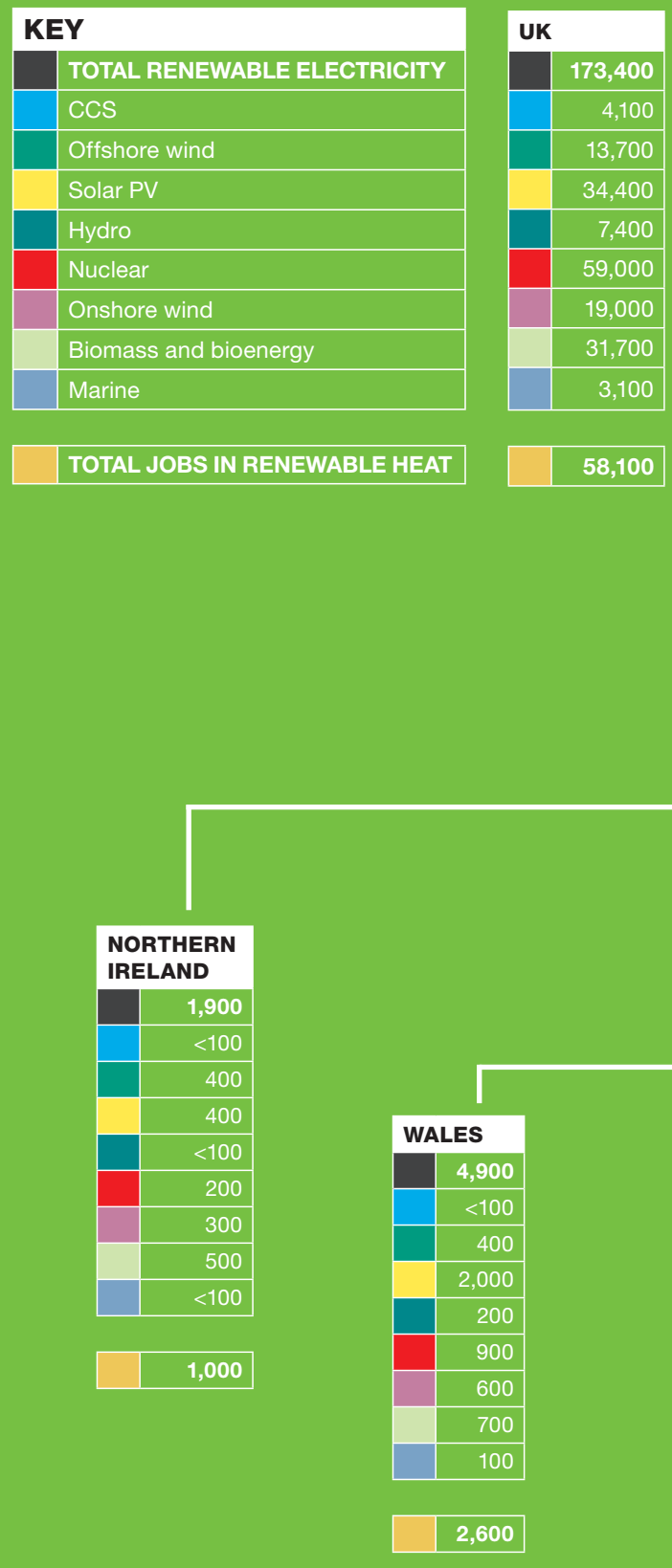
- Across the UK the low-carbon electricity sector supports over 170,000 jobs directly and in the supply chain[1]. Many of these are highly skilled and well paid.

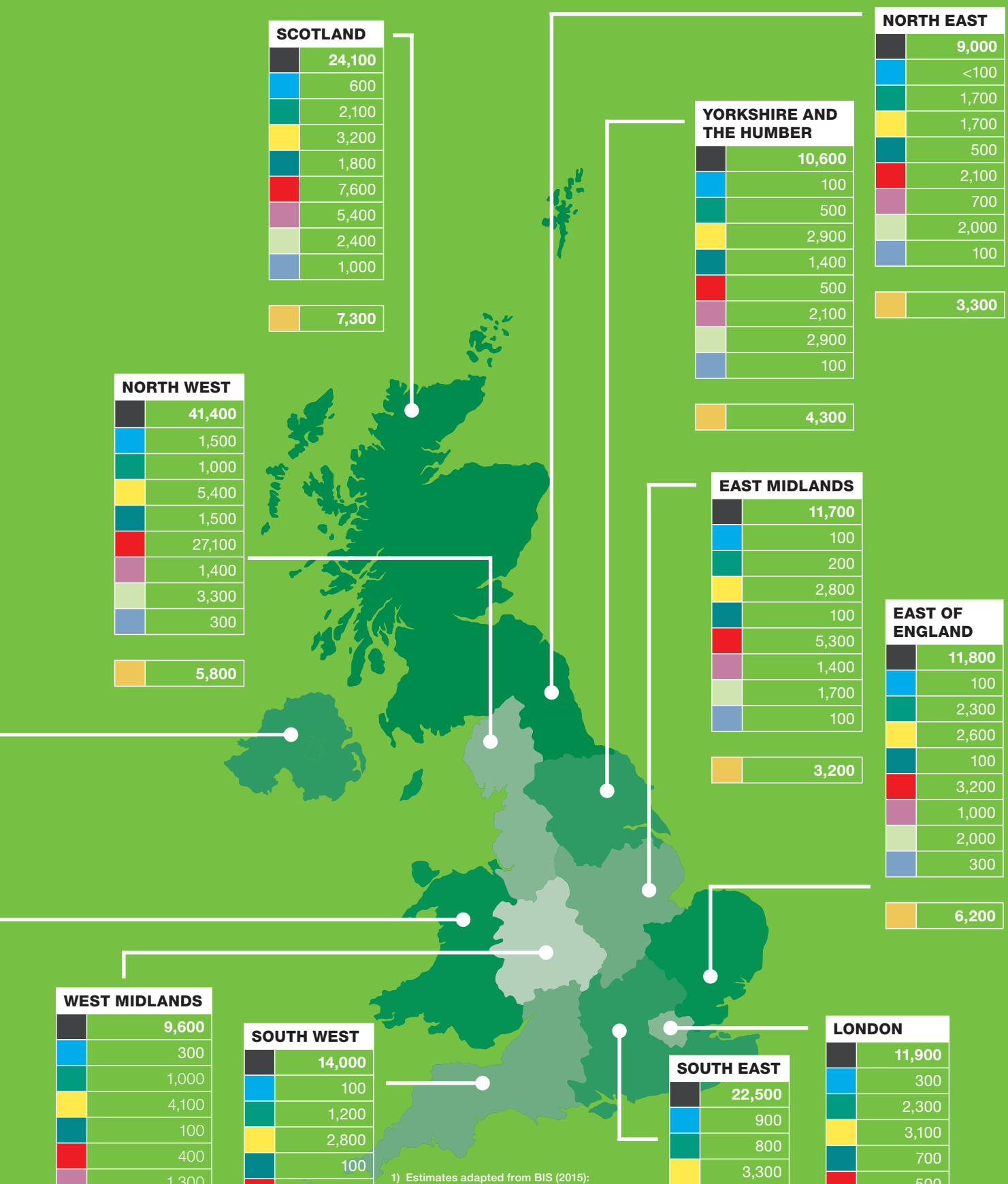
- Top 3 regions for low-carbon electricity jobs:
  - North West: 41,400
  - Scotland: 24,100
  - South East: 22,500

- Top 3 technologies for low-carbon electricity jobs:
  - Nuclear: 59,000
  - Solar PV: 34,400
  - Biomass and bioenergy: 31,700

- Women are generally under-represented in the energy sector and the low carbon sector is no different. For example, around 28% of employees in the Scottish renewables sector are women[2] and women only account for 9% of board appointments in the wider energy sector[3].

- The Government is taking steps to address this disparity – for instance, we are encouraging women to study STEM subjects and have recently worked with the sector to launch the POWERful Women network.





SCOTLAND	
	24,100
	600
	2,100
	3,200
	1,800
	7,600
	5,400
	2,400
	1,000
	7,300

NORTH EAST	
	9,000
	<100
	1,700
	1,700
	500
	2,100
	700
	2,000
	100
	3,300

YORKSHIRE AND THE HUMBER	
	10,600
	100
	500
	2,900
	1,400
	500
	2,100
	2,900
	100
	4,300

NORTH WEST	
	41,400
	1,500
	1,000
	5,400
	1,500
	27,100
	1,400
	3,300
	300
	5,800

EAST MIDLANDS	
	11,700
	100
	200
	2,800
	100
	5,300
	1,400
	1,700
	100
	3,200

EAST OF ENGLAND	
	11,800
	100
	2,300
	2,600
	100
	3,200
	1,000
	2,000
	300
	6,200

WEST MIDLANDS	
	9,600
	300
	1,000
	4,100
	100
	400
	1,300
	2,200
	100
	5,500

SOUTH WEST	
	14,000
	100
	1,200
	2,800
	100
	6,100
	1,200
	2,200
	200
	4,800

SOUTH EAST	
	22,500
	900
	800
	3,300
	900
	5,200
	2,500
	8,200
	700
	9,800

LONDON	
	11,900
	300
	2,300
	3,100
	700
	500
	1,100
	3,700
	100
	4,500

1) Estimates adapted from BIS (2015): The Size and Performance of the UK Low Carbon Economy (www.gov.uk/government/publications/low-carbon-economy-size-and-performance); and REA (2014) REview

2) Estimates are for employees in 2013 and include those employed in the supply chain, and are rounded to nearest 100.

3) Estimates for biomass and bioenergy include activity relating to the manufacture of equipment, fuels, and generation of electricity from biomass, waste, and anaerobic digestion

4) Estimates for renewable heat include heat from waste, biomass, geothermal, heat pumps and solar thermal, and also includes production of alternative fuels, heat networks and heat recovery and ventilation.

5) Figures may not sum due to rounding.

CASE STUDY

Stephanie and Lynsay Kelly: Sellafield Ltd

Stephanie and Lynsay Kelly are both employed at Sellafield Ltd and have won separate work-related awards. Stephanie was crowned 'Apprentice of the Year' at the Golden Apple Awards, while Lynsay won the prize for 'best technician' from the Nuclear Institute for outstanding performance in her role as a control systems engineer.

CASE STUDY

Rachael – Trainee Engineering Technician, E.ON Technology GmbH

Rachael joined E.ON from the British Army – she worked in the Royal Electrical Mechanical Engineers and in telecommunications. After leaving in 2013, she was keen to get back into engineering.

"I already had some knowledge but I really wanted to learn more," she explains. "This traineeship seemed like the perfect opportunity. What's great about it is we've been doing a different thing each week."

One of the big draws for Rachael was the chance to gain qualifications.

"After I've completed the two-year scheme and got my NVQ, I can do an HNC and apply for a permanent role. The opportunities for progression are there."

Rachael says this is an environment where all sorts of people can thrive.

"It's not all about getting your hands dirty – there's a lot of maths and scientific thinking to be done too. In my experience, women are every bit as good at engineering as men!"

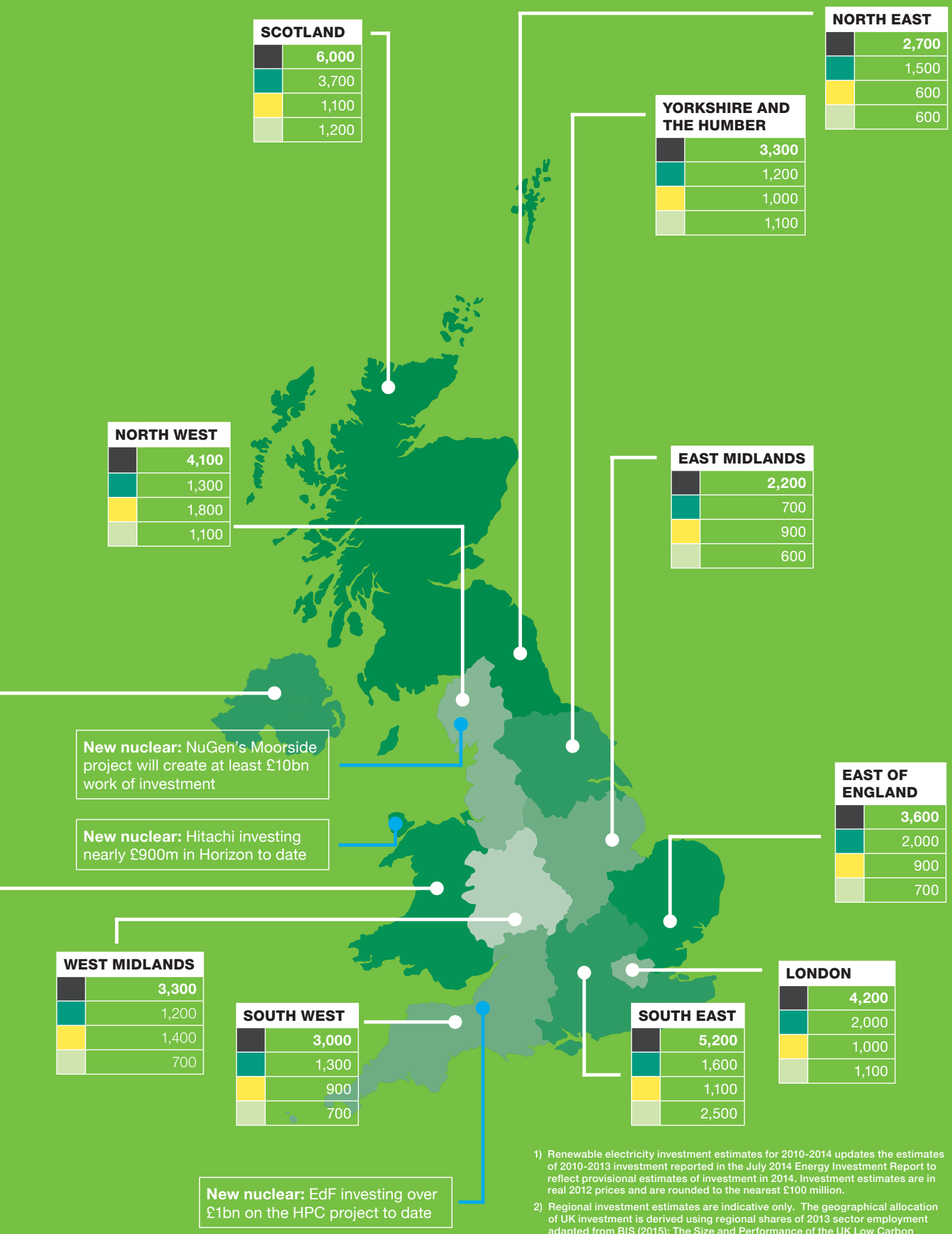
Estimated investment in renewable electricity technologies and new nuclear 2010-2014

KEY	
	TOTAL RENEWABLE ELECTRICITY
	Wind
	Solar PV
	Other renewables

UK	
	39,600
	17,400
	11,400
	10,800

NORTHERN IRELAND	
	700
	400
	100
	200

WALES	
	1,400
	500
	700
	200



1) Renewable electricity investment estimates for 2010-2014 updates the estimates of 2010-2013 investment reported in the July 2014 Energy Investment Report to reflect provisional estimates of investment in 2014. Investment estimates are in real 2012 prices and are rounded to the nearest £100 million.
2) Regional investment estimates are indicative only. The geographical allocation of UK investment is derived using regional shares of 2013 sector employment adapted from BIS (2015): The Size and Performance of the UK Low Carbon Economy; and REA (2014) REview.
3) Nuclear electricity investment estimates for 2010-2014 are based on expenditures in the period by NuGen related to their Moorside site, on the purchase and development of Horizon Nuclear Power with sites at Wylfa and Oldbury, and expenditures on the Hinkley Point C project.
4) Figures may not sum due to rounding.

Energy Supply

Offshore Wind

KEY FACTS: OFFSHORE WIND[57]	
Estimated Investment 2010-2014 (£2012)	£9.5 billion
Employment Level 2013	13,700
Installed Capacity at end of Q3 2014 (GW)	4.4
Pipeline Data (GW)	1.1 under construction 10.2 awaiting construction 7.6 submitted
2020 Deployment Range (GW)	8-15

The UK has more offshore wind than any other country. It is estimated that the offshore wind sector attracted **£9.5 billion** of investment between 2010 and 2014.

Building on our strengths

Government is committed to the growth of the UK offshore wind sector as part of a cost-effective, secure, low carbon energy mix and our decision to proceed with a major expansion of offshore wind is based on a strategy of investing early in emerging low carbon technologies where the UK has real potential.

The UK market is the world's largest and is consistently rated as the most attractive place to invest in offshore wind.[58] The UK now has over 4 GW of installed capacity with another 1 GW under construction. In 2014, the offshore wind sector delivered 13.4 TWh of electricity into the national grid,[59] an 18% increase on 2013.

Investors from countries including South Korea, Canada and Norway, among many others, have chosen to invest in this island's vast natural resource.

But the success of this renewable energy technology is also testament to consistent Government support through policies that provide a stable market framework to attract investment, a competitive supply chain and a strong tradition of working in partnership with industry.

