DEPARTMENT OF ENERGY & CLIMATE CHANGE

UK Renewable Energy Roadmap

July 2011

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Ministerial Foreword

The nations of the United Kingdom are endowed with vast and varied renewable energy resources. We have the best wind, wave and tidal resources in Europe.

The UK leads the world in offshore wind, with more than 700 turbines already installed, and is accelerating the deployment of onshore wind with the biggest projects in Europe already operating and under construction in Scotland and Wales. Taken together onshore and offshore wind provide enough power for more than two and a half million homes. But we could do so much more. Our challenge is to bring costs down and deployment up.

This document – the UK's first Renewable Energy Roadmap – sets out our shared approach to unlocking our renewable energy potential.

This UK Roadmap builds on the actions already underway: financial support mechanisms for renewables, the Green Investment Bank to help companies secure investment in green infrastructure, and encouraging the development of new offshore wind manufacturing facilities at port sites.

The Government's Electricity Market Reform White Paper, published alongside this Roadmap, sets out our reforms to the separate Great Britain and Northern Ireland markets for all forms of electricity generation. Reform will ensure that low-carbon electricity from a diverse range of sources - not just renewables - becomes a more attractive choice for investors, delivering long-term change while minimising cost to the consumer.

Renewable energy isn't just about electricity. This year, we worked together to create the world's first incentive to support the widespread deployment of renewable heat. This new financial mechanism will encourage installation of equipment like heat pumps and biomass boilers – reducing emissions and supporting 150,000 jobs in the UK's heating industry.

Likewise, the Renewables Transport Fuels Obligation and support of over £400million to increase uptake of ultra-low carbon vehicles will help to reduce the carbon impact of transport. The UK Government will also be publishing a Bioenergy Strategy by the end of this year to give a clear signal on the most cost-effective and sustainable role for bioenergy in heat, transport and electricity, which between them could contribute around half of the overall 2020 target.

We also recognise the need to reduce demand. Energy efficiency is the most cost effective way of closing the gap between supply and demand, which is why we have launched the Green Deal and the roll out of smart meters in Great Britain. Much is already being done across the UK yet there are other opportunities to tap into energy efficiency potential, which will be a key area of work for the new Office of National Energy Efficiency working alongside the Office for Renewable Energy Deployment in partnership with the Devolved Administrations.

Renewable energy already employs more than a quarter of a million people; by 2020, it could be over half a million. The creation of jobs in the renewable energy sector, investment in new manufacturing capability, and the consequent direct and indirect benefits will support our transition to a green economy.

Getting more renewable energy across the UK can give us much more security and a greater degree of energy independence – helping to shield us from global fossil fuel price fluctuation.

Timely investments will ensure renewable energy will have a long-term role to play as part of a mix of low carbon generation. Alongside energy efficiency, nuclear, and carbon capture and storage, renewable energy will help reduce UK emissions in line with our carbon budgets and help keep us on track to hit our 2050 target – an 80% cut in emissions.

To consider how we might get there, the UK Committee on Climate Change have published renewable energy scenarios to 2030. The UK Government will respond to this advice by the end of the year; this response, alongside the Annual Energy Statement and policies to meet the 4th Carbon Budget, will place renewables firmly within the energy mix.

The time for broad strategy statements has passed. The UK Renewable Energy Roadmap sets out a comprehensive suite of targeted, practical actions to accelerate renewable energy in the UK – driving innovation and the deployment of a wide range of renewables. It will help the UK Government meet our EU 2020 target, and should ensure that the cost of renewable energy falls over time. It complements and strengthens parallel activity by the Devolved Administrations in Wales, Scotland and Northern Ireland, each of which has set its targets and ambitions, which taken together make a major contribution to renewable deployment.

By working together we can build a cleaner, greener energy future. This UK Renewable Energy Roadmap helps to show us the way.

Rt Hon Chris Huhne MP
Secretary of State for
Energy and Climate Change

Rt. Hon Carwyn Jones AM
First Minister of Wales

Arlene Foster, MLA
Minister of Enterprise,
Trade and Investment

Fergus Ewing MSP
Minister for Energy,
Enterprise & Tourism

Executive Summary

The Coalition Government has made clear its commitment to increasing the deployment of renewable energy across the UK in the sectors of electricity, heat and transport. This will make the UK more energy secure, will help protect consumers from fossil fuel price fluctuations, is driving investment in new jobs and businesses in the renewable energy sector, as well as keep us on track to meet our carbon reduction objectives for the coming decades. Renewables will be a key part of the decarbonisation of the energy sector necessary by 2030, alongside nuclear, carbon capture and storage, and improvements in energy efficiency.

Over the last year the Office for Renewable Energy Deployment in DECC, has been working with market participants and others from across the renewables sector to better understand how much renewable energy can be deployed through to 2020, and to identify the current constraints which must be addressed to allow this rapid transformation.

The result, from multiple sources, forms the heart of this plan – a delivery Roadmap to set us on the path to achieve the UK's renewable energy target over the next decade.

Our evidence shows that:

- Even though we are starting from a low level, the UK can meet the target to deliver 15% of the UK's energy consumption from renewable sources by 2020. Recent 'bottom-up' analysis, tested with industry, suggests that there is significant upside potential as well as downside risk to deployment;

- Based on current information, and taking account of their long term potential as well as their cost effectiveness, 8 technologies are capable of delivering more than 90% of the renewable energy we need for 2020;

- Renewable electricity has become well established. The existing pipeline[1] of large-scale projects is strong, and allowing for historic dropout rates, has the potential to put us on track to deliver a total of 29 GW of operational capacity by 2020;

- The pipeline for renewable heat projects is less well developed, but following the introduction of the world's first incentive for renewable heat, could deliver as many as 124,000 renewable heat installations by 2020;

- Road transport biofuels already make up over 3% by volume of all road transport fuels and are proposed to increase to 5% by 2014. Subject to the results of current consultations, Government will come forward with options

[1] Source: Renewable Energy Planning Database (REPD). REPD planning data does not currently pick up conversion from coal plant or new-build capacity for co-firing.

in Spring 2012 for the period after 2014;

- The costs of renewable energy technologies are uncertain but are expected to fall over time as supply chains develop, technical challenges are overcome, and the cost of capital reduces with lower risk;

- There are cross cutting barriers to deployment for all or many of the renewable energy technologies as well as barriers that apply to specific technologies, all of which need to be addressed to achieve our aims for deployment and cost reduction.

This Roadmap shows where we are now; analysis of how deployment may evolve by 2020, together with separate estimates of the market's view of the potential; and the actions required to set us on the path to achieve the deployment levels anticipated in our analysis.

While renewable deployment across all technologies will be important, the Roadmap focuses in particular on the 8 technologies that have either the greatest potential to help the UK meet the 2020 target in a cost effective and sustainable way, or offer great potential for the decades that follow. The key actions in this Roadmap for each of the 8 technologies are:

- **Onshore wind:** Provide long term certainty for investors through electricity market reform and a managed transition from the Renewables Obligation. Reform the planning system to ensure it supports economic growth and gives communities a greater stake in development. Co-fund the development of technical solutions to overcome windfarm interference with aviation radar and broker roll-out plans, including through a new Memorandum of Understanding with industry. Upgrade onshore transmission capacity and ensure that developers secure timely and cost-effective access to the network and put in place a process to monitor delivery;

- **Offshore wind:** Establish an industry Task Force to set out a path and action plan to reduce the costs of offshore wind to £100/MWh by 2020. Provide up to £30m of direct Government support for offshore wind cost reduction over the next 4 years. Work through the Offshore Wind Developers Forum to support the development of the supply chain alongside action to encourage new manufacturing facilities at port sites. Manage conflicts with oil and gas exploration, provide greater certainty over financial incentives, and ensure timely and coordinated development of the grid through the Offshore Transmission Coordination Project;

- **Marine energy:** Provide up to £20m over the next 4 years to support innovation in wave and tidal devices and commission marine energy testing facilities at the National Renewable Energy Centre (NaREC) early in 2012. Work with The Crown Estate to introduce a knowledge sharing network to accelerate the level of marine energy deployment. Provide guidance to the sector by March 2012 to help develop Marine Energy Parks in order to stimulate the supply chain. Manage potential conflicts with other users of the

sea by working with marine regulators and publishing later this year the response to the wave and tidal elements of the Offshore Energy Strategic Environmental Assessment;

- **Biomass electricity:** Publish a UK Bioenergy Strategy later this year articulating a clear vision for the growth of sustainable biomass energy in the UK. Apply the Strategy in deciding, a year ahead of the original timetable, new Renewables Obligation bands to come into force from April 2013, and link payments to sustainability standards from April 2013. Focus on measures to support long-term waste fuel supplies including through possible landfill restrictions on waste wood. Work with regulators to introduce cost effective fuel monitoring and sampling systems and ensure that environmental legislation does not have an unintended impact on renewable energy plant;

- **Biomass heat:** Increase the attractiveness of biomass heat and biomethane injection into the grid through introduction of the Renewable Heat Incentive (RHI) and the Renewable Heat Premium Payment (RHPP) in Great Britain. Consult this summer on a new scheme to support renewable heat in Northern Ireland subject to agreement of the Northern Ireland Executive. Ensure sustainability of biomass heat through the introduction of reporting criteria for feedstock from 2011 and emission performance standards under phase 2 of the RHI. Work with regulators to enable Anaerobic Digestion plant to benefit from reduced regulatory burdens and faster permitting, including whether it is appropriate to amend regulations which apply to biogas injection to the grid;

- **Ground source and air source heat pumps**: Introduce the RHI for non-domestic installations and the RHPP for eligible domestic scale heat pumps. Streamline the planning and consenting processes through the provision of guidance for open-loop ground source heat pumps and permitted development rights for some air source heat pumps on domestic properties. Collect data on how best to improve heat pump performance and raise the technical abilities of installers by tightening standards of training under the Microgeneration Certification Scheme;

- **Renewable transport:** Identify and agree a preferred approach to achieve the 2020 transport sub-target, and actions for implementation after 2014. Consider the European Commission's proposals on Indirect Land-Use Change impacts of biofuels with a view to ensuring effective standards. Support the market for plug-in vehicles by making up to £30m available for investment in recharging infrastructure and providing a grant of up to 25% of the purchase price (capped at £5000) for eligible electric, plug-in hybrid or hydrogen fuel cell cars.

Taking these actions will not only help drive deployment across the UK but will also be key to reducing the costs of renewables, enabling technologies to mature so that over the medium to long-term they no longer need additional support to compete on a level playing field against other low carbon

technologies.

Of course, technology costs, innovation breakthroughs and barriers to deployment will change over time. Government will closely monitor deployment and the development of the market. We will update the Roadmap on an annual basis so that we know how we are doing and whether other technologies can make a bigger or cheaper contribution than is assumed here.

We want the UK to be the location of choice for inward investment and a world class centre of energy expertise. The actions set out in this Roadmap will enable us to successfully exploit our renewable resources, make a strong contribution to our energy needs, provide opportunities for jobs and wealth creation, and contribute to efforts to reduce emissions of harmful greenhouse gases.

Chapter 1 - Introduction

Government commitment to renewables

1.1 The Coalition has made clear its commitment to increase the amount of renewable energy deployed in the UK. This will make the UK more energy secure, will help protect consumers from fossil fuel price fluctuations, will help drive investment in new jobs and businesses in the renewable energy sector, as well as keep us on track to meet our carbon reduction objectives for the coming decades.

1.2 Our goal is to ensure that 15% of our energy demand is met from renewable sources by 2020 in the most cost effective way. Ambition is equally strong across all areas of the UK, where the Devolved Administrations have set themselves challenging domestic targets for both the level of renewable electricity and heat consumption by 2020.

Ambitions in Scotland, Wales and Northern Ireland

All across the UK, action is being taken to use our significant resources to deploy renewables still further and faster, ensuring security and sustainability of energy supply. In addition to the overarching UK renewables target, the Devolved Administrations have set ambitious but achievable targets at a domestic level:

- The Scottish Government has introduced a target to deliver 100% renewable electricity by 2020;
- The Northern Ireland Executive has a target to deliver 40% renewable electricity and 10% renewable heat by 2020;
- The Welsh Government has indicated that it has the potential to produce twice the amount of electricity it currently uses from renewable sources by 2025, and deliver 4 GW of this from marine energy.

1.3 Our ambition extends beyond 2020. Recent independent advice[2] from the Committee on Climate Change (CCC) has made clear the long term role for renewable energy. The CCC concluded that there is scope for the penetration of renewable energy to reach 30 - 45% of all energy consumed in the UK by 2030. CCC also recognised that achieving this level of growth would require resolution of current uncertainties and cost reductions. This Roadmap sets out how we will tackle the non-financial barriers to renewables deployment, enabling the market to grow in line with our goals for 2020 and beyond.

[2] UK Government commissioned independent advice on the level of ambition for renewable energy to 2020 and 2030 from the Committee of Climate Change (CCC). The UK Government will respond to the CCC recommendations alongside the 4th Carbon Budget later this year.

Ensuring value for money

1.4 Securing renewable sources of energy is a key pillar of the UK Government's strategy for a diverse, low carbon energy system alongside nuclear, cleaner coal and gas, and energy efficiency. However, as a relatively new, emerging set of technologies, renewables tend to be more expensive than existing fossil fuel generation.