It is no surprise then that the world's largest offshore wind farm is located here. The London Array consists of 175 turbines that can generate enough energy to power the equivalent of nearly half a million UK homes and reduce CO_2 emissions by more than 650,000 tonnes a year.[60] This is equivalent to emissions savings from around 400,000 fewer cars being driven in 2013.[61] At the peak of construction, over 75 organisations were involved and up to 1,000 people were working on site.[62]

But this is not a one-off. The UK now has over 20 fully operational offshore wind farms with many more at various stages of development, such as Westermost Rough, 8 km off the Yorkshire Coast. The project will see the first commercial deployment of Siemens' 6 MW turbine. Its lower weight and efficiency is helping to bring down the cost of offshore wind energy production. To date, the vast majority of offshore wind turbines has been in the 3.0 to 3.6 MW range.

"Making the most of Britain's home grown energy is creating jobs and businesses in the UK, getting the best deal for consumers and reducing our reliance on foreign imports. Wind power is vital to this plan, with **£14.5 billion**[63] invested since 2010 into an industry which supports over **30,000 jobs.**"

Energy and Climate Change Secretary Ed Davey on the announcement of the go-ahead for Dogger Bank Creyke Beck A and B wind project

The project also marks the first time that the UK Government-owned Green Investment Bank (GIB) – whose purpose is to accelerate the UK's transition to a greener economy – has invested in offshore wind farm construction.

The Government has provided strong and consistent support to the sector in order for it to flourish and grow. Firstly, this support has been provided through the Renewables Obligation and in future through Contracts for Difference, a key plank of our Electricity Market Reform programme. In February 2015, we announced the results of the first round of allocation for financial support under the Contracts for Difference regime, which included plans to support two new offshore wind farms with total combined capacity of over 1.1 GW, expected to be delivered between 2017 - 2019.[64]

In order to ensure that investment levels were maintained during the transition to the new regime, the Government also provided support through the Final Investment Decision (FID) Enabling for Renewables scheme to eight projects, out of which five were for offshore wind energy. Just over two months after being awarded, Statoil and Statkraft announced their decision to start building the 402 MW Dudgeon Offshore wind farm.

Later, in December 2014, DONG Energy announced their decision to build the offshore wind farm Burbo Bank Extension in Liverpool Bay. A 32-turbine strong site, the farm will provide enough power to meet the electricity demands of around 200,000 homes.

Significant support under this Government for expansion of offshore wind has had considerable follow-on benefits for the UK economy through the growth of the supply chain in this country. For example, Siemens, the largest engineering company in Europe, is to invest £310 million with its partner Associated British Ports to build an offshore wind blade manufacturing and servicing facility in the Yorkshire and Humber region. And on the Isle of Wight, joint venture company MHI (Mitsubishi Heavy Industries) Vestas Offshore Wind will establish an offshore wind blade factory, resulting in £200 million of positive economic impact and supporting over 200 jobs.[65]

There are some great examples of export success too. JDR Cables based at Hartlepool Port has secured their third order for inter-array cables into German offshore wind farms, the most recent one being the Vattenfall AB Sandbank project, announced in September 2014. The company has now won more than £100 million of orders.

In January 2015, Offshore Structure Ltd was recruiting for 70 new employees to make monopiles for offshore wind in Teesside.

This growth of the supply chain in the UK not only brings jobs and investment, but moving the manufacture of parts and the provision of services closer to the infrastructure that is being built also reduces the cost of offshore wind electricity generation, delivering more for Government investment in the industry and reducing the cost of support for energy bill-payers in the medium to long term.

The opportunity on offer

In November 2014, the co-Chairs of the Offshore Wind Industry Council asked Managing Director of Siemens' UK and North West Europe, Matthew Chinn to consider what more industry and government could do to support the development of the UK's offshore wind supply chain.

The resulting review – 'UK Offshore Wind Supply Chain: A Review of Opportunities and Barriers' found that:

- the offshore wind supply chain in the UK has been successful particularly in the areas of operation and maintenance, array cables and substation manufacture

- there are big opportunities on offer in these sectors and significant scope to now move into the towers, foundations and export cable markets.

The report also makes 24 recommendations to the Offshore Wind Industry Council which are currently being taken forward by the relevant government departments and members of the Council.

Since then, there have been further successes for the UK's green growth, including the announcement in February 2015 that a new offshore wind farm Dogger Bank Creyke Beck A and B received planning permission. This project will consist of up to 400 wind turbines, around 130km off the coast of the East Riding of Yorkshire. With a maximum capacity of 2400 MW it will generate enough electricity to power the equivalent of almost 2 million homes and supporting 900 jobs in Yorkshire and Humberside once built.[67]

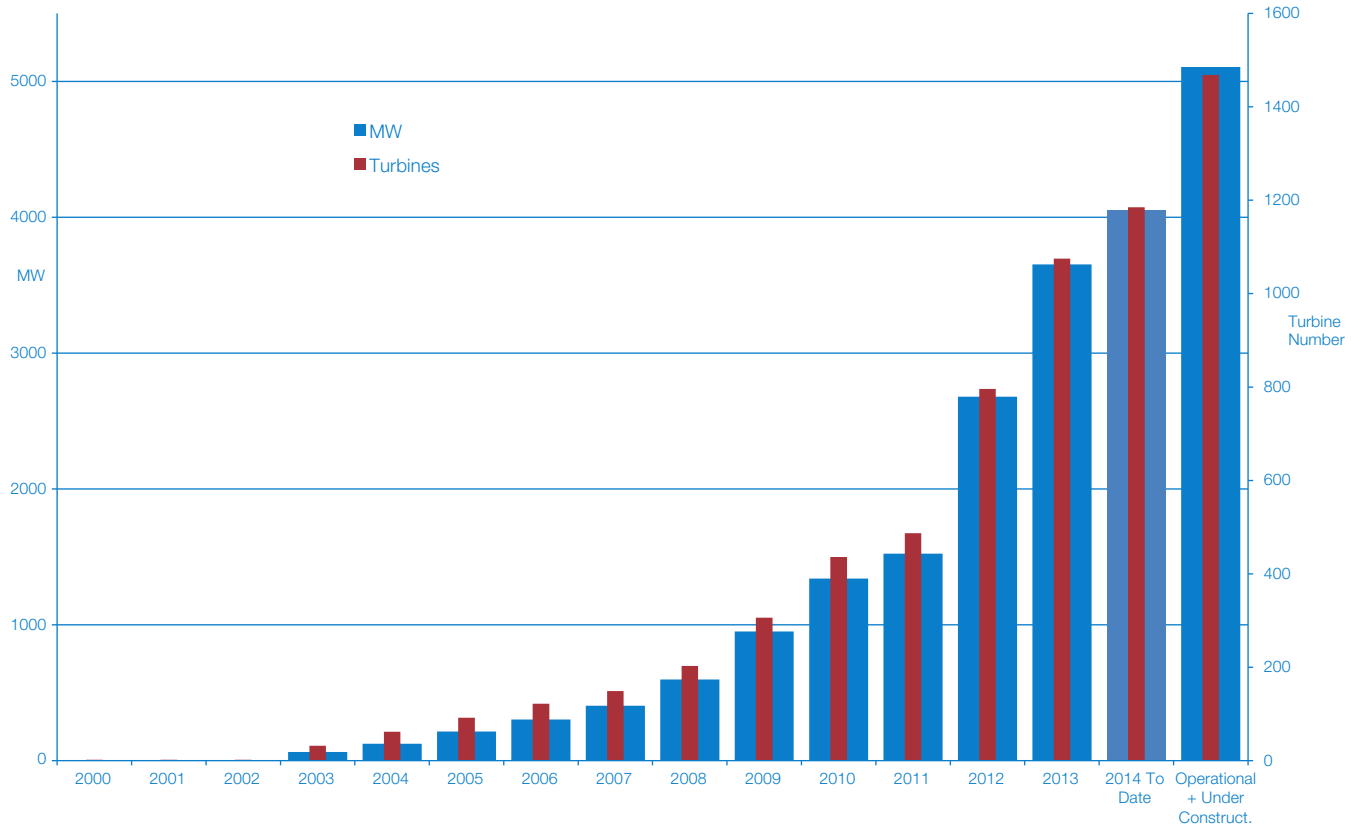
More broadly, investment in the sector has been bolstered by the UK Government's Green Investment Bank plans to launch a £1 billion offshore fund which will kick start further developments.[68]

> The cost of offshore wind projects is already falling and we expect this to continue as the sector matures.

The Cost Reduction Monitoring Framework[69] was established in order to provide a consistent way to measure the cost of offshore wind projects in the UK. The report shows that levelised costs have fallen faster than anticipated, from £136/MWh for built projects in 2010/11 to £121/MWh for projects taking FID in 2012-2014 with the main driver being the move to larger, more efficient turbines.

The results of the first CfD auction on 26 February 2015 also confirm that costs are falling, with the clearing prices over 14% lower than the administrative strike price of £140/MWh. We are offering contracts to Neart na Gaoithe, a 448 MW site in the outer Forth estuary which cleared at £114.39/MWh and the 714 MW East Anglia One project which cleared at £119.89/MWh.[70]

Figure 6: Offshore wind deployment over time.



Source: Energy Trends

CASE STUDY 1

Siemens and Associated British Ports (ABP)

The announced construction of a blade manufacturing, assembly and servicing facilities at Alexandra Dock in the Yorkshire and Humber region will be a boon to the UK's offshore wind industry and local communities.

Set to support around 1,000 jobs in one of the most deprived regions in England, both during construction and in the supply chain, the project has already secured its first customer for the facility, Dudgeon Offshore Wind Farm.

With its partner, Associated British Ports, Siemens is to invest £310 million in the project to deliver world-class products and facilities.[71]

Computer generated image of Siemens and ABP Green Port Hull development
Image courtesy of Siemens

CASE STUDY 2

Scottish Power: West of Duddon Sands offshore wind farm

Scottish Power's West of Duddon Sands wind farm[72] officially opened in October 2014. The Farm is located approximately 20 km off the coast of Barrow-in-Furness in North West England and consists of 108 turbines. Each turbine has a capacity of 3.6 MW and the wind farm will generate enough electricity to meet the annual electricity demands of around 280,000 homes. The project has employed more than 1,000 people.

One of the biggest benefits to the project has been the new £50 million offshore wind terminal at Belfast Harbour. The terminal is the first purpose-built offshore wind installation and pre-assembly harbour in the UK and Ireland and supports up to 300 jobs, ranging from welders to electricians and engineers. The size and scale of the harbour has allowed for continual delivery of turbine components, and round-the-clock operations.

The electricity generated initially connects in to a specially designed offshore substation. The voltage from the turbines is increased and two export cables then take the electricity ashore to the onshore substation at Heysham, where the wind farm is connected to the UK national grid.

The Operations and Maintenance base for the wind farm is a newly constructed facility in Barrow, which will support more than 40 highly-skilled jobs for at least the next 20 years.

Construction of West of Duddon Sands offshore wind farm
Image courtesy of Scottish Power Renewables

Onshore Wind

KEY FACTS: ONSHORE WIND[73]	
Estimated Investment 2010-2014 (£2012)	£7.9 billion
Employment Level 2013	19,000
Installed Capacity at end of Q3 2014 (GW)	8.1
Pipeline Data (GW)	1.3 under construction 5.2 awaiting construction 5.7 submitted
2020 Deployment Range (GW)	11-13

Around **5%** of the UK's electricity comes from onshore wind, by 2020 this could double to about **10%.**[74]

Building on our strengths

As one of the most established and cost-effective renewable technologies, onshore wind has grown rapidly in the UK, accounting for the largest share of renewable electricity capacity (35%) at the end of 2014 quarter three.[75]

The UK has one of the strongest wind resources in Europe and thanks to a stable investment framework, developers are building onshore wind farms across the country.

Onshore wind farms in the UK already harness enough of this free, natural resource to provide the equivalent of 4 million homes today with electricity. By 2020, they could provide enough power for the equivalent of between 6.7 million and 8.1 million homes.[76]

The achievements are already impressive. But there is also a healthy pipeline of projects in the UK - planned, built and financed by large utility companies and, increasingly, independent developers from the UK and abroad.

Secondary investment by financial investors plays a key role in recycling developer capital, allowing them to move on to new projects. For example, EDF Energy Renewables recently sold a majority stake in three of its UK onshore wind farms to China Nuclear Power Corporation.

EDF Energy Renewables intends to use the money released by the sale to make further investment in UK renewable projects.[77]

Projects now under construction will have a cumulative installed capacity of 1.3 GW and projects awaiting construction could provide 5.2 GW of cumulative installed capacity.[78]

The strength of the onshore wind pipeline gives us confidence that this sector will be able to make its expected contribution of 11-13 GW of installed capacity towards our legally binding 2020 renewable energy target.[79]

The UK has consistently been ranked among the top ten most attractive countries to invest in onshore wind energy.[80]

Supporting local communities

Communities who host onshore wind farms are contributing to a national need for clean energy. It is only right that this contribution should be recognised and we have taken a number of steps since 2010 to ensure that communities see a real benefit. We are pleased to see that the concept is now well embedded in the system.

For instance in 2011, industry, backed by government, introduced a commitment to provide benefit funds for local communities hosting wind farms in England. Similar commitments were made in Scotland, Wales and Northern Ireland in 2013.[81]

We have also launched, with non-profit trade association Renewable UK and Regen SW, an online Register of Community Benefits and Engagement for English onshore wind developments.[82]

This lets wind farm operators, fund administrators and communities upload their wind farm data showing location as well as the amount of benefits received and what they are achieving with them – a valuable resource for the whole country. It also helps other communities to negotiate the best benefit packages.

We have also convened a Shared Ownership Taskforce, including representation from project developers, trade bodies, community energy groups, to agree a Framework for how to increase the offer of shared ownership to communities. The Taskforce launched their Framework at the end of last year. This provides a guide for both developers and communities on the offer of shared ownership. The Government published its response to the Taskforce Framework in February 2015, setting out how Government will support the implementation of the Framework.[83] Our shared ownership 'taskforce', made up of members from industry and communities, is taking measures to increase adoption of shared ownership of new, commercial onshore renewables developments.[84]

In October 2014, to improve transparency and communication between developers, communities and local authorities,[85] we published best practice guidance on community benefits and community engagement for onshore wind developers in England.

In November 2014, the UK Green Investment Bank (GIB) expanded its investment remit to include community-scale renewables, including wind projects, with the launch of a £200 million lending programme to address funding gaps in the markets.[86]

In 2013, the sector supported **19,000 jobs** – an average annual increase of **10%** since 2010.

Courtesy of SSE

Delivering the benefits

The impact of these benefits can be seen across the UK. Since April 2011, industry estimates that funding worth at least £7.7 million annually has been committed by onshore wind projects which have become operational in this time (ie: 135 projects).[87] £192.5 million is expected to be paid to local communities over the lifetime of these projects.[88]

Communities agree with developers how to use the funds. Some renewable energy generators are even offering cheaper bills directly to customers who live in the proximity of their wind farms. RES intends to offer £200 a year off bills for the next 25 years for 500 residents near its proposed Culachy wind farm in Scotland.[89] In other parts of the country, developers are providing funds to support community institutions.

A good example is the Middlemoor wind farm in Northumberland, which has provided funds for roof repairs in the Eglingham Village Hall and learning resources, equipment and outdoor protective clothing for Little Acorns pre-school.[90]

The largest wind farm in Scotland, Whitelee has already provided almost £2 million for local community projects.[91] England's largest wind farm in Keadby, Lincolnshire, will provide £8.5 million to the local community over the next 25 years.[92] Pen y Cymoedd, the largest wind farm in Wales, will provide a £1.8 million a year fund for local communities.[93]

The opportunity on offer

As one of the most well-established and cost-effective renewable technologies, onshore wind has grown rapidly in the UK, helped by a stable investment framework, significant cost reductions and a healthy pipeline of projects.

Onshore wind provided nearly 5% of the UK's total electricity generation in 2013[94] and could account for 10% of our electricity generation in 2020.[95]

The cost of onshore wind has been coming down, which has been reflected in the reduction of support levels required to bring forward projects.[96] The cost of electricity generated by onshore wind is projected to decrease. According to our figures, the UK levelised costs for onshore wind technologies above 5 MW are projected to decrease by around 13% between 2014 and 2020.[97]

Industry are working to bring down cost further and they are confident that by 2020 onshore wind will be the cheapest form of new electricity generation.[98]

Our recent auction for Contracts for Difference highlights continued cost reduction in the onshore wind sector. 27 contracts were offered in total following the auction, with 15 offered to onshore wind projects. Together these projects total almost 750MW, and are expected to be delivered between 2016 - 2019.

Successful developers include a number of smaller and independent generators as well as larger developers. Contracts were offered at or below £82.50 per MW hour – far less than we've paid in the past, showing the value of competition for driving value for money for consumers.[99] Levels of support under Contracts for Difference will decrease in the years ahead to take account of expected cost reduction from the wind sector.