1.5 Doing nothing is not necessarily the least cost option given the potential price rises of fossil fuels in the future and the potential impacts on security of supply. However, there is a clear need to deliver our goals in a way that is consistent with sustainable economic growth and minimising the impacts of energy and climate change policies on consumer bills. We are already taking steps to maximise cost effectiveness and value for money through:

- **Undertaking regular review of technology costs**: Renewable technology costs are expected to fall with time. It is our responsibility to ensure that developers have an adequate incentive to drive early deployment but that they are not overcompensated at the expense of the consumer;

- **Tackling non-financial barriers and supporting the supply chain**: Take action to help drive down technology costs, and support inward investment in the supply chain to increase competition and move manufacturing closer to the point of installation;

- **Working within public spending and affordability limits**: Manage our policies to stay within cost limits and achieve our goals in a way that is consistent with sustainable economic growth and minimising the impact on consumer bills;

- **Reforming the electricity market**: The package of Electricity Market Reform (EMR) measures has been designed to be the most cost effective means to meet our energy and climate change objectives. This means that, while electricity bills are expected to increase in the years ahead due in part to rising wholesale electricity and carbon prices, our reforms are likely to limit this increase for domestic, non-domestic and energy intensive consumers;

- **Promoting energy efficiency**: Our target is a percentage of overall energy consumption, if we can reduce our consumption we reduce our need for deployment. Reduced energy consumption will also reduce bill impacts.

1.6 Alongside these steps to reduce the costs of domestic action, we have the potential to work with our European partners on renewables deployment. This could provide an important mechanism to safeguard UK consumers in the event that the costs of domestic deployment do not come down sufficiently, and alternative, cheaper opportunities arise in other countries where the UK could "trade" through the use of the flexibility mechanisms in the Renewable Energy Directive.

1.7 This should not be viewed as a one-way exercise – trading presents an opportunity for the UK. We have an abundant offshore wind resource and could also export energy generated in UK waters to neighbouring Member States. As part of this we could see offshore wind projects connected across the British Isles and to mainland Europe, increasing our security of supply as part of an "All Islands Approach", and providing new manufacturing and jobs in the renewable energy sector in the UK. We will look to ensure that we have powers to enable both export and import of renewable energy under the flexibility mechanisms in the Renewable Energy Directive where this can secure the greatest benefit to the UK.

Box 1: All Islands Approach

Ministers from the British Isles, the Channel Islands and the Isle of Man recently signed up to co-operate on exploiting the major wind and marine resources in and around the islands. The nations involved agreed to co-operate in an All Islands Approach to energy in the June 2011 British Irish Council held in London.

The All Islands Approach to energy resources across the British Islands and Ireland will encourage and enable developers to exploit commercial opportunities for generation and transmission, facilitate the cost-effective exploitation of the renewable energy resources available, and increase integration of our markets and improves security of supply.

Optimising the natural resource available around our islands would benefit us all. It makes sense to develop and share clean, green secure energy with our neighbours rather than import vast amounts of fossil fuels from far flung parts of the world. In practice, more interconnection between the islands would mean that on, for instance, a very windy day in mainland Britain, surplus power could be sold to Ireland and mainland Europe, as well as enabling imports of electricity from Ireland and mainland Europe, when required.

The approach will encourage and enable developers to exploit commercial opportunities for generation and transmission, facilitate the cost-effective exploitation of the renewable energy resources available, and increase integration of members markets and improve their security of supply.

The Renewable Energy Roadmap

1.8 Over the last year the Office of Renewable Energy Deployment has been working with industry, financiers, the Devolved Administrations and others to understand recent trends in renewables deployment in the UK, and the pipeline of projects that could come forward before 2020, as well as the barriers that need to be overcome to enable these projects to be delivered successfully and cost effectively. This document sets out that analysis together with a targeted programme of action that Government is taking to increase renewables deployment.

1.9 This Roadmap is the first of a kind. Whilst it sets out a comprehensive programme of action, it also recognises that the barriers to deployment,

technology costs, and innovation breakthroughs will change with time. The Roadmap establishes a process of monitoring and evaluation that will enable us to adjust our approach. We propose to publish updates on an annual basis.

Chapter 2: Analysis

2.1 We have gathered evidence on the potential deployment and costs of renewable energy technologies to 2020. This has allowed us to understand how, and with which mix of technologies, the market can deliver 15% of our energy consumption from renewable sources by 2020.

2.2 We have also examined the most recent data on current deployment levels and projects which are in the pipeline for possible deployment in the future. By comparing the potential level of deployment in 2020 against baseline data we have estimated growth rates for each technology and, where possible, how much of the increase could be met from projects already in the pipeline.

2.3 Analysis of the pipeline has also allowed us to map the stages of deployment for key technologies, identify the challenges they face, and develop a targeted programme of actions.

Deployment of renewable energy to 2020

2.4 Our analysis of potential deployment to 2020 considers factors such as technology cost, build rates, and the policy framework. These variables have been modelled to produce illustrative 'central ranges' for deployment.

2.5 The central ranges do not represent technology specific targets or the level of our ambition. They are based on our current understanding of deployment, costs and non-financial barriers and could change significantly as the market evolves to 2020[3]. Indeed in some cases – such as for offshore wind – we are targeting specific actions to reduce cost and increase likely deployment. In others, forthcoming work – including on the RO Banding Review consultation and decisions on biofuels – could have an impact. We will update our analysis annually to reflect the evolution of policy and observed levels of deployment.

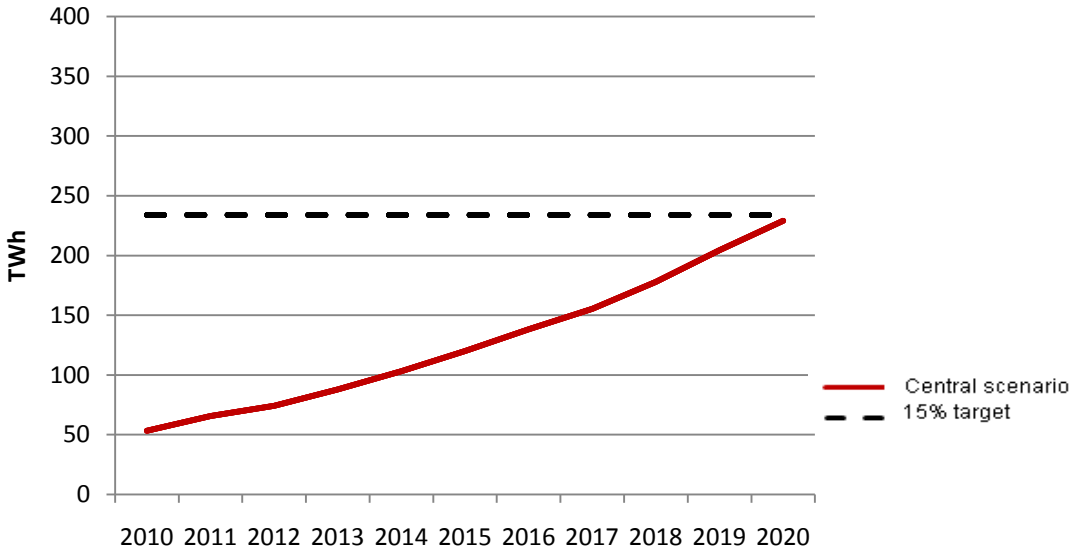
2.6 Figure 1 aggregates the central view of deployment across technologies. It illustrates that, despite uncertainty about the contribution from individual technologies (discussed in Chapter 3), the UK can deliver 234 TWh of renewable energy overall in 2020 – equivalent to 15% of our projected energy consumption[4]. Whilst the contribution from individual technologies could vary, underachievement on one will allow the UK to deliver more of another within its financial support framework[5].

[3] Figures for the heat sector reflect uncertainty in potential growth rates and the rates of return needed to incentivise take-up. In the electricity sector the range reflects preliminary analysis of the uncertainty of the impact on deployment of changes to fossil fuel prices, future cost reductions, the success of overcoming non-financial barriers to deployment.

[4] Energy demand is forecast to be 1557 TWh in 2020 in the Government's central projection on the RED definition.

[5] In the case of renewable transport, targets for biofuels have not yet been set beyond 2014.

Figure 1: Central view of deployment and the 15% target



2.7 The analysis also indicates that approximately 90% of the generation necessary to meet the 15% target can be delivered from a subset of 8 technologies (set out in Figure 2 below). These technologies are particularly significant due to their cost effectiveness, potential level of deployment, and importance to the UK's 2050 energy mix.

Figure 2: Technology breakdown (TWh) for central view of deployment in 2020

	Central range for 2020 (TWh)
Onshore wind	24-32
Offshore wind	33-58
Biomass electricity	32-50
Marine	1
Biomass heat (non-domestic)	36-50
Air-source and Ground-source heat pumps (non-domestic)	16-22
Renewable transport	Up to 48TWh
Others (including hydro, geothermal, solar and domestic heat)	14
Estimated 15% target	234

2.8 This Roadmap, and our action to tackle non-financial barriers to deployment, is focused on these 8 technologies. The remaining renewable energy generation necessary to meet the 2020 target will come from technologies such as hydropower, solar PV, and deep geothermal heat and power. These will generally qualify for renewable financial incentives and will benefit from action to unblock cross-cutting non-financial barriers, including those set out in the recent Microgeneration Strategy for England. Microgeneration technologies will also benefit from the Government's commitment to Zero Carbon Homes.

Case study: Solar PV

Solar photovoltaic (PV) technology has shown significant development in recent years, with ongoing technological improvements and capital costs falling. By the end of May 2011 nearly 38,000 solar PV installations in Great Britain were receiving support through the Feed-in Tariff (see below).

The appetite for solar PV technology is global, led by a number of major international markets, and this wide uptake is playing a major part in driving down costs. Modules and inverters account for over half of the final cost of an installation, and we understand that this is where there is greatest scope for further cost reductions. As a relatively small player in the international solar PV market, the UK is necessarily a "price taker" – we benefit from the global cost reductions.

The Government believes that solar PV could potentially have a role to play in larger-scale UK renewables deployment in the future, though this will depend on a number of factors. One of these is that sufficient cost reductions will need to be achieved so that the viability of projects is not dependent on significant subsidy. Work for industry[6] suggests that this point may be reached during this decade.

To demonstrate our commitment to solar PV as a large scale generation source in the UK, the Government currently provides financial support for the technology through the Renewables Obligation. The rate is set so that solar PV can be supported and contribute to large-scale renewables generation and to encourage cost reduction to improve its competitiveness against more established technologies. The Renewables Obligation is subject to a Banding Review this year, with new rates to take effect from April 2013.

In addition, at present the Feed-in Tariffs scheme supports small-scale solar PV generation such as the solar tiles on the roof of the house illustrated above. The scheme is currently being reviewed; new rates for PV installations over 50 kW will take effect from 1 August 2011, and any further rate changes that arise from the review for installations at all scales will take effect from April 2012 (unless the review reveals the need for greater urgency).

Uncertainties in delivering our 2020 ambition

2.9 In developing a programme of action for renewables it is also important to take account of wider uncertainty. Key uncertainties include future energy demand, the cost of technologies, and the level of renewable energy deployment which industry believes can be achieved.

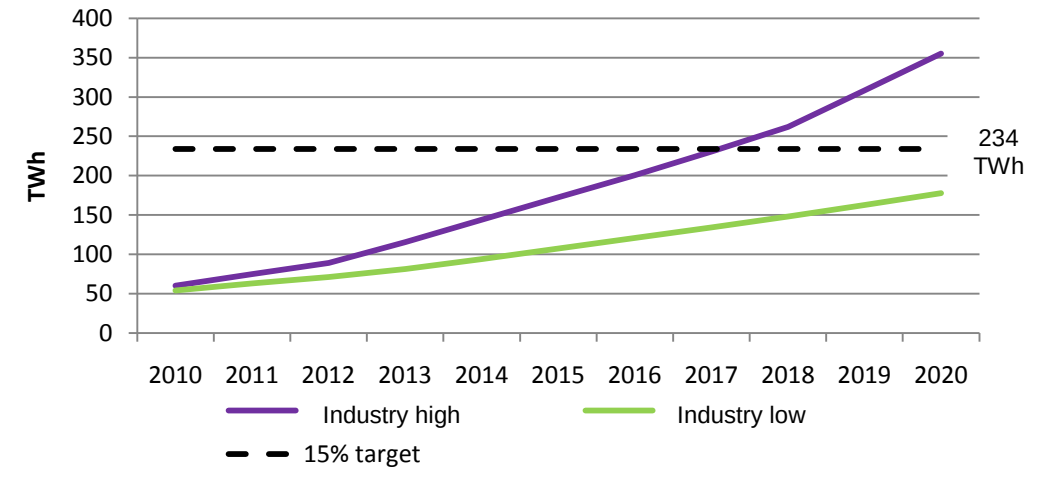
[6] UK solar PV industry outlook: The UK 50 kW to 5 MW solar PV market (Ernst & Young, June 2011) www.oursolarfuture.org.uk/wp-content/uploads/The-UK-50kW-to-5-MW-solar-PV-market-190611-Final.pdf

2.10 To illustrate the uncertainty around deployment potential we have gathered initial views from the market[7] about the range of growth levels they considered feasible for individual technologies. The analysis, set out in Box 2, shows that there is significant upside potential to deployment if markets develop more quickly than expected (the 'industry high' scenario) but also downside risk if we are less successful in removing barriers ('industry low')[8].

Box 2: Industry deployment scenarios

DECC's work on deployment uncertainty to 2020 relies on analysis by AEA Technology, who used published literature and discussions with industry to arrive at an initial view of the market's ability to deploy renewables across the decade. The analysis was stakeholder-focused and was 'bottom up' (based on considering the market's appetite for individual technologies and projects) rather than the 'top-down' model-based approach. The results, presented in Figure 3, were subsequently tested with a wide range of companies.

Figure 3: Upside potential and downside risks to deployment – industry scenarios



2.11 In Chapter 3 we overlay industry high and low scenarios for each technology around the central ranges discussed above. For most technologies the central range lies inside the industry scenarios, although for marine this is not the case – a difference which reflects the greater levels of uncertainty for early-stage technologies.