CASE STUDY

SSE

The largest wind farm in England at Keadby, West of Scunthorpe in North Lincolnshire, has 34 turbines with a total installed capacity of 68MW – enough to power the equivalent of around 40,000 homes annually.[100] The project is now fully operational and started exporting power to the grid at the end of 2014.

SSE Keadby Wind Farm Community Fund provides around £170,000 per year to local community projects that show a clear community benefit and 'leave a legacy'.

Ed Davey with SSEs Paul Smith and Sam Cunningham at the official opening of Keadby wind farm
Courtesy of SSE

CASE STUDY

Project RM

The government's Aviation Plan[100] was set up to facilitate dialogue between the aviation and renewables industries to find solutions to the impact of turbines on Air Traffic Control radars. One of the workstreams identified was an upgrade to air traffic control service NATS' En-Route radars called Project RM.

The rollout of Project RM was realised in February 2014 when Vattenfall and SSE signed an agreement with NATS to fund the £12million upgrade programme on the two principal impacted radars. This allowed the release of aviation planning conditions for Ray Wind Farm and Blackcraig Wind farm.

Project RM also acts as an enabler for other developers to use the mitigation on a fair and equitable cost share basis. It is expected that the current infrastructure upgrade could release over 2GW of wind energy.

Lowther Hill Radar Station
Image courtesy of Vattefall

- UK installed capacity 2010-14: 7,303 MW
- Capacity by technology 2010-14:
  - Wind offshore: 2,306 MW
  - Wind onshore: 2,400 MW
  - Solar Photovoltaics: 270 MW
  - EFW incineration: 791 MW
  - Biomass (dedicated): 1,536 MW
- Top 3 projects by capacity:
  - Drax Biomass Power Station Units 2 and 3: 1,290 MW
  - Greater Gabbard Wind Farm: 504 MW
  - West of Duddon Sands Wind Farm: 389 MW

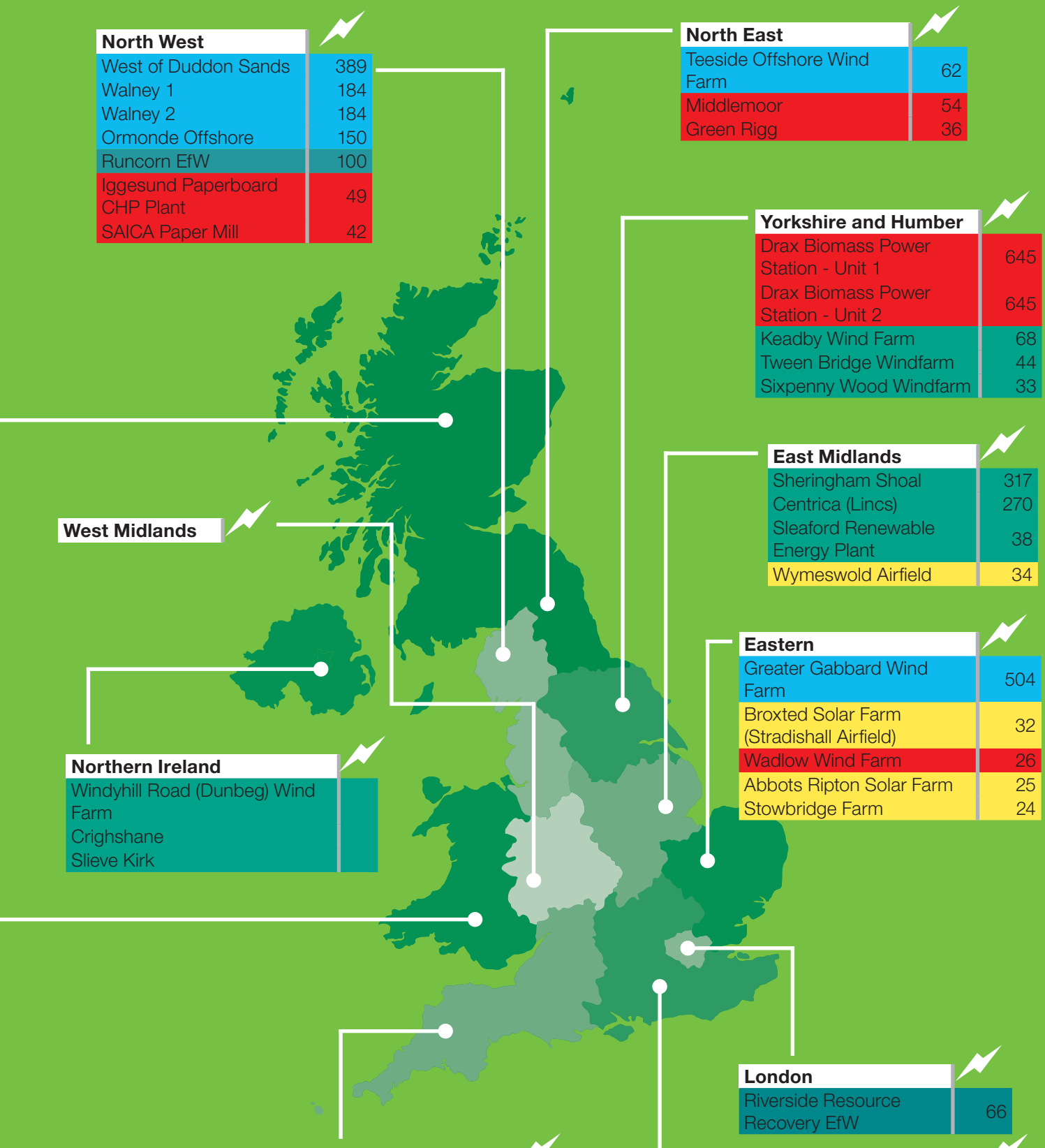
KEY
WIND OFFSHORE
WIND ONSHORE
SOLAR PHOTOVOLTAICS
EFW INCINERATION
BIOMASS (DEDICATED)

INSTALLED CAPACITY (MWelec)

Scotland	
Clyde Wind Farm	350
Griffin Wind farm	156
Fallago Rig	144
Crystal Rig Wind Farm Phase 2a	138
Harestanes	136
Arecleoch Windfarm	120
Whitelee Windfarm Extension phase 2	109
Whitelee Windfarm Extension Phase 1	108
Robin Rigg East	90
Gordonbush	70
Berry Burn	67
Tullis Russell Paper Mill	65
Mid Hill I	58
Mark Hill	56
Baillie Wind Farm	53
Lochluichart	51
Camster	50
Carraig Gheal	46
Beinn an Tuirc Phase 2	44
Fairburn	43
Hill of Towie (Drummuir)	42
Edinbane Wind Farm	41
Rothes Wind Farm (Extension)	41
Achany Wind Farm	38
Novar Wind Farm (Extension)	37
Calliachar	32
West Browncastle	30
Drone Hill	29
Kelburn	28

Wales	
Gwynt y Mor	374
Mynydd y Betws	38
Fenton Home Farm	31
Maesgwyn	26
Pant y wal	25

Map of renewable projects commissioned since 2010 (>20 MW)



North West	
West of Duddon Sands	389
Walney 1	184
Walney 2	184
Ormonde Offshore	150
Runcorn EfW	100
Iggesund Paperboard CHP Plant	49
SAICA Paper Mill	42

North East	
Teeside Offshore Wind Farm	62
Middlemoor	54
Green Rigg	36

Yorkshire and Humber	
Drax Biomass Power Station - Unit 1	645
Drax Biomass Power Station - Unit 2	645
Keadby Wind Farm	68
Tween Bridge Windfarm	44
Sixpenny Wood Windfarm	33

East Midlands	
Sheringham Shoal	317
Centrica (Lincs)	270
Sleaford Renewable Energy Plant	38
Wymeswold Airfield	34

West Midlands

Eastern	
Greater Gabbard Wind Farm	504
Broxted Solar Farm (Stradishall Airfield)	32
Wadlow Wind Farm	26
Abbots Ripton Solar Farm	25
Stowbridge Farm	24

Northern Ireland	
Windyhill Road (Dunbeg) Wind Farm	
Crighshane	
Slieve Kirk	

London	
Riverside Resource Recovery EfW	66

South West	
Fullabrook Down Wind Farm	66
Canworthy Water	41

South East	
Thanet	300
Landmead Farm (East Hanney)	46
Kencot Hill Solar Farm (revised application)	37

Sources: Renewable Energy Planning Database, January 2015 and DECC's survey of Major Power Producers

The chart shows the cumulative development of all offshore wind since 2000 in terms of MW installed and turbine numbers (inclusive of the demonstration sites) and the capacity of developments currently in construction and to become operational in the near future.

Solar photovoltaics (PV)

KEY FACTS: SOLAR PV[101]	
Estimated Investment 2010-2014 (£2012)	£11.4 billion
Employment Level 2013	34,400
Installed Capacity at end of Q3 2014 (GW)	5.0
Pipeline Data (GW)	0.9 under construction 3.2 awaiting construction 1.4 submitted
2020 Deployment Range (GW)	12-14

Kingsgate House in London Building -Integrated PV
Image courtesy of Romag

£11.4 billion of estimated investment in the Solar PV sector between 2010 and 2014.

Building on our strengths

Solar PV is a success story in this country. The cost of solar PV installations continues to fall, which is reflected in the number of installations across the country. Deployment of solar PV in February 2010 was 33 MW. Currently, the UK has a total capacity of around 5 gigawatts (GW) of electricity generated by around 650,000 installations.[102] The statistics speak for themselves. In the lifetime of this Parliament alone, some 99% of the UK's total solar PV has been installed.

We recently reached 2.8 GW of small scale solar PV deployed across more than 630.000 installations in the UK. Slightly more than 2,000 domestic homes have solar PV installed per week.[103]

Solar is a UK success story. The Electricity Market Reform (EMR) Delivery Plan anticipated 10-12 GW of capacity by 2020. This has since been revised upwards, reflecting higher than expected deployment of large scale solar under the Renewables Obligation (RO), and we now anticipate reaching 12-14GW of solar by 2020.[104]

We see smaller-scale renewable and low carbon energy generation as a vital part for the UK's energy mix. Deployment of solar PV remains one of our priority renewable energy technologies and, consequently, deployment has been rapid over the last four years, in part driven by a large drop in technology costs globally.

'The cost of electricity generation by Solar PV is projected to decrease. According to published figures, the levelised costs for large scale solar PV technologies are projected to decrease by around 28% between 2014 and 2020.[105]

We continue to roll out and develop our plans for solar PV energy. Last year, we published the first ever UK Solar PV Strategy, to set out the steps that UK government is taking to support the sector by removing non-financial barriers, and the actions we will take in collaboration with the domestic and commercial sectors to maintain success.

We have recently made some policy changes to support deployment of solar PV on commercial and industrial scale buildings. And we are leading by example. The Cabinet Office is undertaking a programme to promote the installation of solar panels across the Government's estate. The programme focuses on installing appropriate Solar PV on rooftops and other sites that will remain in government long term use. The programme is exploring possible sites (including rooftop, car park and ground mount) and supporting development through standardising long-term leases. This is being done in conjunction with the Government Property Unit. The intention of this work is to generate a significant reduction in energy bills for the host departments.

The plan is to install an initial 500MW of Solar PV generation. The process of identifying sites has already resulted in several pilot projects being identified. Given the significant extent of the Government's estate, the initial 500MW is just the tip of the iceberg.

The UK has 5GW of solar PV capacity, with almost **99%** of the capacity built under this Government.[107]

And in the private sector, Marks and Spencer has recently installed the UK's largest single roof-mounted solar panel array at its East Midlands distribution centre, at 6.1 MW. The system will generate over 5,000 MWh of electricity annually and make the distribution centre almost self-sufficient during the day.

The opportunity on offer

Our Solar PV Strategy focuses on realising our aims through innovation, partnership, job creation and increased investment in the UK, as well as a reduction in harmful emissions.

We support the deployment of solar PV at all scales and see the future of the solar PV industry in the UK centred around three markets:

- small-scale building-mounted PV panels, typically on housing, small commercial premises and community buildings
- PV panels mounted on commercial and industrial buildings, larger public and community buildings
- large scale industrial ground-mounted solar farms, as long as they are well sited and sensitively developed, preferably on previously-used land.

Solar power is not just a means to provide affordable, clean energy. It is also a powerful way to stimulate economic growth through small to medium-sized enterprises (SMEs) and job creation. In 2013, it is estimated that the industry supported around 34,400 jobs.[108] Given the increased rate of deployment however, it is likely to have continued to grow since then.

In February 2015, following the first allocation of Contracts for Difference funding, we announced that five new large-scale solar projects have been successful, with total combined capacity estimated to be over 70 MW and expected to be delivered between 2015 – 2017.[109]

Where any barriers to progress exist, Government continues to take steps to overcome them and to open up access to further investment opportunities to encourage deployment at all scales, for example:

- we have improved the Feed-In Tariff (FIT) scheme to ensure that ground-mounted solar PV deployment does not trigger a drop in tariffs in the building-mounted sector. This will provide an incentive for greater amounts of building-mounted solar
- Department for Communities and Local Government issued a public consultation on increasing the development threshold to allow solar installations as large as 1 MW to progress without the need for planning permission
- we have consulted on options to allow transfer of installations between buildings without loss of Feed-In Tariff allowing building owners and users to benefit from a more flexible approach to solar PV deployment on buildings. This will also provide greater certainty for investors who may be concerned about the risk to their ability to redevelop

- we continue to work with a wide range of interested parties about building- or rooftop-mounted solar PV to simplify the process and to provide assurance to landowners and leaseholders
- we are working with industry to find ways to reduce costs and encourage building-integrated solar PV to provide additional jobs and investment in the UK.

CASE STUDY

Swansea University, Tata Steel, BASF and NSG Pilkington

The objective of the SPECIFIC research centre at Baglan Energy Park in Wales is to create a new generation of products for building-integrated PV (BIPV) to enable the generation, storage, release and conservation of energy.

The centre is developing ways in which buildings themselves can act as 'power stations', through the use of a special lightweight photovoltaic (PV) coating for steel and glass building materials which harnesses solar energy to produce electricity.

SPECIFIC, formed in 2011, is led by a consortium of business and academic partners with a commitment of £20 million funding over five years.[110]

Image courtesy of CSER

Castle Donington
Image courtesy of M&S

Marine technologies

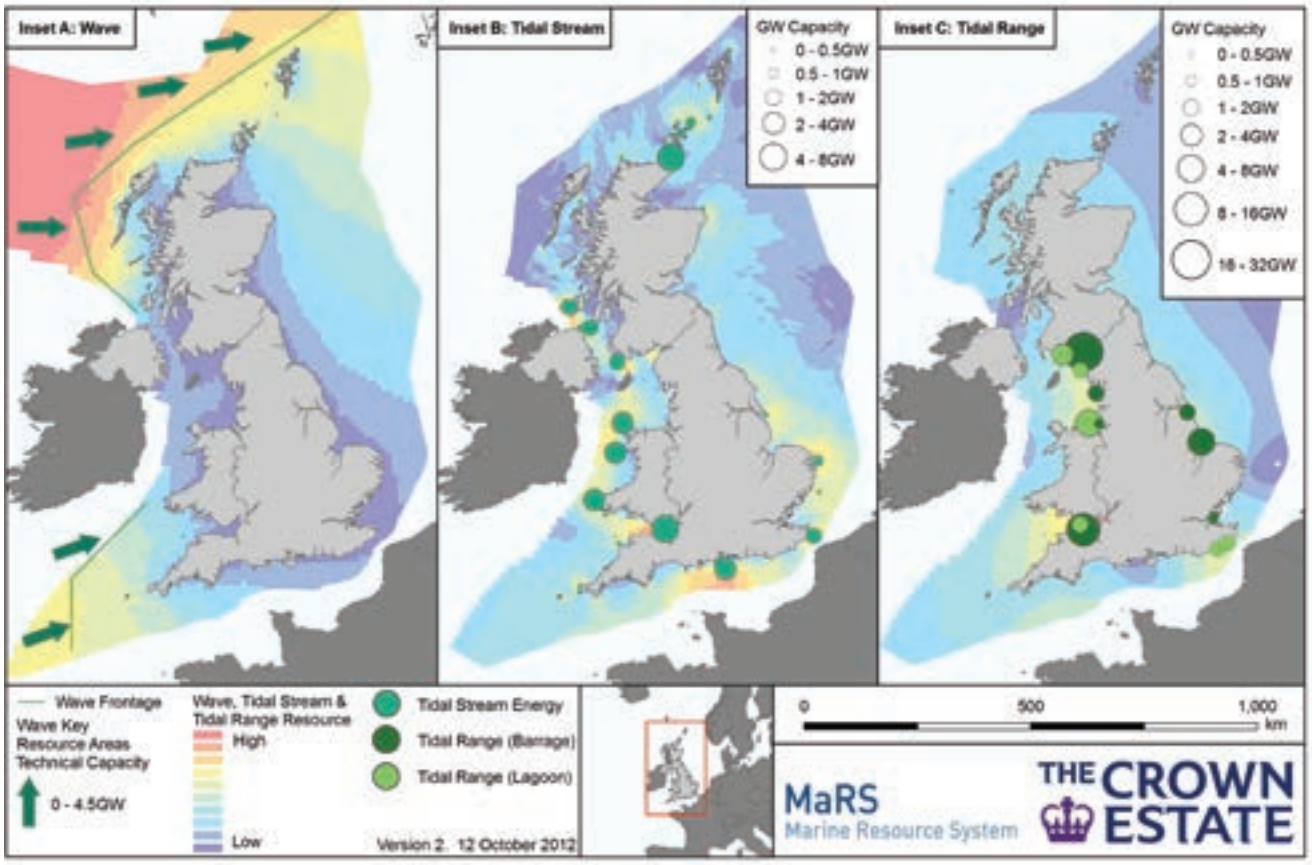
KEY FACTS: Marine[111]	
Estimated Investment 2010-2014 (£2012)	£0.1 billion
Employment Level 2013	3,100
Installed Capacity at end of Q3 2014 (GW)	Less than 0.1
Pipeline Data (GW)	0.0 under construction 0.1 awaiting construction 0.3 submitted
2020 Deployment Range (GW)	c 0.1

The UK is one of the best places to invest in marine renewables.[2] It is estimated that marine energy technologies attracted **£100 million** of investment between 2010 and 2014.

With a unique geography, the UK is exposed to the force of the Atlantic's waves, has access to some of Europe's fastest tidal currents and is home to the second highest tidal range in the world.[112]

Today, the UK is ranked one of the world's most attractive places to invest in marine energy,[113] with arguably the strongest policy framework of support anywhere in the world.[114]

Figure 7: UK Wave, Tidal Stream and Tidal Range Resource



Source: The Crown Estate

It is no surprise then that the UK has long been seen as a global focal point for the development and deployment of all forms of marine energy.

There are numerous sites around the UK where wave and tidal stream devices could be deployed. Similarly, tidal range projects such as lagoons or barrages, could potentially be deployed, particularly around the UK's Western coastline. And while these sources remain largely untapped, marine energy still represents a significant opportunity if they are exploited cost effectively.

The term 'marine energy' comprises three very different technologies, each of which exploits a different resource, is at a different stage of development and presents different challenges and opportunities:

- Tidal Range (lagoons and barrages)
- Wave
- Tidal Stream

Tidal range (barrages and lagoons)

Building on our strengths

The power available from the regular rise and fall of the tides has long been recognised as a valuable energy resource. Tide mills first appeared in Roman times when waterwheels driven by small impounded lakes were used to mill grain.

The UK has one of the richest tidal range resources in the world.

The Severn Estuary for example, which has the second largest tidal range in the world along with other potential sites around the coastline, means that the UK is well placed to benefit from this energy source in the twenty-first century, through construction of tidal lagoons and barrages.[115]

These plants operate in a manner akin to large hydro-power dams as the level of the tide rises and falls.

To date, only a few tidal barrages have been built worldwide, most notably in France, Korea, Russia and Canada. No tidal lagoons have been built to date anywhere in the world.

In the UK, no tidal range installations have been built so far, but potential developers are beginning to consider the scope for deploying these around the UK coastline. The Crown Estate estimates the theoretical potential for up to 45 GW of tidal barrages and 14 GW of tidal lagoons in the UK.[116]

The Government believes that there is significant potential for the deployment of tidal lagoons in the UK. Lagoon technology could theoretically contribute up to 25TWh/year, the equivalent of 8% of the UK's electricity consumption in 2013, of indigenous, predictable and low carbon electricity

Energy and Climate Change Secretary Ed Davey in Budget 2015

The opportunity on offer

Although the Government's 2010 Severn Tidal Power study determined that it did not see the strategic case for Government bringing forward a Severn Tidal power scheme, the Government remains open to considering well developed, privately financed schemes.

Following renewed interest in tidal range in the UK from developers, and particularly tidal lagoons, the Government announced that DECC would explore the potential for a future tidal lagoon programme in the UK.

In Budget 2015 the Government announced that it has decided to enter into the first phase of negotiations on a Contract for Difference (CfD) for Swansea Bay Tidal Lagoon (without prejudice to the planning decision on the project). DECC also published a government response to the Swansea Bay CFD stakeholder engagement document which highlights the rationale for its approach to potential CFD mechanisms for the Swansea Bay Tidal Lagoon project and future lagoon industry.

There are many possible UK sites which could potentially be exploited and Government is aware of a number of projects which are being considered by developers, both in the Severn Estuary area and elsewhere.

CASE STUDY

Swansea Bay Tidal Lagoon

The best-developed project presented to Government to date is for a 320 MW tidal lagoon in Swansea Bay being developed by Tidal Lagoon Power Ltd. The lagoon is anticipated to generate around 0.5 terawatt hours (TWh) of electricity annually. This first-of-a-kind tidal lagoon in Swansea Bay could establish a scalable blueprint for future, larger projects.

The project submitted its application to the Planning Inspectorate (PINS) in February 2014 and a decision on planning is anticipated during 2015. As announced in the 2015 Budget, the Government has now entered into the first phase of negotiations on a Contract for Difference (CFD) for Swansea Bay Tidal Lagoon (without prejudice to the planning decision on the project) to determine whether the project is affordable and value for money for consumers, and whether it will drive down costs for tidal lagoon power in the UK.

Wave and Tidal Stream

Building on our strengths

Wave energy devices extract the energy within the waves which move across the surface of the ocean. This encompasses a diverse range of technology, approaches and devices.

Tidal stream energy meanwhile extract the energy created when the movement of the tides creates fast flows of water around headlands and between land masses (such as between islands).

The Crown Estate has leased the seabed for up to 1.8 GW of wave and tidal stream deployment in Scotland and Northern Ireland in the world's first commercial wave and tidal stream leasing rounds.

This has helped to lay the foundations for MeyGen, potentially the first pre-commercial scale array in the world (see case study on p56) when it begins deployment in 2016.

A 300 MW tidal stream project is planned in the Alderney Race in the Channel Islands, while further wave and tidal stream deployment is being explored around the coast of Northern Ireland, Shetland (Scotland) and Pembrokeshire (Wales).

The tidal stream sector is at the pre-commercialisation stage. For example, tidal stream turbine designs have largely coalesced around horizontal-axis turbines mounted on the sea-bed. A number of promising designs have been extensively tested at full scale in the sea.

A number of turbine designs are ready to test in array formation and the sector is now developing the first small demonstration arrays with a view towards beginning deployment of commercial scale tidal stream farms towards the end of the decade.

The wave sector is at an earlier stage, with a number of promising devices under development. For example, the sector is today developing promising prototype devices which, in the coming years should move to the demonstration stage, deployed in small arrays before being deployed on commercial wave farms.

So the challenge now is to provide sufficient confidence to attract the investment required to develop both individual devices and array projects further.

The opportunity on offer

Wave and tidal stream energy could have a massive impact on both carbon reduction targets and on the economy.

Developing the potential of wave and tidal stream resources could also help the UK achieve its ambitious low carbon energy objectives.

While both the wave and tidal stream industries are still in relatively early stages of development, the UK is seen as a global focal point for the development and early deployment of these technologies for a number of reasons.

Primarily, the UK has an excellent marine resource. Scottish waters offer the majority of the UK's wave resources but there are also numerous potential sites across the UK.

This country also has the world's most comprehensive policy, testing and support infrastructure in place. We support the creation of a wave and tidal stream testing infrastructure in the UK through the work that goes on at three test centres which each provide a range of facilities including onshore component testing and two in-sea testing of devices and arrays. They are:

- The European Marine Energy Centre (EMEC) in Orkney, the world's first marine energy test facility, established in 2003
- The National Renewable Energy Centre (NAREC) in Northumberland
- Wave Hub in Cornwall.

We bolster ongoing innovation through several organisations, co-ordinated across Government and devolved administrations by the Low Carbon Innovation Co-ordination Group (the co-ordination vehicle for the UK's major public sector backed funding and delivery bodies in the area of low carbon innovation) for example:

- The Research Councils
- Innovate UK
- The Energy Technologies Institute
- The Offshore Renewable Energy Catapult.

There is regular engagement between DECC ministers and industry through the Marine Energy Programme Board (MEPB) and we have made financial support available for demonstration and early commercial array deployment as follows:

- the Marine Energy Array Demonstrator (MEAD) fund offered grants for pre-commercial array projects[117] (see case study)
- we have ring-fenced up to 100 MW-worth of revenue support under the Renewables Obligation and Contracts for Difference (CfDs) initiatives for wave and tidal stream up to 2019[118].
- we have revised the Technology and Innovation Needs Assessment (TINA)[119] on wave and tidal stream energy to inform future policy and allow Government to target funding most effectively[120].

Wave and tidal stream energy has great potential to meet this country's energy needs. Up to 100 MW of generation capacity may be able to be deployed by 2020, and by around 6.5-13 GW in medium and high scenarios.[121]

CASE STUDY

MeyGen

The MeyGen project, based in the Pentland Firth's Inner Sound, will be the world's first full scale tidal array. The 6 MW demonstration array begins development in 2016 and will be the first stage of a larger project to deploy a range of turbines with Atlantis Resources and Andritz Hydro devices. Investment for the project was confirmed in summer 2014 with a funding package comprising equity, debt and grants, including a £10 million grant from the Marine Energy Array Demonstrator (MEAD) fund.

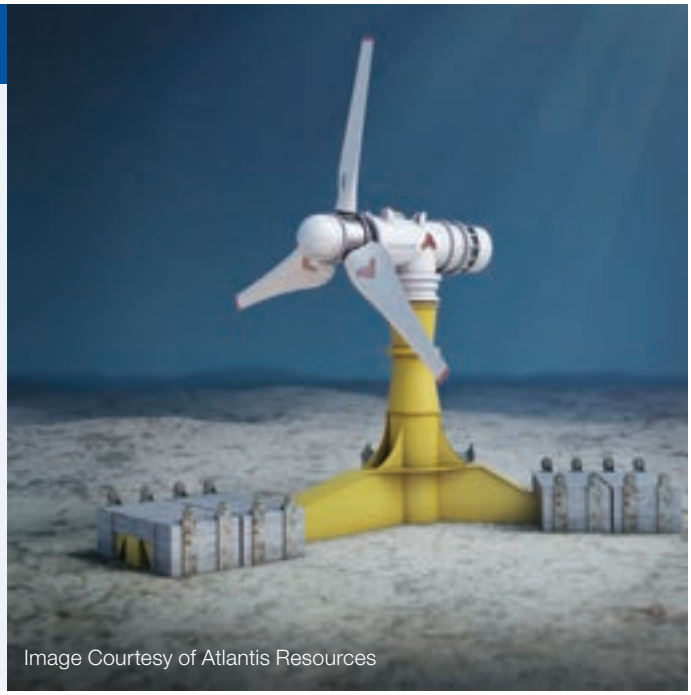


Image Courtesy of Atlantis Resources

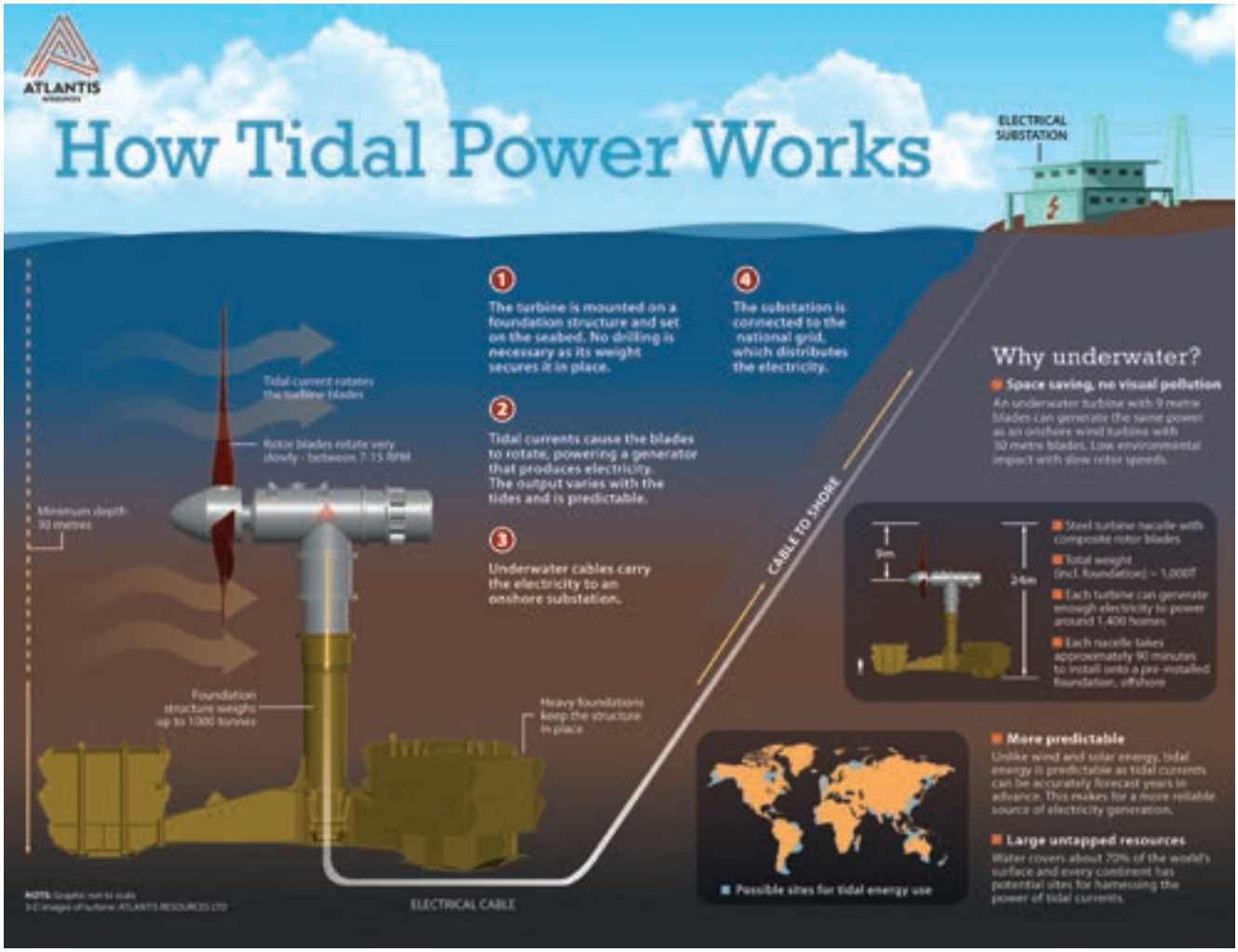


Image Courtesy of Atlantis Resources

Biomass and bioenergy

KEY FACTS: BIOMASS AND BIOENERGY [122]	
Estimated Investment 2010-2014 (£2012)	£8.8 billion
Employment Level 2013	31,700
Installed Capacity at end of Q3 2014 (GW)	4.4
Pipeline Data (GW)	0.7 under construction 0.1 awaiting construction 3.8 submitted
2020 Deployment Range (GW)	Advanced Conversion Technologies (with or without Combined Heat and Power) – c0.2-0.3 Large Scale Anaerobic Digestion (with or without Combined Heat and Power) – c0.3-0.4 Biomass Conversions – c1.7-3.4 Dedicated Biomass with over 2GW Combined Heat and Power – c0.3-0.6 Energy from Waste with Combined Heat and Power – c0.4 Landfill Gas – c0.9 Sewage Gas – c0.2 Other Biomass – c1.4-1.5

The Biomass and Bioenergy electricity sector attracted **£8.8 billion** of estimated investment between 2010 and 2014.

Building on our strengths

We estimate that between 2010 and 2014, biomass and bioenergy electricity technologies attracted £8.8 billion of investment. In the second quarter of 2014, the UK had achieved 4.4 GW of installed capacity.

Solid biomass is plant or animal material of recent biological origin which can be used to produce heat and/or electricity. Dry biomass (e.g. wood or straw) can be combusted to produce heat for use locally or to drive a steam turbine to generate electricity.

Wet biomass (for example food waste or manure) can be anaerobically digested to produce methane, which can then be combusted for heat or power generation or further refined and injected into the gas grid.

The 2012 Bioenergy[123] Strategy has guided the extent to which the Government has supported heat and power from biomass. The Bioenergy Strategy identifies higher and lower risk sustainable biomass deployment pathways that can help contribute towards our 2020 renewable energy objectives, and to our longer term decarbonisation targets. Biomass technologies include:

- Conversions of coal power stations to burn biomass instead of coal ("biomass conversions") or as well as coal ("co-firing")
- New build dedicated biomass power stations, with or without Combined Heat and Power ("CHP")
- Energy from waste power stations, with or without CHP
- Anaerobic Digestion (AD) plants, sewage gas plants and landfill gas plants
- Advanced conversion technologies (ACT) such as gasification and pyrolysis plants

We have taken a cautious approach and controlled support for the biomass electricity-only technologies (conversions, co-firing, and dedicated biomass (see below)). We continue to support biomass for heat, biomass CHP and energy from waste technologies, as they encourage the efficient use of resources.