2.12 Recent work for DECC suggests that, although renewable electricity[9] and heat[10] technologies are generally more expensive than fossil fuel generation,

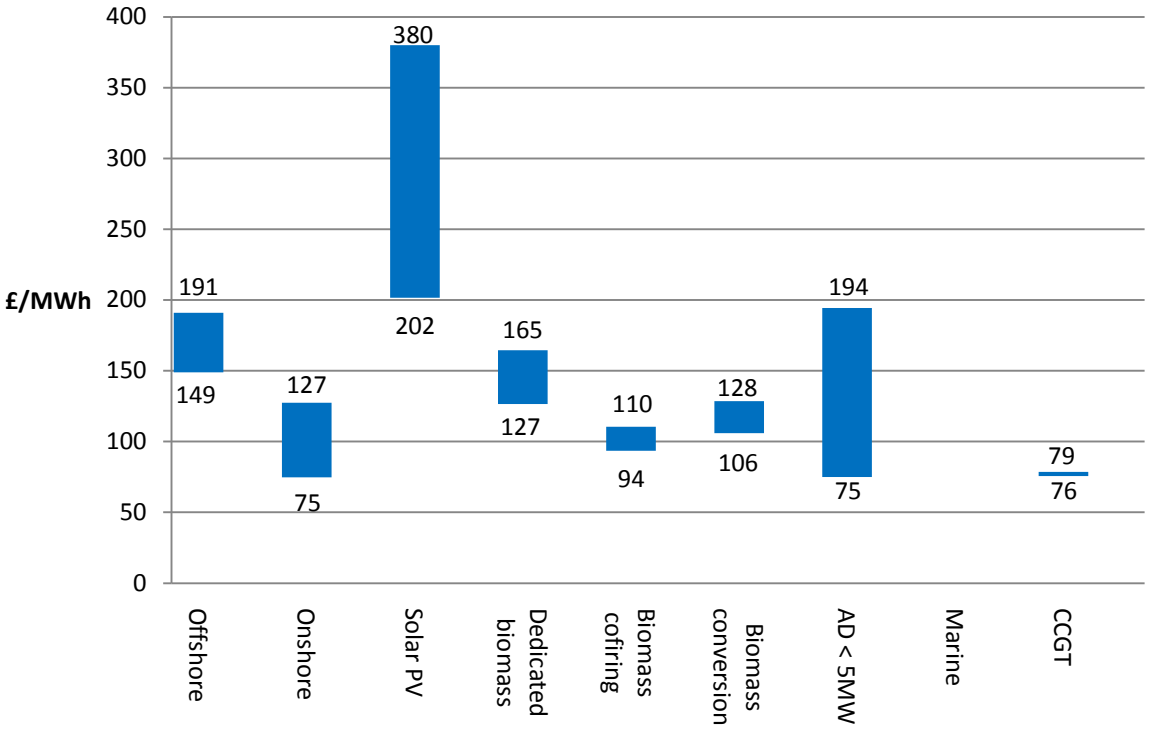
[7] *Analysis of Renewables Growth to 2020*, AEA Technology.

[8] Scenarios presented in Box 2, and by technology in Chapter 3, do not include contribution we expect from domestic heat (for which policies are being finalised) and use different load factors from central range.

[9] Costs are expressed in 2010 prices. Costs for renewable electricity are based on capital and operating costs, including fuel costs, provided by Arup and Ernst & Young to inform the 2011 Banding Review. Costs for CCGT are based on work by PB Power. Cost ranges are based on varying capital costs. Costs for 2020 for offshore wind reflect both Round 2 project and Round 3 projects / projects in Scottish Territorial Water projects,

costs are uncertain and are likely to come down over the longer term. The results of our analysis are set out in Figures 4-7 below for projects achieving financial close in 2010 or 2020.

Figure 4: Estimated levelised cost ranges for electricity technologies in 2010



whereas the figures for 2010 reflects only Round 2. There is no data for marine in 2010 as the marine technologies which are of interest for 2020 have not yet been fully commercially deployed.

[10] Cost ranges for heat are based on capital, borrowing, operating, fuel and barrier costs provided by AEA Technology to support development of the Renewable Heat Incentive. They refer to non-domestic sector installations. Due to a lack of reliable data we assume that costs for biogas are fixed over time.