By the third quarter of 2014, the UK had **4.4 GW** of installed biomass electricity capacity[124]

Biomass conversion

Biomass conversions are a quick, cost-effective transitional means of decarbonising the electricity grid by replacing coal used in existing UK power plants.

Biomass conversions are already an important part of the UK's energy mix and very much a renewables success story: we anticipate supporting over 2 GW capacity in the UK by 2020, greater than any other individual country in the EU.

The 1 GW of capacity of the biomass conversion projects which were awarded an investment contract under the FID Enabling for Renewables process is securing the future of existing capacity and managing the transition to low carbon technology. Investment contracts have been signed for up to 1.4GW of biomass (two conversion projects at Drax (Yorkshire) and Lynemouth (Northumberland) and biomass CHP project with MGT (Teeside). DECC expects these plants to deliver around 8TWh of generation in 2020.[125]

The opportunity on offer

Our focus is on providing support for biomass conversions through the Contracts for Difference (CfD) process rather than through the Renewables Obligation. A strike price has been set for this technology, enabling it to take part in the competitive allocation process. We are aiming to announce the budget for the second CFD round later in July 2015, ahead of a round in October 2015.

CASE STUDY – Drax Unit 2

According to Drax, their three coal-to-biomass conversions are expected to cost £700 million and help to safeguard 1,200 jobs. The second of three biomass conversions was completed in October 2014.

Drax's new biomass receipt, storage and distribution systems, which will support the converted units, were officially launched in December 2013. This included new rail links and specially-designed rail wagons which link, via a new enclosed conveyer belt system, with the innovative new 'inflated' storage domes.

The Unit 2 biomass conversion has a capacity of 645 MW, which Drax expects to save 3.6 million tonnes of CO_2 emissions per year (based on Unit 2's 2014 emissions).[126]

ECO domes
Courtesy of Drax Power Ltd

Dedicated biomass

Dedicated biomass refers to new build biomass electricity capacity, with or without Combined Heat and Power (CHP). Dedicated biomass plants can use a wide variety of biomass feedstocks, from virgin and waste wood, to straw and other agricultural residues such as olive cake and sunflower seed husks to dry animal material such as chicken litter.

The opportunity on offer

The Renewables Obligation is an incentive scheme for the deployment of large-scale renewable electricity in the UK. It provides financial support for dedicated biomass electricity plants, but the support is capped, and no more than a total of 400MW new build capacity will be supported within the RO period from 2013 to 2017. Around 300MW of projects have either a confirmed or a provisional place within the cap with around 100MW still available.[127]

Dedicated biomass *with* CHP continues to be supported under the RO and the CFD, and is not subject to the cap.[128]

Biomass and Energy from Waste Combined Heat and Power (CHP)

There have been a number of recent developments. In 2014, new biomass CHP plants began operating at Cameronbridge, Markinch, and Sleaford, totalling 117 MW electrical capacity.[129]

Blackburn Meadows (30 MW) began power-only operation in 2014 and is expected to begin operating as CHP in the first half of 2015.[130]

The European Commission has given state-aid approval for MGT Teeside's Renewable Energy Project, a dedicated biomass plant with CHP – another important step in the reform of the UK electricity market. It is the first biomass plant to be approved under the UK's Contract for Difference scheme.

According to MGT Teeside, the project is expected to save 1.2 million tonnes of CO_2 a year and to generate electricity for the equivalent of 600,000 homes.[131]

To be eligible for payment, the Teesside Renewable Energy Project fuel supply will have to meet our criteria for the sustainable management of biomass, including reducing greenhouse gas emissions.

The opportunity on offer

Looking ahead, biomass CHP is a priority in this area of energy due to the higher efficiency with which CHP can utilise biomass. The best UK biomass CHP plants utilise around twice as much of the biomass energy content as a biomass power-only plant would.

Unlike other biomass power generation technologies, biomass CHP is eligible for Contracts for Difference of a full 15 years' duration. Energy from Waste is eligible for Contracts for Difference only if the projects are developed and operate as CHP. Indeed, the first allocation round of the CfD auction in February 2015 saw 2 successful Energy from Waste with CHP projects with combined capacity of 95 MW to be delivered between 2018 – 2019.[132]

In 2014, plans for two major new biomass CHP projects were revealed.

John Laing and the UK Green Investment Bank (GIB) announced plans for a £74 million energy facility at Speyside in Scotland, developed by Estover Energy Ltd. The project will provide power to more than 20,000 homes and heat for a large whisky distillery.[133]

The second announcement, the result of a partnership between Stobart and GIB, was for plans to build a biomass CHP plant at Widnes, Cheshire. The plant will go live by December 2016 and is set to support more than 200 construction jobs and 20 full-time jobs once construction is completed.[134]

According to the developer, it will cut greenhouse gas emissions by around 1.3 million tonnes, the equivalent of taking almost 30,000 cars off the road.

Together the plants will produce 36 MW of electrical capacity.

We are aware of a further 850 MW of potential projects at various stages of development in the pipeline.[135]

CASE STUDY – RWE Markinch Biomass CHP

RWE has invested around £200 million in its 65 MW Markinch biomass CHP plant,[136] which is 90% fuelled by waste wood. It provides power and process steam to the Tullis Russell paper mill in Fife, Scotland – replacing its coal-fired boilers – as well as exporting power to the grid.

Operation began in February 2014 and the plant will generate 346 GW hours of electricity and approximately 500 GW hours of useful heat each year, with an overall efficiency of 66%. The plant is supporting 37 permanent jobs while safeguarding 500 jobs at the Tullis Russell site.

Image courtesy of RWE

Anaerobic Digestion (AD)

Anaerobic digestion takes biomass and converts it into methane which can be converted into electricity, heat or transport fuel.

As well as making a significant contribution to our energy targets, re-using food and farm wastes in this way provides other environmental benefits including effective waste management, production of fertiliser, greenhouse gas savings and income diversification for farmers.

One tonne of food waste that cannot be prevented, processed in an AD plant, saves about half a tonne of carbon dioxide equivalent compared to putting into landfill.

Since the publication of the AD Strategy and Action Plan in 2011,[137] the AD sector has experienced strong growth. At the end of 2014, 160 MW was in operation; a 280% increase in installed capacity since the publication of the Strategy.[138]

The industry is expected to continue to deploy. An additional 280 MW of projects have already received planning permission but are not yet operational.

The opportunity on offer

We aim to achieve about 0.3-0.4 GW of power from Anaerobic Digestion by 2020.[138] There is still waste available for the AD sector, the key opportunity being to expand our AD capacity on-farm using sustainable feedstock.

Out of around 100 million tonnes of slurry and manure produced in the UK, only half a million is currently being processed in AD plants. Food waste that is being disposed of could also be used in AD. Similarly, there are opportunities to expand the income of AD plants by ensuring that AD plants are making the best use of heat or diversifying into biomethane injection or the transport fuel market.

The UK government provides incentives for heat and biomethane injection into the gas grid in the Renewable Heat Incentive, for large-scale power in the Renewables Obligation and Contracts of Difference, and for small scale electricity in the Feed-in Tariff, and for transport fuels in the Renewable Transport Fuels Obligation.

These incentives allow AD plants to successfully compete in the energy markets.

Although most investments to date have been largely equity, financial institutions are increasingly considering introducing debt into the AD market, including the UK Government's Green Investment Bank, which, as well as providing equity loans

through fund managers Greensphere and Foresight, is seeking to encourage investment in smaller-scale recycling and waste UK projects via a new fund.

The UK government also offers a range of loans on commercial terms and grants for feasibility studies to drive innovation and cost reduction in the sector.

These include the £10 million AD loan Fund, from charity Waste & Resources Action Programme (WRAP) which works with businesses, individuals and communities to achieve a circular economy by reducing waste. WRAP has also recently expanded its eligibility to small scale on-farm plants. WRAP also administers the Driving Innovation in AD, and the £15 million Rural Community Renewable Energy Fund.

Advanced Conversion Technologies (Gasification and Pyrolysis)

Advanced Conversion Technologies (ACT) produce fuels derived from waste or biomass.

Not only do they have a flexible input, from mixed residual waste to wood, they also have a flexible output which can be converted into a very diverse range of fuels suitable to generate electricity, heat, advanced biofuels and chemical feedstocks that can be used to make a range of high value products.

These are an emergent set of technologies that are currently experiencing a high level of activity and potentially rapid growth in the electricity sector.

Although about 50 MW is currently operational, a further 700 MW of consented projects are under development; many of which are first-of-a-kind plants that use novel technology.[139]

The first CfD auction, which took place in February this year, saw three successful ACT bids with combined estimated capacity over 60 MW.

The opportunity on offer

There are a range of studies which identify that there is waste available for advanced conversion technologies to develop further.

For example, the Green Investment Bank market report[140] on waste identifies between 4-7 million tonnes of waste, representing an investment opportunity of about £5 billion, mainly taking advantage of waste arising from the commercial and industrial sectors.

Advanced Conversion Technologies can receive support by generating electricity under the Renewables Obligation and Contracts for Difference regimes, and by generating heat under the Renewable Heat Incentive. Under the latter scheme, Advanced Conversion Technologies research and development projects focused on injecting biomethane into the gas grid are eligible to receive support.

The Renewable Transport Fuel Obligation provides support to projects investigating the production of advanced biofuels.

There has been funding available for innovation improvements through the £2.8 million Energy Technologies Institute Gasification project and the £25 million advanced biofuel demonstration project.[141]

As the number of commercially operational plants increases, as does the confidence of the financial institutions seeking to make investments. Air Products' second project in Tees Valley is due to supply renewable energy through a power purchase agreement with the Cabinet Office Energy for Growth scheme.

Hydropower

KEY FACTS: HYDROPOWER[142]	
Estimated Investment 2010-2014 (£2012)	£0.3 billion
Employment Level 2013	7,400
Installed Capacity at end of Q3 2014 (GW)	1.7
Pipeline Data (GW)	0.0 under construction 0.1 awaiting construction 0.0 submitted
2020 Deployment Range (GW)	c 1.7

The Feed-in-tariff has supported **550** hydropower installations, totalling around **60MW.**

Building on our strengths

Hydropower has been a source of UK renewable electricity since the 1950s. It accounts for about 1.7% of total electricity generation today.[143]

Large-scale hydropower will remain a vital part of the whole energy mix within the UK's electricity supply, although most suitable large-scale sites have already been used.

A number of large-scale sites need to be refurbished and operators of these facilities will be seeking investment. One such site, the Fasnakyle hydropower facility in Scotland, was recently successful in the Capacity Auctions, winning a one year contract, providing a Capacity of 69 MW. However, a single year's capacity contract will be insufficient to fund full refurbishment.

The opportunity on offer

Small-scale generation is a major area of growth, and there are significant opportunities in this sector. More than 550 hydro installations with total capacity of almost 60 MW have been accredited under the Feed in Tariffs (FITs) scheme since 2010,[144] with the added benefit that Hydro facilities can tend to be very long lived.[145]

Studies in Scotland, England and Wales indicate that there is a potential 1–2.5 GW of small scale hydro remaining to be exploited.[146]

The Government's UK Green Investment Bank is seeking to support UK hydro projects via a series of funding initiatives.

CASE STUDY

Green Highland Renewables

Hydro specialist Green Highland Renewables[147] has recently commissioned and exported power from a 2 MW hydro scheme at Chonais, about one hour west of Inverness.

The rocky, steep topography makes it one of the most challenging hydro projects ever undertaken at this scale.

This scheme required 2.7 km of penstock (pipeline), of which 700 metres was installed using horizontal directional drilling. This technique has never previously been used on a hydro project of this size in the UK.

The Chonais development is one of around 40 projects currently under the management of Green Highland Renewables, which has gained consent for more than 50 sub-2 MW schemes to date.

Green Highland Renewables hydro scheme
Image courtesy of Green Highland Renewables

Hydro scheme under construction
Image courtesy of Green Highland Renewables

Nuclear

KEY FACTS: NUCLEAR[148]	
Estimated Investment 2010-2014 (£2012)	£2.5 billion
Employment Level 2013	59,000
Installed Capacity at end of 2013 (GW)	9.4
Pipeline Data (GW)	Up to 16 GW by 2030

By 2020 we could see around **£14.5 billion** of investment.

Building on our strengths

Nuclear is destined to play a vital role in the UK's home-grown, low-carbon, affordable and reliable energy mix. It will help to support British consumers and businesses, and keep the lights on in the years ahead.

The UK government has a clear strategy on nuclear power involving the build of new power stations, maintaining current plants and cleaning up the older ones while safely and securely managing waste. Government envisages a highly capable and competitive UK nuclear industry, standing as a global leader and capitalising on domestic and international market opportunities across the civil nuclear lifecycle creating new jobs and greater investment across the sector.

Existing nuclear currently meets approximately 19% of the UK's electricity demand with current capacity at 9.4 GW.[149] The majority of these stations will close by 2030 however, having reached the end of their operational lives. The first closure will be at Wylfa at the end of 2015, leaving open one of several opportunities across the country for a decommissioning project.

To replace the existing fleet, the UK has attracted significant private investment into its domestic new nuclear programme. Sweeping reforms of the UK energy market have created one of the world's most attractive electricity investment markets. Contracts for Difference, like the one being negotiated for Hinkley Point C, form the cornerstone of these reforms.

They help to incentivise electricity generators to invest in low-carbon methods without distorting the market, and provide a competitive rate for industry. This means we can provide confidence, stability and certainty for investors in the future of UK electricity generation.

There are now firm development plans for at least 11 reactors on five different sites, namely Hinkley Point C, Sizewell, Moorside, Wylfa Newydd (the new name for Wylfa) and Oldbury. All of the new nuclear projects are progressing towards final investment decisions, with approximately £2.5 billion already committed.

In October 2014 the European Commission approved the State aid package for Hinkley Point C which could be built and operated by NNBG (a subsidiary of EDF Energy). This reinforced our view that the plans provide a fair deal for both bill-payers and investors and marks a huge step towards commissioning the first nuclear power station in the UK for a generation.

The Government and EDF are continuing to work together to finalise the Hinkley project, including the full terms of the Contract for Difference, and the financing arrangements for the project, including support from the UK Guarantee.

Contracts for Difference like the one being negotiated for Hinkley Point C will provide greater confidence and stability for our future electricity generation more broadly – it's a certainty any investor would want before committing money to large energy infrastructure projects.

Artist's impression of Wylfa Newydd,
courtesy of Horizon Nuclear Power

We are also paving the way for more nuclear in the UK, with further stations planned for Anglesey, Cumbria, Suffolk and Gloucestershire. Horizon's Hitachi UK-ABWR reactor design is progressing through Generic Design Assessment and the project recently completed its first public consultation.

Of course, in order to build and operate new stations, and manage their legacy, we need to ensure the UK has the appropriate skills, supply chain and industry in place. In 2013, 59,000 people worked in the civil nuclear industry and its supply chain, and thousands more will be needed as new nuclear build programmes gathers pace.

Since 2012 DECC, the Department for Business, Innovation and Skills and others have provided more than £100 million to support our vision for nuclear innovation. We are ensuring UK enterprises – from universities providing the workforce and the research, to manufacturers who can help build the plants – benefit the thousands of new jobs.

New nuclear will deliver substantial economic benefits to our economy and act as a springboard to create opportunities overseas.[150]

According to the World Nuclear Association, there are 437 operating reactors worldwide, 70 under construction, 183 planned and 311 proposed.[151] By 2060, the capacity of nuclear generation globally could treble.[152]

The opportunity on offer

For UK firms that can grow their share of the global nuclear market, the commercial opportunities are immense.

In nuclear decommissioning, our companies will be able provide a significant contribution to overseas civil nuclear programmes. They will be able to draw on extensive specialist experience to provide:

- legal, regulatory and financial knowledge
- engineering/technical and scientific services
- programme management
- plant and equipment supply
- education and training programmes
- full fuel cycle capability
- asset management and decommissioning
- waste management expertise.

By 2030, the International Atomic Energy Authority estimates that 145 reactors will have been decommissioned at a cost of £250 billion. By 2050, $1 trillion (around £600 billion) will have to be spent on nuclear decommissioning. In the UK, we expect that 11 existing reactors will begin defueling and decommissioning by 2030. We want to see the UK take advantage of this and for our nuclear industry to become a global leader.