Figure 5: Projected levelised cost ranges for electricity technologies in 2020

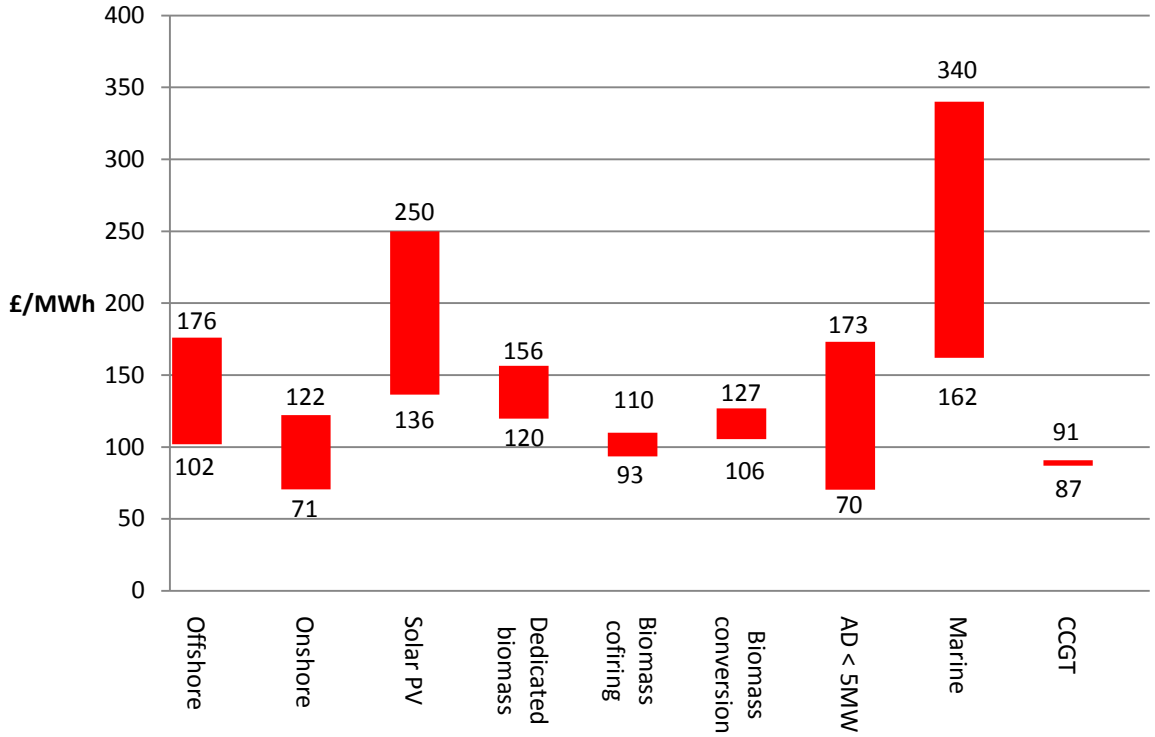


Figure 6: Estimated levelised cost ranges for heat technologies in 2010

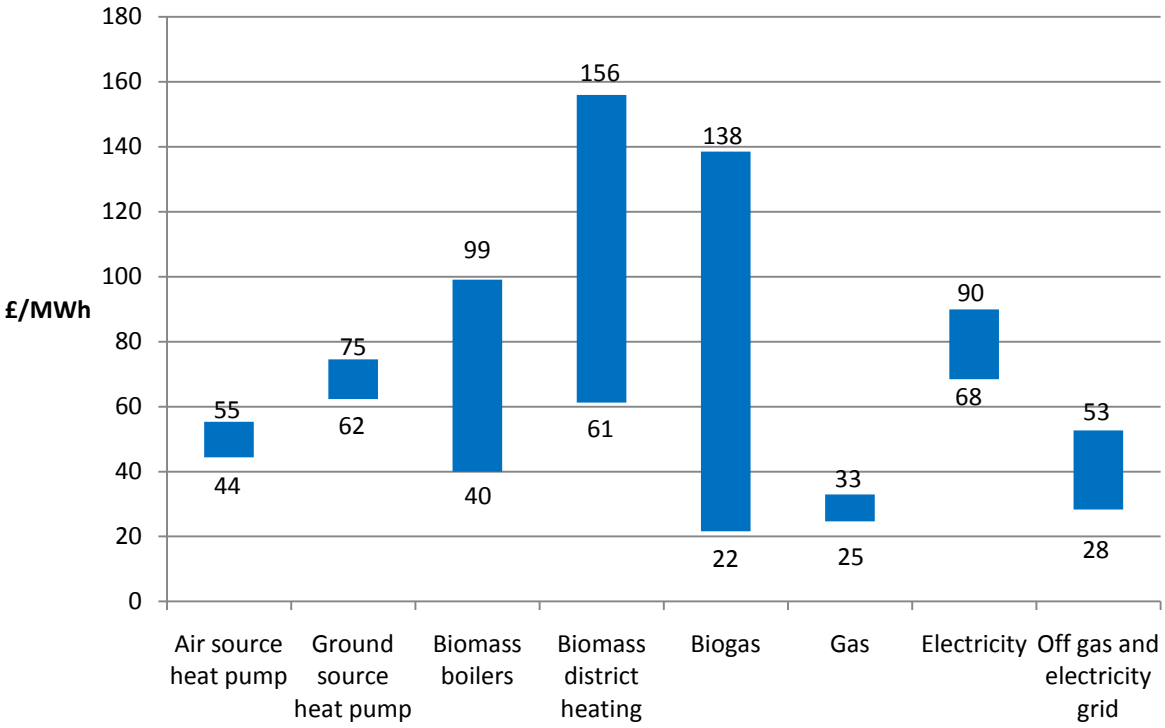
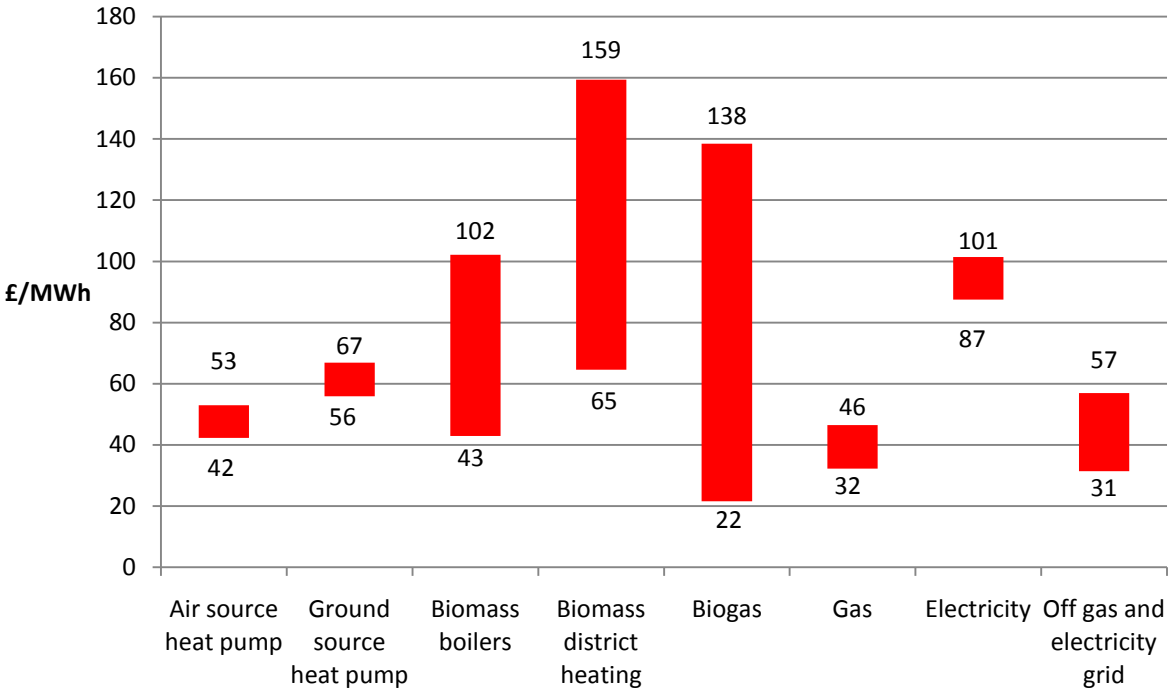


Figure 7: Projected levelised cost ranges for heat technologies in 2020



2.13 The range of cost uncertainty is particularly large for technologies such as marine, which is at the early stages of commercial deployment in the UK, and biomass heat technologies, for which supply chains have not yet been tested at scale. Cost reductions are expected to be most pronounced for electricity technologies, particularly offshore wind and solar PV, as supply chains and technologies develop to 2020. The cost of generating heat and electricity from fossil fuels is also expected to rise over time.

2.14 It is essential that costs of renewable technologies fall over the decade as deployment increases. Our goal in the medium to long term is to help renewables compete on a level playing field against other low carbon technologies. We will regularly review our subsidy programmes to take account of cost changes from supply chain development, learning, and technical breakthrough.

2.15 Uncertainty about projected energy demand is also a consideration. DECC analysis suggests that uncertainty around factors such as GDP growth, prices, consumer behaviour and the impact of energy efficiency policy mean that total energy demand could vary from our central projection. Our estimates suggest a margin of uncertainty of at least +/- 8% from our 2020 central estimate of 1,557 TWh. An increase of 8% would add around 19 TWh to our deployment goal of 234 TWh for 2020. DECC's Office of National Energy Efficiency is putting in place a range of policies to drive energy efficiency in the UK.