Domestically, last year the Nuclear Decommissioning Agency (NDA) Estate spent nearly £1.8 billion in the supply chain at tier 2 and below. This collaborative procurement programme made savings of over £60 million last financial year.[153]

NDA expects shortly to announce that it has met its 20% target agreed with DECC for work allocated to small-to-medium-sized businesses. This means more than £320 million a year was spent with this vital group.[154]

Carbon capture and storage

Building on our strengths

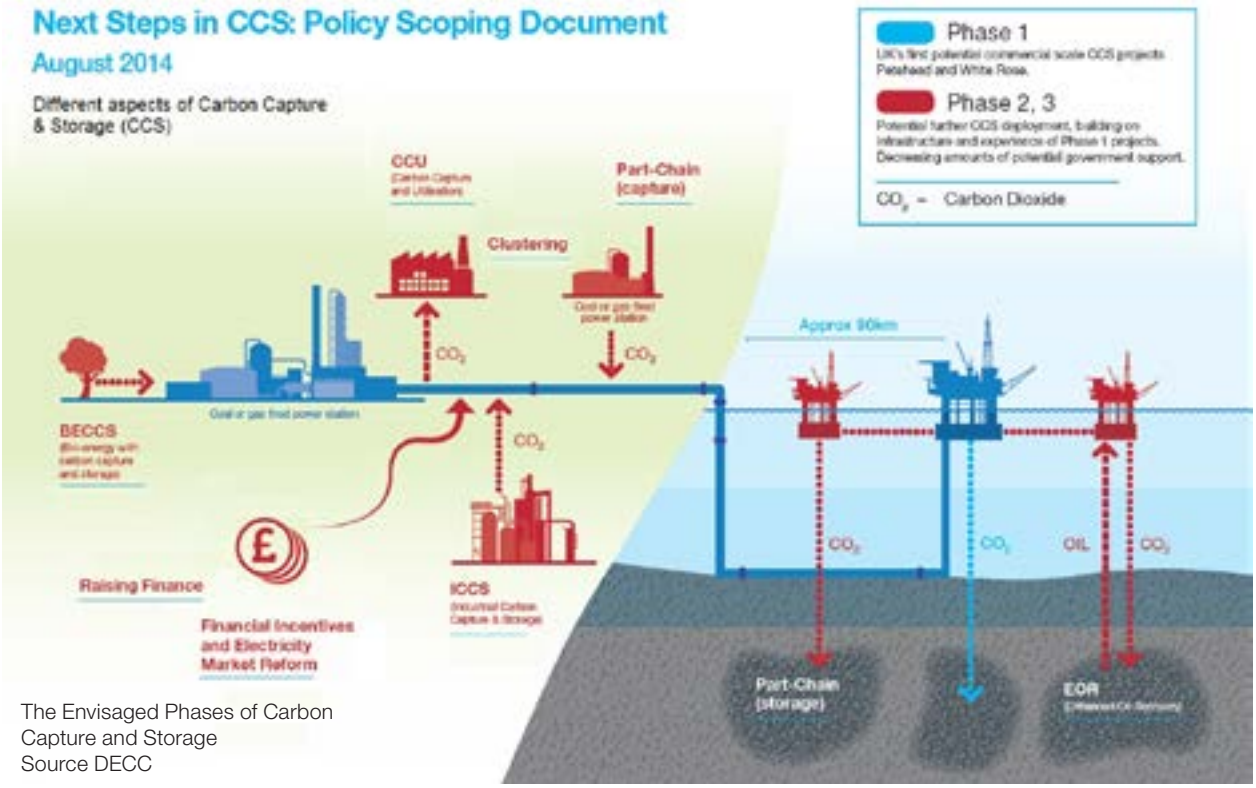
CCS is a proven technology that could play a vital part of decarbonising the UK's (and globally) power sector. It is also the only credible technology to decarbonise some energy intensive industries such as steel and cement industries.

CCS offers an opportunity to create regional carbon capture and storage clusters bringing together industry and power plants.

This is a great economic opportunity, to help prevent 'carbon leakage' and provide low carbon growth opportunities within these clusters.

The UK government is already taking action to support this through the £1 million funding to the Tees Valley City Deal. This will examine the feasibility of establishing Teesside as the go-to location for future clean industrial development by creating Europe's first CCS equipped industrial zone.

CCS describes a suite of technologies that remove harmful carbon dioxide emissions from the production of energy by fossil fuels gas and coal. Captured emissions are then transported to be stored permanently, usually under the seabed.



The Envisaged Phases of Carbon Capture and Storage
Source DECC

In 2013, the CCS sector and its supply chain supported **4,100 jobs** across the UK.[1]

CCS technology is an extremely valuable asset in a low-carbon economy. It is one of the only technologies that can safely remove carbon dioxide from fossil fuel power plants and other industrial processes, such as steel or cement production.

It is important to remember that fossil fuels will remain part of the mix as back-up generation for some time to come because the power they produce can be balanced with intermittent renewable energy supplies, like wind power, or less flexible, like nuclear. CCS plants can also still provide valuable back-up generation.

By 2050, CCS could provide more than 20% of the UK's electricity and save us more than £30 billion a year in meeting our climate targets.[155]

The EU 2030 Energy and Climate Change Framework recognises CCS as an important low carbon technology. By 2050, CCS could provide more than 20% of the UK's electricity and save us more than £30 billion a year in meeting our climate targets.[156]

This is why the UK has positioned itself at the forefront of CCS innovation and the Government is working with industry to create a new cost-competitive CCS industry. Additionally, our trailblazing £1 billion initiative, the CCS Commercialisation Programme, aims to launch the first commercial-scale plants in the UK – White Rose and Peterhead CCS projects.

White Rose CCS Project

Led by CCS consortium Capture Power and partly funded by the European Union's NER 300 programme, White Rose is located at the Drax Power Station site near Selby, North Yorkshire. The plant will generate electricity for export to the Electricity Transmission Network and capture around 2 million tonnes of CO_2 per year – 90% of all CO_2 emissions produced by the adjacent power station.[157]

Peterhead CCS Project

Up to 10 million tonnes of CO_2 emissions will be captured from the Peterhead Power Station in Aberdeenshire, Scotland and then transported around 100 km offshore by pipeline for long-term storage 2 km under the North Sea in the depleted Goldeneye gas reservoir.[158] The programme is led by global energy firm Shell in conjunction with UK energy company SSE.

Our document published in August 2014, 'Next Steps in CCS: Policy Scoping Document'[159], sets out plans to support industry in further CCS projects, summarises Government's policies and actions to support deployment and invites views on addressing the challenges of implementing CCS.

The opportunity on offer

The White Rose and Peterhead CCS projects represent potential investment of more than £2 billion.[160] In return, the plants will potentially:

- provide enough clean electricity for the equivalent of more than 1 million homes
- support over 2,000 jobs in Scotland and Yorkshire during construction
- increase turnover for local businesses during both the construction and operational periods.

In addition, White Rose will potentially capture around 22 million tonnes of CO_2 annually. We have committed to providing up to £1 billion in capital as well as operational support to the projects and both the consortiums and the UK government will make a final investment decision in the first quarter of 2016.

This work complements wider activity led by UK Government, for example, the Cross-Government CCS research and development Programme.[161] The programme offers £125 million funding from the DECC, Innovate UK (formerly the Technology Strategy Board), the Research Councils and the Energy Technologies Institute, a public-private partnership between global energy and engineering companies and the UK Government.

More than 100 separate projects have already been funded through this programme which provides:

- £62 million to support fundamental research
- £28 million to support the development and demonstration of CCS components and technologies like turbines or new solvents to capture CO_2
- £35 million for pilot-scale projects to bridge the gap between research and commercial-scale deployment.

As a CCS leader, the UK is now in a position to be able to further develop the supply chain and export internationally. There is even potential for the UK to become a storage 'hub' for North West Europe by tapping in to home-grown expertise developed in the North Sea oil and gas sector.

Our drive to stimulate further innovation and investment in CCS continues.

Government's Business Secretary, Vince Cable, recently announced that Innovate UK is making available up to £5 million for projects that stimulate innovation in the use of fossil fuels, including CCS projects.[162]

The aim of the More Efficient Conventional Fuels Competition is to improve efficiency, reduce cost and minimise the environmental impact of coal, natural gas and oil. Projects could apply from March 2015 and need to be business-led and involve small to medium-sized businesses.

We announced the availability of additional funding for CCS research, development and innovation through the Energy Entrepreneurs Fund, which

By 2050, CCS could provide more than **20%** of the UK's electricity and save us more than **£30 billion** a year in meeting our climate targets.[3]

supports the development of state-of-the-art technologies in the areas of energy efficiency, power generation, heat and electricity storage and CCS.

The Energy Entrepreneurs Fund makes £5 million available for projects in 2015-2016, with up to £2.5 million prioritised for CCS projects.[163]

And we are also spending up to £2.5 million on the identification of new sites deep under UK seabeds to store CO_2 emissions using CCS technology. The funding is from our Innovation Fund, and will be delivered by the Energy Technologies Institute during 2015–2016.[164]

According to the Energy Technologies Institute's UK Storage Appraisal Project, geological formations beneath the UK's North Sea could store almost 80 billion tonnes of CO_2 – more than enough to meet the needs of the UK's CCS projects for the next 100 years.[165]

To further ease the way for investors, we will continue to create financial incentives for the next phase of CCS deployment beyond the CCS Commercialisation Programme. Throughout 2015 we will develop for a Contract for Difference for the White Rose and/or the Peterhead programmes to ensure the very best deal.

A second, generic Contract for Difference is under development ahead of the next phase of CCS projects. Any CCS Contract for Difference design will consider progress in the CCS Commercialisation Programme Competition where it is relevant for other early-stage projects.

We are already in a good position. The engineering skills required for CCS are plentiful in the UK, thanks to long-standing experience in the oil and gas, energy supply and process industries.

The UK also has some well-established research and development programmes in the public and the private sector, for example, UK and Engineering and Physical Sciences Research Council and DECC supported the creation of the UK Carbon Capture and Storage Research Centre and the Imperial College Centre for Carbon Capture and Storage.

CCS is good news for employment too. The UK Government aims to deploy cost-competitive CCS by the 2020s. In 2013, the CCS sector and its supply chain supported 4,100 jobs across the UK. By 2030, the industry could support between 15,000 and 30,000 jobs,[166] based on each of the planned projects, any new projects, as well as the potential jobs supported by industrial CCS.

Renewable and low carbon heat

KEY FACTS: Renewable Heat Deployment Supportd by the RHI[167]	
Estimated Investment 2011/12-2013/14 (£2012)	~£1 billion
Jobs Supported – 2020/21	Up to 25,000 jobs
Installed Capacity at end of Q3 2014 (GW)	Over 1 GW
2020 RHI Renewable Heat Deployment Range (TWh)	13.7 – 43.8 TWh

Between now and 2020 we expect investment in renewable and natural gas-fuelled Combined Heat and Power (CHP) systems of around **£5 billion.**[5]

Building on our strengths

Nearly half of all the energy supplied in the UK is used for heating buildings and for industrial processes, including over 60% of all gas consumed.[168] Decarbonising heat is an enormous – and largely untapped – investment opportunity.

Condensing gas boilers

One of the most common ways to see low carbon heat in action is through the use of condensing boilers which are typically more than 90% efficient.[169] The efficiency gain comes from recovering heat that would otherwise be lost in flue gases to pre-heat cooler water re-entering the boiler from the radiator system.

The market for new gas boilers in the UK is worth £3.75 billion a year.[170] In the UK, almost all new gas central heating and oil-fired boilers must be high-efficiency condensing boilers. Consequently, the UK has Europe's largest market for high efficiency condensing gas boilers. Householders buy more than 1.5 million condensing gas boilers a year.[171]

This has had a positive knock-on effect for skills and employment opportunities, with more than 100,000 registered gas engineers across the country now available to fit these boilers.[172]

That number is likely to grow because we estimate that a further 10 million gas boilers will be replaced in homes between now and 2020, saving each household between £20 and £120 or more per year in reduced bills.[173]

Renewable Heat

On the renewable side, heating can also be decarbonised by using renewable fuels. In particular, the UK Government is promoting renewable fuel sources through the uptake of:

- air-source, water-source and ground-source heat pumps
- biomass boilers
- biomass Combined Heat and Power
- biogas boilers and biogas Combined Heat and Power
- biomethane injection to grid
- deep geothermal
- solar thermal.

We estimate that the domestic Renewable Heat Incentive (RHI) would drive around **£3 billion** of investment in new, lower carbon, heating systems between now and 2020[4], supporting up to **5,000 jobs** by 2020.

The UK Government introduced the Renewable Heat Incentive (RHI), the world's first long-term financial incentive scheme for renewable heat generation in 2011, in recognition of the important role of these technologies in reducing greenhouse gas emissions and meeting climate change and renewable energy targets.

The RHI is aimed at both domestic and non-domestic users of renewable heat technologies, and aims to drive around £12 billion of investment in new, renewable heating systems between now and 2020.

The domestic scheme is aimed at homeowners, private landlords, social landlords and self-builders who use air-source, ground-source and water-source heat pumps; biomass boilers and biomass stoves with integrated boilers; and some solar thermal panels. The domestic RHI is targeted at, but not limited to homes that are off the gas grid, as these have the most potential to save on fuel bills and decrease carbon emissions.

The non-domestic scheme supports industry, businesses and public sector non-profit organisations as well as heat networks that use biomass boilers, air-source, ground-source and water-source heat pumps; deep geothermal; solar thermal collectors; biomethane to grid (see case study); biogas; and renewable Combined Heat and Power (CHP) systems.

Already, since the launch of the non-domestic Renewable Heat Incentive (RHI) in November 2011, over 2 TWh of renewable heat has been generated. By the end of January 2015, there were 7,675 accredited installations under the scheme, representing over 1,200 MW of capacity,[174] with over 21,000 heat meters installed.[175]

The domestic RHI was launched in April 2014. By the end of January 2015, 6,244 new renewable heat installations were accredited under the scheme. A further 15,688 legacy installations have also been accredited since the start of the scheme.[176]

Renewable heat consumption was up 40% between 2010 and 2013.[177]

The opportunity on offer

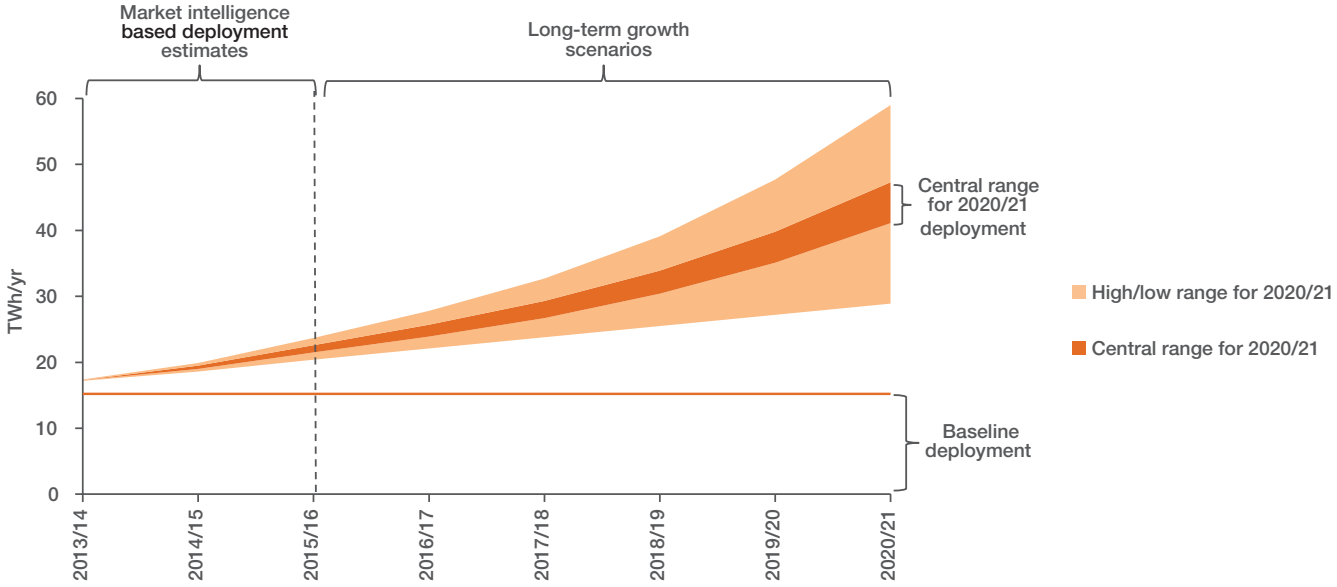
To meet the UK's renewable and low carbon energy targets in 2020 and 2050, we must prepare now for the deployment of renewable and low-carbon heating.

We estimate that the domestic Renewable Heat Incentive (RHI) would drive around £3 billion of investment in new, lower carbon, heating systems between now and 2020. The incentive will help to achieve the projected growth rates in new renewable heat installations that we estimate are possible (see chart below), supporting up to 5,000 jobs by 2020.

Within commercial, public and industrial sectors, we estimate that in order to contribute the central range of deployment potential shown and make vital contributions to renewable energy and carbon targets, the non-domestic Renewable Heat Incentive needs to result in around £9 billion of investment between now and 2020, supporting up to 20,000 jobs by 2020.[184]

The renewable and low carbon heat sector provides great opportunities for improving skills too. The UK Government has invested £650,000 in a training voucher scheme to train domestic heating engineers to install and maintain renewable heating systems. This is an important step towards boosting the installer base and supply chain and has improved the skills of nearly 850 installers.[182]

Deployment of total renewable heat supported by the Renewable Heat Incentive under different scenarios.



Source: RHI Impact Assessment[180]

The sector also offers potential for growth in new markets for heat metering, renewable heating system design and installation, sustainable biomass fuel supply and auditing.

Heat networks (district heating schemes)

Heat networks supply heat from a central source directly to homes and businesses through a network of pipes carrying hot water. According to Government estimates, they could supply as much as 14% of UK heat demand by 2030 and 43% by 2050.[186]

We also support more than 180 heat network projects across 115 local authorities, including £9.7 million of grant funding.

A report by the Committee on Climate Change[185] agreed with us that heat networks will continue to play an important part of the overall plan for lower carbon heating in the decades ahead. As such, our interactive, digital National Heat Map aimed at local authorities, community groups and private developers, shows the opportunities for heat networks – and will shortly show in the same tool the opportunity for larger-scale water-source heat pumps.

Government offers support in the form of expert guidance and funding to local authorities through the Heat Networks Delivery Unit. Demand has been high. The Unit now supports 180 projects in 115 local authorities.[186]

Almost £7 million has been awarded to support developments in the last year, an investment which could result in £400 to £800 million of capital investment opportunity over the next 10 years.[187]

We have published further information about the investment opportunities presented by the expansion of heat networks in our January publication Delivering UK Energy Investment: Networks.[188]

Combined Heat and Power

Between now and 2020, we expect investment in renewable and natural gas-fuelled Combined Heat and Power (CHP) systems of around £5 billion.[189]

Accredited CHP systems save at least 10% of primary energy use (the energy associated with the raw fuel before it is transformed into an energy source), which can lead to significant energy bill savings.[190] It typically has an efficiency rate of more than 80% and can reduce carbon emissions by up to 30% compared with conventional power-station-to-boiler generation.[191]

The UK government provides several incentives for CHP plants, including the Climate Change Levy Exemption and Business Rates Exemption. They may also qualify for support from the Renewable Heat Incentive, if the fuel is renewable, the Feed-in Tariff scheme for micro-CHP and Contracts for Difference for Biomass CHP (see Biomass and Bioenergy chapter).

CASE STUDY

ReFood

When the non-domestic Renewable Heat Incentive was launched in 2011, there were no commercial scale biomethane to grid plants in the UK. The sector has seen significant growth and investment over the past year with 27 plants in the process of applying for support from the Renewable Heat Incentive as of the end of January 2015. Nine of these applications have been accredited to the scheme.[192]

One such plant is green energy company ReFood's £22 million biomethane-to-grid plant at Widnes in Merseyside, completed in 2014. It supports 35 full-time jobs and will produce enough gas to supply 10,000 homes annually.[193]

Biomethane is produced from biogas, created from plant or animal waste that would otherwise go to landfill. The waste is stored in tanks without oxygen and micro-organisms digest the waste to create the biogas using anaerobic digestion. The biogas is then upgraded to biomethane (involving the removal of carbon dioxide and other gases) and injected directly into the gas network to supply homes and businesses, in the same way as natural gas.

ReFoods Biomethane to Grid plant, Widnes
Image courtesy of ReFood

Innovation

Innovation

While it is vital to invest in today's infrastructure, to ensure our current energy needs are met, we also need to develop cleaner and more efficient technologies for the future.

Innovation is necessary if we are to transition to a society where competitively-priced, accessible low carbon energy in our homes and workplaces is the norm, while phasing out our reliance on fossil fuels.

Research, development, demonstration and fine-tuning low carbon technologies also stimulates employment, boosts skills and helps regional economies to flourish.

The UK is well placed to capitalise on its strengths to lead the future development of key low carbon technologies, including offshore wind, nuclear, and Carbon Capture and Storage.

Now however, maintaining the momentum will be crucial in order to:

- reduce the cost of future energy supply
- deliver affordable energy to households and businesses
- ensure that future generations can access a sustainable energy supply that does not rely on fossil fuels.

Glovebox, Nuclear Fuel Centre of Excellence
Image courtesy of The University of Manchester

"Large, technical projects are traditionally hard for small enterprises to undertake and impossible to fund, and the DECC process has been highly supportive, providing essential funding not available from any other sources. As a result of the grant we have been able to save **55%** of our workforce and we forecast that we will grow **25–35%** for the next three years. In addition, we expect our exports to increase to account for **25%** of our total sales."[194]

– Pete Scott, CEO, Fern-Howard, an efficient lighting designer and manufacturer supported by EEF.

In the UK, we are already in a good position. Over £1 billion of public money has supported academia and industry-led low carbon programmes between 2011 and 2015, which includes funding from the Research Councils UK and other organisations that form the Low Carbon Innovation Coordination Group.[195] We have world-class universities and research centres continually seeking more efficient methods; and the UK Government has built a trusted, strong policy framework bolstered by funding mechanisms that support a wide range of low carbon technologies.

We are completely behind the drive for innovation and have plugged into the UK's entrepreneurial spirit to offer programmes that encourage businesses to develop new low carbon technologies.

Our programmes are not just focussed on large-scale generation but on smaller-scale generation too; delivering improved energy efficiency technologies in our homes and workplaces, giving consumers more choice.

We have made up to £185 million available for low carbon innovation between 2011-2015 with a budget of over £60 million available between 2015/2016.[196] This funding is aimed at the development of technologies ranging from Carbon Capture and Storage, bioenergy, nuclear and buildings technologies, such as low-carbon building materials, and machines to install insulation in hard-to-reach places.

Since November 2011, we have awarded more than £15 million to help fund 20 offshore wind development and demonstration projects.[197] This funding will help companies to develop and test technologies that can cut the costs of offshore wind energy in the run-up to 2020.

We want smaller companies to benefit too. Our innovation programme has supported more than 200 companies, around 70 of which are small or medium sized businesses. Innovation funding plays an important role in supporting energy targets, while creating jobs and investment.

Our Energy Entrepreneurs' Fund Scheme was designed to help bring a range of new and innovative, low carbon products to market. These include energy efficiency technologies, alongside power generation and energy storage technologies. Companies have received additional funding for business and technical incubation support, particularly small and medium sized businesses, including start-ups.

We have already awarded grants to some 70 businesses under the first three funding rounds. The results are impressive. DECC's analysis shows those businesses have so far created or supported around 290 jobs and have stimulated £26.6 million of private sector investment through match funding, and an additional £10.2 million of private investment funding.

DECC has made up to **£185 million** available for low carbon innovation between 2011 and 2015 supporting over 200 UK based businesses.

With limited resources we need to carefully prioritise our support for technologies. For this purpose, Technology Innovation Needs Assessments (TINAs)[198] led by the members of the Low Carbon Innovation Co-ordination Group now informs public sector investment in low carbon innovation. The TINAs identify the cost reduction and economic benefits specific innovations can deliver.

The UK is not alone in transforming its energy system, and the scale of the challenge faced is larger than any single country's budget can address. Partnering with other countries in sharing skills, knowledge and developing programmes supports the delivery of our national and international objectives.

The UK has a strong track record of securing access to European energy research and innovation support, securing involvement in 64% of funded projects, offering UK participants crucial access to knowledge, contacts and future opportunities. This equates to €35 million funding, out of the €390 million budget from the European Commission, representing 9% of the allocated budget for 2013.

We are also leading major transnational European low carbon programmes in areas including bioenergy and offshore wind. In addition, we are supporting UK businesses to access European low carbon innovation funding worth up to €500 million through the Horizon 2020 programme focussed on energy efficiency, renewable energy technologies, smart grids and smart cities.[199]

Continued innovation will help to create a competitively-priced energy landscape for the long term and it is innovation that will underpin the transition to a low-carbon future.

CASE STUDY

DB Wind UK

Huddersfield-based DB Wind UK was awarded a grant of £1.2 million to develop and test their innovative gearbox designed for use in 7 MW offshore wind turbines.[200]

DW Wind UK is now continuing to develop this next-generation 'drivetrain' design with Samsung Heavy Industries. The compact design minimises space requirements and dramatically reduces the weight at the top of the turbine tower which means less wear and tear resulting in less operational downtime for routine maintenance or repair.

These features can together reduce the cost of ownership and ultimately lower the cost of energy for wind turbine operators.

Load test rig for 7MW Offshore Wind Turbine Gearbox
Image courtesy of David Brown Gear Systems Ltd

CASE STUDY

Celtic Renewables

An internationally acclaimed company, Celtic Renewables Ltd, pioneers the production of biobutanol as an advanced biofuel (a direct replacement for petrol) from the waste and residues from the whisky industry.

The company has a patented process that converts the by-products from the Scottish Malt Whisky industry into high performance biofuels like bio-butanol. Now it plans to develop a commercial-scale demonstration facility at Grangemouth in Scotland.

The Scottish Malt whisky industry annually produces around 3,000,000 tonnes of residues. It is predicted that the conversion technique could help to create a new £100-million–per- year industry in the UK.[201]

With huge whisky industries worldwide and the ambition of Celtic Renewables to adapt its process to other biological residues, there is great economic and environmental potential for this innovative process.

Image courtesy of Celtic Renewables

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13 Energy Trends, December 2014, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/388434/et6_1.xls. Based on 2020 generation levels underpinning analysis as set out in the EMR Delivery Plan (see https://www.gov.uk/government/ uploads/system/uploads/attachment_data/file/267614/Annex_D_-_National_Grid_EMR_Report.pdf), and assumed average household electricity consumption in 2013 (see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/338662/ecuk_ chapter_3_domestic_factsheet.pdf)

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2) Employment figures include an estimate of those employed the supply chain, and are taken from BIS (March 2015); The Size and Performance of the Low Carbon Economy.

3) Installed capacity at end of Q3 2014 taken from Energy Trends December 2014, see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/388434/et6_1.xls

4) Pipeline data has been extracted from the Renewable Energy Planning Database (January 2015) comprising of schemes, 1 MW or greater, which have been subject of a planning application. The pipeline data excludes applications which are subject of an appeal following refusal. The 1.1 GW under construction may include some partially operational capacity that is also included in the installed capacity figure. This may include some partially operational wind capacity that is also included in the installed capacity figures.

5) 2020 deployment range taken from EMR Delivery Plan, see https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan.

58 Renewable Energy Country Attractiveness Index, March 2015,EY: http://www.ey.com/Publication/vwLUAssets/Renewable_Energy_Country_Attractiveness_Index_43/$FILE/RECAI%2043_March%202015.pdf

59 Generation returns for 2014 to The Crown Estate

60 Based on 630 MW generating around 2 TWh annually and long run marginal emissions factors from Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal, see https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

61 Based on assumed emissions in line with average for new registrations in 2013 - taken from https://www.gov.uk/government/publications/new-car-carbon-dioxide-emissions and estimated average annual mileage per car in 2013 taken from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/342160/nts2013-01.pdf

62 http://www.londonarray.com/

63 Based on the latest evidence (available at the time of the announcement from the July 2014 Energy Investment Report).

64 https://www.gov.uk/government/news/world-leading-auctions-to-provide-major-green-electricity-boost

65 As footnote 11.

66 Energy Trends December 2014, https://www.gov.uk/government/statistics/energy-trends-december-2014

Based on 2020 generation levels as set out in the EMR Delivery Plan (see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/267614/Annex_D_-_National_Grid_EMR_Report.pdf), and assumed average household electricity consumption in 2013 (see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/338662/ecuk_chapter_3_domestic_factsheet.pdf

67 https://www.gov.uk/government/news/hundreds-of-jobs-could-be-created-in-yorkshire-and-humberside-by-a-major-wind-farm

68 24 Jun 2014 GIB announces 2013-14 results and plans to raise a new £1bn fund http://www.greeninvestmentbank.com/news-and-insight/2014/gib-announces-2013-14-results-and-plans-to-raise-a-new-1bn-fund/

69 https://ore.catapult.org.uk/our-projects/-/asset_publisher/fXyYgbhgACxk/content/cost-reduction-monitoring-framework?_101_INSTANCE_fXyYgbhgACxk_redirect=%252Four-projects

70 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/407059/Contracts_for_Difference_-_Auction_Results_-_Official_Statistics.pdf

71 http://www.siemens.co.uk/en/news_press/index/news_archive/2014/siemens-announces-green-port-hull-wind-manufacturing-site-improvements.htm

72 http://www.scottishpowerrenewables.com/news/pages/official_opening_following_full_power_at_west_of_duddon_sands_offshore_windfarm.asp

73 Footnotes to Onshore Wind Key Facts:

1) Estimated Investment 2010-2014 updates 2010-2013 investment reported in the July 2014 Energy Investment Report to reflect provisional estimates of investment in 2014. Although the updated investment estimate has increased by a small amount, relative to the estimate presented in July 2014, we estimate over £1bn of investment in 2014. The small increase therefore reflects a re-estimation of investment in years before 2014.

2) Employment figures include an estimate of those employed the supply chain, and are taken from BIS report.

3) Installed capacity at end of Q3 2014 taken from Energy Trends December 2014, see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/388434/et6_1.xls

4) Pipeline data has been extracted from the Renewable Energy Planning Database (January 2015) comprising of schemes, 1MW or greater, which have been subject of a planning application. The pipeline data excludes applications which are subject of an appeal following refusal. The 1.3 GW under construction may include some partially operational capacity that is also included in the installed capacity figure.

5) 2020 deployment range taken from EMR Delivery Plan, see https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan

74 Energy Trends, December 2014, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/388434/et6_1.xls

75 Energy Trends, Department of Energy and Climate Change, December 2014

76 EMR Delivery Plan, Annex D: Report from the System Operator, Table 6.1.4 GB Generation in 2020, low cost scenario, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/267614/Annex_D_-_National_Grid_EMR_Report.pdf

77 http://newsroom.edfenergy.com/News-Releases/EDF-Energy-Renewables-sells-stake-in-three-UK-wind-farms-to-CGN-31a.aspx

78 The Renewable Energy Planning Database

79 EMR Delivery Plan, page 40, Table 4: Projected Total Capacity (GW, Great Britain, excl. small-scale deployment): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/268221/181213_2013_EMR_Delivery_Plan_FINAL.pdf

80 Renewable Energy Country Attractiveness Index, March 2015 EY: http://www.ey.com/Publication/vwLUAssets/Renewable_Energy_Country_Attractiveness_Index_43/$FILE/RECAI%2043_March%202015.pdf

81 http://www.renewableuk.com/en/publications/index.cfm/Onshore-Wind-A-Community-Commitment

http://www.renewableuk.com/en/news/renewableuk-news.cfm/2013-06-24-wind-industry-makes-promise-to-welsh-communities

http://www.scottishrenewables.com/media/uploads/publications/131104_community_benefit_protocol.pdfhttp://www.ni-rig.org/wp-content/uploads/2013/01/NIRIG-Community-Commitment-FINAL.pdf

82 http://www.communitybenefitsregister.org/

83 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/408440/Government_Response_to_Shared_Ownership_Taskforce.pdf

84 https://www.gov.uk/government/groups/shared-ownership-taskforce

85 'Community Benefits from Onshore Wind Developments: Best Practice Guidance for England ': https://www.gov.uk/government/publications/community-benefits-and-engagement-guidance-for-onshore-wind

86 The GIB intends to lend £100 million to community scale projects with global investment firm KKR intending to lend an additional £100 million. This lending programme will be managed by Temporis Capital: http://www.greeninvestmentbank.com/news-and-insight/2014/200m-of-new-funding-available-for-community-scale-renewables/

87 Wind Energy in the UK (12 November 2014) RenewableUK: http://www.renewableuk.com/en/publications/index.cfm/state-of-industry-report-2014

88 Wind Energy in the UK (12 November 2014) RenewableUK: http://www.renewableuk.com/en/publications/index.cfm/state-of-industry-report-2014

89 http://www.culachy-windfarm.co.uk/news/latest-news/10th-february-2015-residents-to-benefit-from-annual-£200-electricity-discount/

90 http://www.rwe.com/web/cms/en/1304104/rwe-innogy/sites/wind-onshore/united-kingdom/in-operation/community-benefits/

91 http://www.scottishpower.com/pages/whitelee_extension.asp

92 http://sse.com/newsandviews/allarticles/2014/05/boost-for-north-lincolnshire-community-projects/

93 http://penycymoedd.vattenfall.co.uk/about-the-project/

94 Energy Trends, chapter 6 and table ET 6.1 (March 2014), DECC, https://www.gov.uk/government/statistics/energy-trends-march-2014

95 As set out in the EMR Delivery Plan, in certain scenarios onshore wind could generate 10% of our electricity by 2020. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/268221/181213_2013_EMR_Delivery_Plan_FINAL.pdf

96 Government response to RO consultation (July 2012), DECC: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42852/5936-renewables-obligation-consultation-the-government.pdf

97 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/269888/131217_Electricity_Generation_costs_report_December_2013_Final.pdf

98 http://www.renewableuk.com/en/publications/index.cfm/Onshore-Wind-Cost-Reduction

99 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/407059/Contracts_for_Difference_-_Auction_Results_-_Official_Statistics.pdf

100 DECC estimate based on 68MW generating around 0.2TWh a year, and assumed average household electricity consumption in 2013 (see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/338662/ecuk_chapter_3_domestic_factsheet.pdf)

101 Footnotes to Solar PV key facts:

1) 2020 Deployment data covers GB. All other data covers UK.

2) Estimated Investment 2010-2014 updates 2010-2013 investment reported in the July 2014 Energy Investment Report to reflect provisional estimates of investment in 2014. Estimated Solar investment has increased from estimates presented in the July 2014 Energy Investment Report due to methodological improvements and updated assumptions on deployment rates over the relevant period.