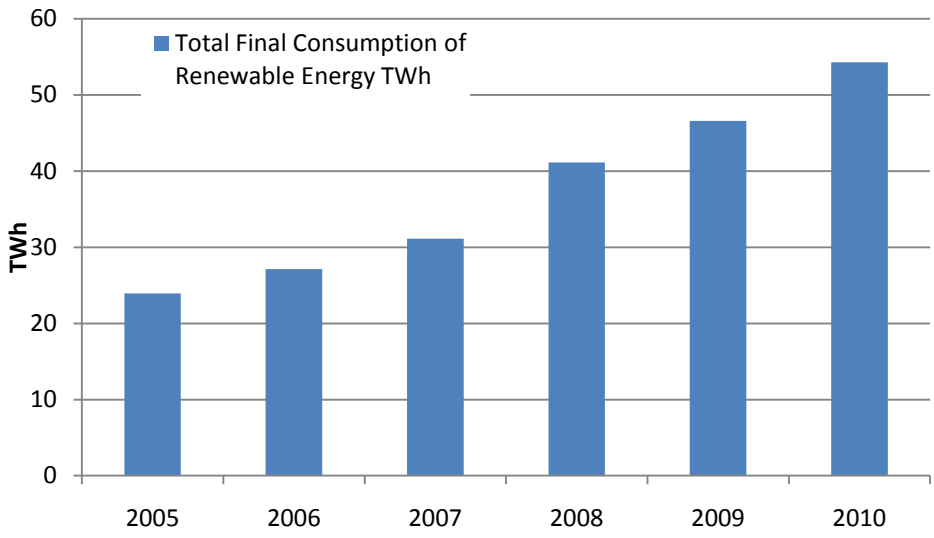
2.16 In Chapter 4 we set out our approach to handling uncertainty in more detail. Our key commitment is to work with industry to refresh the analysis and actions

set out in the Roadmap as new information emerges about deployment, costs, energy demand, and policy impact. We believe that the 15% target is achievable through cost-effective domestic action, but acknowledge the uncertainty and are putting in place a framework to allow contingency action, including taking powers to enable trading, should it be required.

Progress in renewable deployment

2.17 As illustrated in Figure 8, renewable energy accounted for 54 TWh (3.3%)[11] of the UK's total energy consumption in 2010, having increased steadily since 2005, and by 15% between 2008 and 2009. We will need to see more than a four-fold increase in our renewable energy consumption by 2020 if 15% of our energy needs are to be met from renewable sources. Consumption of renewable energy will need to rise by 17% per annum to meet that goal.

Figure 8: UK Renewable Energy Consumption (TWh)[12]



Source: Energy Trends June 2011

2.18 Different levels of growth will be required across the sectors given their varying stages of development. Renewable electricity will need to maintain a growth rate of approximately 15% per annum from the 2010 baseline of 28 TWh. The renewable heat market, which is at an earlier stage of development, will require higher levels of growth, over 19% per annum, to move from the 2010 baseline of 13 TWh[13] to the projection of approximately 73 TWh by 2020.

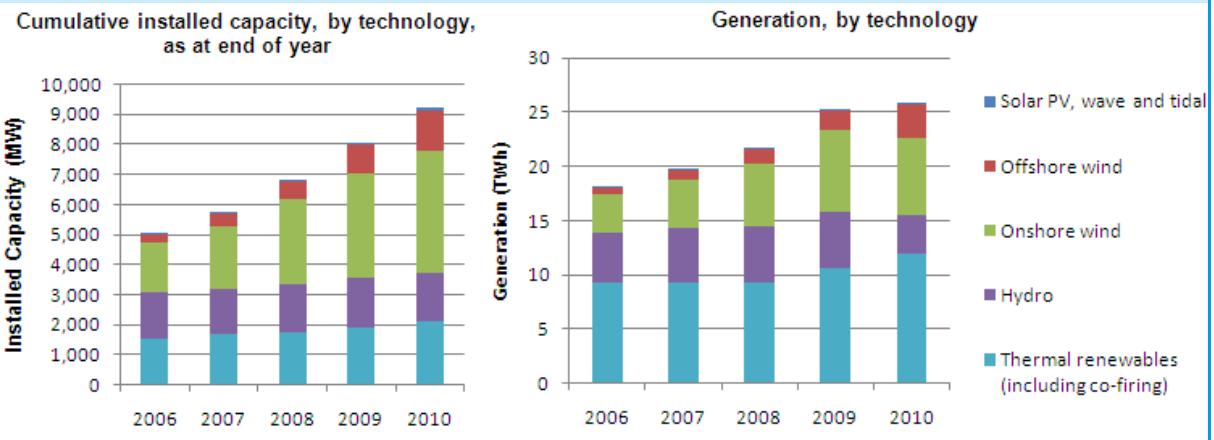
2.19 Box 3 below provides an overview of current deployment levels by technology and the progress which has been made across all areas of the UK.

[11] Source: DECC Energy Trends June 2011. Measured using Renewable Energy Directive methodology
[12] Measured using Renewable Energy Directive methodology
[13] As above

Box 3: Overview of renewables deployment

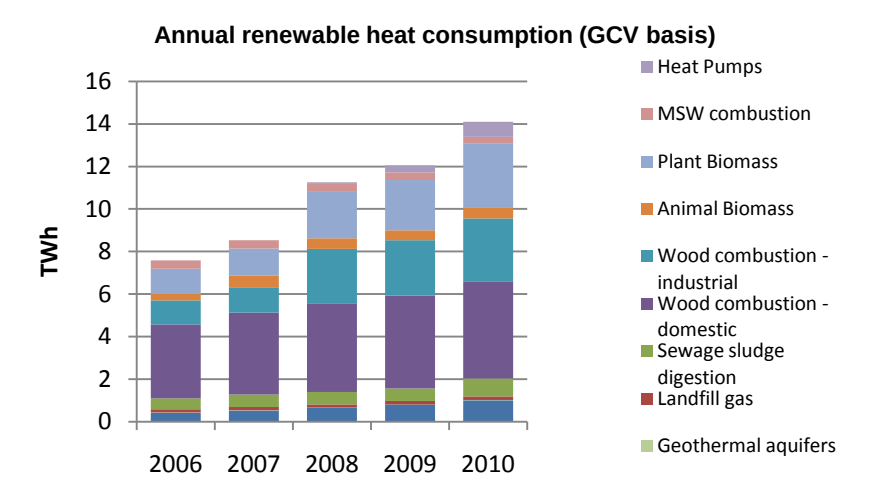
Renewable Electricity

Recent analysis[14] shows that renewable electricity capacity increased by 15% between 2009 and 2010, with onshore wind contributing the largest share. The total installed capacity was 9.6 GW (including co-firing), which is in line with our overall projected growth. Total generation in 2010 was 25.7 TWh. However, the growth in generation between 2009 and 2010 was less strong. This resulted from much lower than average rainfall and the lowest wind speeds this century, reducing hydropower and wind generation.



Renewable Heat

Renewable heat generated 14.1 TWh[15] in 2010, of which biomass heat contributed 12.4 TWh, solar thermal contributed 1 TWh, and heat pumps contributed 0.7 TWh. This represents an increase of 17% from 2009 to 2010.