3) Employment figures include an estimate of those employed the supply chain, and are taken from BIS (March 2015); The Size and Performance of the Low Carbon Economy.

4) Installed capacity at end of 2014 taken from Solar Photovoltaics Deployment 29 January 2015, see https://www.gov.uk/government/statistics/solar-photovoltaics-deployment

5) Pipeline data has been extracted from the Renewable Energy Planning Database (January 2015) comprising of schemes, 1MW or greater, which have been subject of a planning application. The pipeline data excludes applications which are subject of an appeal following refusal.

   As set out in the Government response to the consultation on closure of the RO to solar deployment above 5MW, and its accompanying Impact Assessment, we are anticipating between 3.8 and 6.5GW of solar to be supported by the RO by the time it closes at the end of March 2017. Combined with projections of small scale solar supported under Feed-in Tariffs (FITs), we anticipate that there will be 12-14GW of solar supported. There may be more, depending on how much solar comes forward under future auctions of Contracts for Difference (CfDs). More information about the policy changes about support for solar under the RO is available at https://www.gov.uk/government/consultations/consultation-on-changes-to-financial-support-for-solar-pv.

102 Solar Photovoltaics Deployment 29 January 2015, see https://www.gov.uk/government/statistics/solar-photovoltaics-deployment

103 https://www.gov.uk/government/statistical-data-sets/sub-regional-feed-in-tariffs-confirmed-on-the-cfr-statistics).

104 As set out in the Government response to the consultation on closure of the RO to solar deployment above 5MW, and its accompanying Impact Assessment, we are anticipating between 3.8 and 6.5GW of solar to be supported by the RO by the time it closes at the end of March 2017. Combined with projections of small scale solar supported under Feed-in Tariffs (FITs), we anticipate that there will be 12-14GW of solar supported. There may be more, depending on how much solar comes forward under future auctions of Contracts for Difference (CfDs). More information about the policy changes about support for solar under the RO is available at https://www.gov.uk/government/consultations/consultation-on-changes-to-financial-support-for-solar-pv

105 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/269888/131217_Electricity_Generation_costs_report_December_2013_Final.pdf

106 UK Solar PV Strategy: https://www.gov.uk/government/publications/uk-solar-pv-strategy-part-1-roadmap-to-a-brighter-future

107 Solar Photovoltaics Deployment 29 January 2015, see https://www.gov.uk/government/statistics/solar-photovoltaics-deployment

108 BIS (2015): Size and Performance of the UK's Low Carbon Economy

109 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/407059/Contracts_for_Difference_-_Auction_Results_-_Official_Statistics.pdf

110 http://specific.eu.com/

111 Footnotes to Marine key facts :

1) 2020 Deployment data covers GB. All other data covers UK.

2) Estimated Investment 2010-2014 updates 2010-2013 investment reported in the July 2014 Energy Investment Report to reflect provisional estimates of investment in 2014. Investment estimates rounded to nearest £100m.

3) Employment figures include an estimate of those employed the supply chain, and are taken from BIS (March 2015); The Size and Performance of the Low Carbon Economy.

4) Installed capacity at end of Q3 2014 taken from Energy Trends December 2014, see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/388434/et6_1.xls

5) Pipeline data has been extracted from the Renewable Energy Planning Database (, January 2015) comprising of schemes, 1 MW or greater, which have been subject of a planning application. The pipeline data excludes applications which are subject of an appeal following refusal.

   2020 deployment range taken from EMR Delivery Plan, see https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan

112 Sustainable Development Commission, Turning the Tide: Tidal Power in the UK http://www.sd-commission.org.uk/publications.php?id=607

113 Renewable Energy Country Attractiveness Index, EY, March 2015: http://www.ey.com/Publication/vwLUAssets/Renewable_Energy_Country_Attractiveness_Index_43/$FILE/RECAI%2043_March%202015.pdf

114 According to Edward Davey in his address to the UK Tidal Energy Summit, Nov 2014

115 Turning the Tide, Tidal Power in the UK, 2007, Sustainable Development Commission. http://www.sdcommission.org.uk/publications.php?id=607

Severn tidal power: feasibility study conclusions, DECC 2010. https://www.gov.uk/government/collections/severn-tidal-power-feasibility-study-conclusions

116 UK Wave and Tidal Key Resource Areas Project, The Crown Estate (2012): http://www.thecrownestate.co.uk/media/5476/uk-wave-and-tidal-key-resource-areas-project.pdf

117 https://www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/marine-energy

118 https://www.gov.uk/government/consultations/electricity-market-reform-further-consultation-on-allocation-of-contracts-for-difference

119 The TINAs are a collaborative effort of the Low Carbon Innovation Co-ordination Group (LCICG)

120 https://www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/marine-energy

121 Technology Innovation Needs Assessment – Marine Energy Summary Report, Low Carbon Innovation Co-ordination Group, August 2012. http://www.carbontrust.com/media/168547/tina-marine-energy-summary-report.pdf

122 Footnotes to Biomass and Bioenergy key facts:

1) 2020 Deployment data covers GB. All other data covers UK.

2) Estimated Investment 2010-2014 updates 2010-2013 investment reported in the July 2014 Energy Investment Report to reflect provisional estimates of investment in 2014. 2015-2020 investment range based on EMR Delivery Plan modelling, adjusted for provisional estimates of 2014 investment and updated modelling, in particular the inclusion of successful projects offered an investment contract. Investment range based on smaller range of scenarios than 2020 deployment range. Investment data includes dedicated biomass, biomass conversions, bioliquids, energy from waste, anaerobic digestion (including small scale), advanced conversion technologies, landfill and sewage gas (including Combined Heat and Power variations of any of these technologies). Investment estimates rounded to nearest £100m.

3) Employment estimates include the supply chain, and are adapted from [BIS report TBC] using ReView (REA, 2014); and DUKES (DECC, 2014). Employment estimates include biomass power generation, equipment design and production, fuel production, electricity from waste, and anaerobic digestion.

4) Data for biomass and bioenergy will include some employment attributable to heat technologies as available data is not able to be disaggregated

5) Installed capacity at end of Q3 2014 taken from Energy Trends December 2014, see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/388434/et6_1.xls. Data includes animal and plant biomass, landfill gas, sewage sludge digestion, Anaerobic Digestion, and energy from waste.

6) Pipeline data has been extracted from the Renewable Energy Planning Database (January 2015) comprising schemes, 1MW or greater, which have been subject of a planning application. The pipeline data excludes applications which are subject of an appeal following refusal.

7) Based on 2020 generation levels underpinning analysis as set out in the EMR Delivery Plan (see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/267614/Annex_D_-_National_Grid_EMR_Report.pdf) and a single scenario reflecting support for over 2GW of conversions. Data for 'other biomass' covers dedicated biomass without CHP, bioliquids with or without CHP, energy from waste without CHP, and small scale anaerobic digestion

123 https://www.gov.uk/government/publications/uk-bioenergy-strategy

124 Energy Trends, December 2014, see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/388434/et6_1.xls

125 https://www.gov.uk/government/statistics/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes

126 Drax's own calculations.

127 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/231102/RO_Biomass_Sustainability_consultation_-_Government_Response_22_August_2013.pdf

128 https://www.gov.uk/government/publications/applying-for-a-place-within-the-400mw-cap-on-new-build-dedicated-biomass-projects-renewables-obligation/applying-for-a-place-within-the-400mw-cap-on-new-build-dedicated-biomass-projects-renewables-obligation

129 CHP Quality Assurance programme

130 http://pressreleases.eon-uk.com/blogs/eonukpressreleases/archive/2014/06/25/2367.aspx

131 http://teesside.mgtpower.com/

132 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/407059/Contracts_for_Difference_-_Auction_Results_-_Official_Statistics.pdf

133 http://www.laing.com/news/221/27/John-Laing-announces-plans-to-invest-in-new-biomass-CHP-plant-in-Scotland.html

134 http://www.greeninvestmentbank.com/news-and-insight/2014/110m-funding-secured-for-biggest-waste-wood-renewable-energy-facility-in-the-north-west/

135 DECC: based on data from REPD, CHPQA, the web and stakeholder engagement.

136 http://www.rwe.com/web/cms/en/429434/rwe-innogy/sites/power-from-biomass/united-kingdom/markinch-biomass-chp-plant/

137 https://www.gov.uk/government/publications/anaerobic-digestion-strategy-and-action-plan

138 DUKES

139 https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan

140 http://www.greeninvestmentbank.com/media/25376/gib-residual-waste-report-july-2014-final.pdf

141 https://www.gov.uk/government/news/25-million-funding-for-green-transport-fuel-plants, http://www.eti.co.uk/project/waste-gasification/

142 Footnotes to Hydropower Key Facts:

1) 2020 Deployment data covers GB. All other data covers UK.
2) Estimated Investment 2010-2014 updates 2010-2013 investment reported in the July 2014 Energy Investment Report to reflect provisional estimates of investment in 2014. Investment data includes large and small scale hydro technologies. Investment estimates rounded to nearest £100m.
3) Employment figures include an estimate of those employed the supply chain, and are taken from BIS (March 2015); The Size and Performance of the Low Carbon Economy.
4) Installed capacity at end of Q3 2014 taken from Energy Trends December 2014, see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/388434/et6_1.xls
5) Pipeline data has been extracted from the Renewable Energy Planning Database (January 2015) comprising of schemes, 1MW or greater, which have been subject of a planning application. The pipeline data excludes applications which are subject of an appeal following refusal.
6) 2020 deployment range inclusive of both large and small scale deployment. Data presented inclusive of c1.7 GW large scale deployment as set out in EMR Delivery Plan, see https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan

143 Source: Energy Trends, December 2014, table 5.1, at: https://www.gov.uk/government/statistics/electricity-section-5-energy-trends. 2013 Q4 to 2014 Q3

144 DECC Feed in Tariff statistics: https://www.gov.uk/government/collections/feed-in-tariff-statistics

145 For example Fasnakyle was constructed in 1951.

146 Opportunity and environmental sensitivity mapping for hydropower in England and Wales, March 2010: http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/geho0310bryf-e-e.pdf

147 http://www.greenhighland.co.uk/

148 Footnotes to key facts for nuclear:

1) 2010-2014 investment estimate includes the purchase and development of Horizon Nuclear Power by GE Hitachi, the purchase of the Moorside site by NuGen and expenditures in the period relating to the development of Hinkley Point C.
2) Employment level: Source: BIS (March 2015); The Size and Performance of the Low Carbon Economy.
3) Installed Capacity at end of 2013, taken from Digest of UK Energy Statistics, 2014, table 5.12, at: https://www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes

149 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/338750/DUKES_2014_printed.pdf table 5.10

150 http://world-nuclear.org/info/Facts-and-Figures/World-Nuclear-Power-Reactors-and-Uranium-Requirements/

151 http://www.niauk.org/nuclear-energy-worldwide

152 http://www-pub.iaea.org/MTCD/publications/PDF/Pub1201_web.pdf (more than half of which is of cold war legacy facilities)

153 http://www.nda.gov.uk/publication/supply-chain-development-statistics-analysis-and-summary-of-findings-2013-14/?download

154 All figures supplied by the NDA

155 https://www.gov.uk/government/news/peterhead-carbon-capture-and-storage-project

156 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48317/4899-the-ccs-roadmap.pdf

157 https://www.gov.uk/government/news/draxdrax

158 https://www.gov.uk/government/news/peterhead-carbon-capture-and-storage-project

159 Next Steps in CCS: Policy Scoping Document. Developing an approach for the next phase of Carbon Capture & Storage projects in the UK': https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/341995/Final_Version_Policy_Scoping_Document_PSD.pdf

160 http://www.publications.parliament.uk/pa/cm201415/cmselect/cmenergy/638/63804.htm

161 https://www.gov.uk/government/publications/cross-government-carbon-capture-and-storage-r-d-programme-2011-2015-list-of-projects

162 https://www.gov.uk/government/news/funding-for-innovation-in-cleaner-more-efficient-fossil-fuels

163 https://www.gov.uk/government/publications/energy-entrepreneurs-fund-phase-4-documentsdocuments

164 http://www.eti.co.uk/category/proposals/

165 'The economic benefits of carbon capture and storage in the UK', TUC and CCS Association: http://www.tuc.org.uk/sites/default/files/carboncapturebenefits.pdf

166 Based on an installed capacity of 10 or 20 GW

167 Footnotes to key fact on renewable heat supported by the RHI:

1) Estimate of investment (capital cost of renewable heat technologies) supported by the RHI (non-domestic scheme) and Renewable Heat Premium Payment scheme (the pre-cursor to the domestic RHI that closed at end 2013/14) based upon heat deployment levels for years shown
2) "Jobs Supported" figures are based upon RHI central renewable heat deployment projection. See Annex 10 in: https://www.gov.uk/government/consultations/renewable-heat-incentive-expanding-the-non-domestic-scheme
3) Installed Capacity at end of Q3 2014 (GW) is for non-domestic RHI scheme only
4) "2020 RHI Renewable Heat Deployment Range (TWh)" is based upon RHI low and high renewable heat deployment projections

168 DECC Estimate, based on ECUK 2014 Table 1.07 and DUKES 2014 Table1.1.

169 The Product Characteristics Database: www.ncm-pcdb.org.uk

170 The Future of Heating: Meeting the Challenge", page 74, DECC, 2013 combined with evaluation of the Boiler Scrappage Scheme (eg http://www.energysavingtrust.org.uk/Publications2/Energy-efficiency/English-Boiler-Scheme-Scrappage-evaluation-report)

171 The Future of Heating: Meeting the Challenge", page 74, DECC, 2013

172 The Future of Heating: Meeting the Challenge", page 74, DECC, 2013

173 Policy Impacts on Prices and Bills", DECC, 2013 and DECC estimate, drawing on work for "The Carbon Plan: delivering our low carbon future", HM Government, 2011

174 "Estimated Investment 2013/14-2020/21(£2012)" and "Jobs Supported" figures are based upon RHI central renewable heat deployment projection. See Annex 10 in: https://www.gov.uk/government/consultations/renewable-heat-incentive-expanding-thenon-domestic-scheme

175 Source: Ofgem

176 https://www.gov.uk/government/statistics/rhi-deployment-data-january-2015. 'Legacy' refers to all applications for systems installed before the launch of the domestic RHI scheme on 9 April 2014, whether they claimed a RHPP voucher or not.

177 https://www.gov.uk/government/news/94-million-to-boost-low-carbon-heating b) https://www.gov.uk/government/news/3-million-funding-to-boost-low-carbon-heating

179 Delivering UK Energy Investment: Networks, DECC, January 2015: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/394509/DECC_Energy_Investment_Report_WEB.pdf and Macro Distributed Energy Project Report, Energy Technologies Institute, March 2013

180 https://www.gov.uk/government/consultations/renewable-heat-incentive-expanding-the-non-domestic-scheme

181 https://www.gov.uk/government/consultations/renewable-heat-incentive-expanding-the-non-domestic-scheme

182 https://www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/renewable-heat-incentive-rhi

183 Delivering UK Energy Investment: Networks, DECC, January 2015: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/394509/DECC_Energy_Investment_Report_WEB.pdf

184 Delivering UK Energy Investment: Networks, DECC, January 2015: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/394509/DECC_Energy_Investment_Report_WEB.pdf and Annexes to The Future of Heating: Meeting the Challenge, DECC, March 2013

185 Meeting Carbon Budgets –2014 Progress Report to Parliament, http://www.theccc.org.uk/wp-content/uploads/2014/07/CCC-Progress-Report-2014_web_2.pdf

186 Delivering UK Energy Investment: Networks, DECC, January 2015: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/394509/DECC_Energy_Investment_Report_WEB.pdf; https://www.gov.uk/government/news/3-million-funding-to-boost-low-carbon-heating

187 Delivering UK Energy Investment: Networks, DECC, January 2015: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/394509/DECC_Energy_Investment_Report_WEB.pdf

188 Delivering UK Energy Investment: Networks, DECC, January 2015: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/394509/DECC_Energy_Investment_Report_WEB.pdf

189 “Projections of CHP capacity and use to 2030”, Ricardo-AEA, 2013

190 For more information, see https://www.gov.uk/combined-heat-and-power

191 For more information, see https://www.gov.uk/combined-heat-and-power

192 https://www.gov.uk/government/statistics/rhi-deployment-data-january-2015

https://www.gov.uk/government/statistics/rhi-and-rhpp-deployment-data-december-2014

193 Figures supplied by ReFood

194 https://www.gov.uk/government/news/cutting-edge-low-carbon-energy-projects-get-5-million-funding-boost

195 http://www.lowcarboninnovation.co.uk/

196 https://www.gov.uk/innovation-funding-for-low-carbon-technologies-opportunities-for-biddersbidders

197 Ibid

198 http://www.lowcarboninnovation.co.uk/working_together/technology_focus_areas/overview/

199 http://www.euenergyfocus.co.uk/

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Quotations

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Department of Energy &
Climate Change
3 Whitehall Place London
SW1A 2AW
www.gov.uk/decc
URN: 14D/180