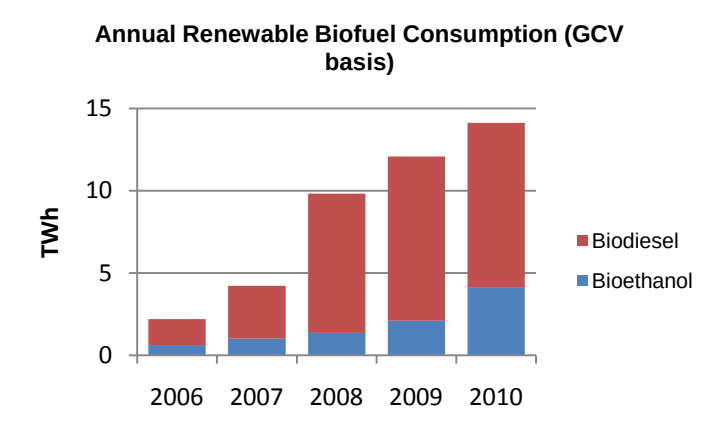
[14] Source: Energy Trends June 2011

[15] Source: Energy Trends June 2011. Measured on Gross Calorific Value basis (as opposed to Renewable Energy Directive methodology)

At present we do not have verified statistics for renewable heat capacity; however, recent market estimates suggest a total installed capacity of at least 1.3 GWth[16], which is broadly in line with our projections.

Renewable Transport

In 2009/10 the UK supplied 3.33% biofuels in road transport[17] by volume, equating to 1,568m litres of biofuels. This was slightly higher than the target of 3.25% required by the Renewable Transport Fuels Obligation Order and a significant increase on the 2.7% supplied in 2008/09. Energy generated from biofuels in renewable transport increased by 23%, from 9.8 TWh in 2008 to 12.7 TWh in 2009. Provisional data for 2010 suggests further growth with biofuels contributing 14.1 TWh[18].



Current pipeline for renewable energy

Pipeline for renewable electricity

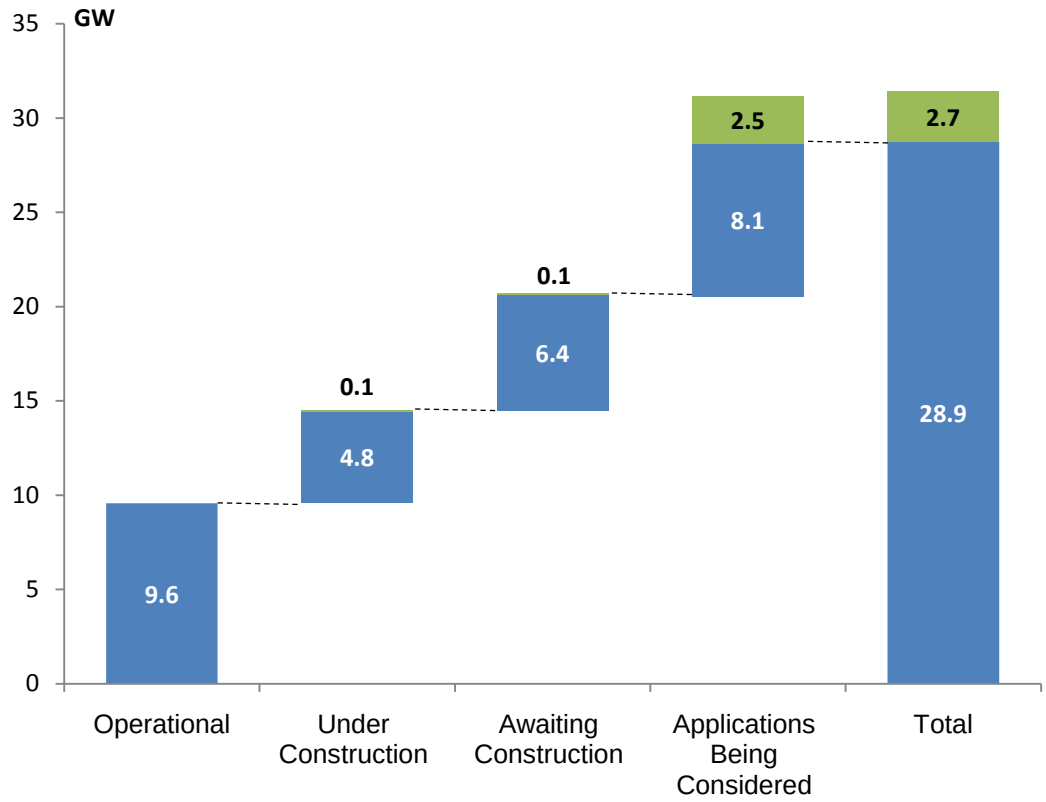
2.20 We expect renewable electricity generation to grow in line with our projections in the coming years. Analysis of the Renewable Energy Planning Database, summarised in Figure 9, suggests that the pipeline for new plant across the UK is currently healthy, with around 22 GW[19] of potential new capacity in planning, consented or under construction. When taken together with existing capacity and accounting for historic consenting rates[20], we could see around 29 GW in operation in 2020.

2.21 However, the analysis also indicates that we cannot be certain that all the projects in the pipeline will be consented or commissioned or that they will progress quickly enough to contribute when needed. This is why the

[16] Source: AEA market surveys. The estimate for biomass boilers is thought to be conservative.
[17] Source: Year Two of the RTFO, Renewables Fuel Agency Report 2009/10
[18] Source: Energy Trends, June 2011
[19] This figure does not include conversion from coal plant (this is currently not picked up in REPD) or co-firing capacity.
[20] Planning and post-consent success rate based on capacity from 2007-present, weighted by country in planning stage.

Overarching National Policy Statement for Energy[21] states that there is an urgent need for new large scale renewable energy projects to come forward to ensure that we meet the 2020 target and wider decarbonisation ambitions.

Figure 9: Pipeline for large scale electricity, including attrition rates[22]



2.22 Onshore wind is the biggest single contributor to the pipeline, with over 11 GW of capacity in planning, consented, or under construction. The offshore wind pipeline is currently near 6 GW and is expected to grow as site applications for Scottish Territorial Waters and Round 3 offshore wind are submitted for consideration from 2012. There is currently 4.3 GW of biomass electricity in the pipeline, including energy from waste[23]. However, we anticipate that the potential pipeline is higher than this, as many fossil fuel to biomass conversion projects are not currently captured within our statistics. In addition, co-firing biomass with coal – one of the most cost-effective means of producing renewable electricity – could provide up to 400 MW of capacity in 2011.

2.23 An initial assessment of renewable electricity projects currently under construction[24], suggests that a further 4 GW could come into operation by the end of 2012.

[21] Overarching National Policy Statement for Energy, DECC (2011)
[22] Based on historic consenting rates, the capacity shown in green could potentially be lost from the pipeline
[23] As 19 above.
[24] Based on analysis of renewable electricity projects over 50MW using the Renewable Energy Planning Database https://restats.decc.gov.uk/cms/planning-database and commercial information

Pipeline for renewable heat

2.24 Whilst we have evidence on renewable electricity, the available data on renewable heat is less well developed. Over the coming year DECC will gather data on installed heat and on the future pipeline based on available planning and permitting information, and market intelligence. This, together with information from preliminary accreditation of Renewable Heat Incentive (RHI) installations (driving up to an additional 100,000 heat pumps and an additional 24,000 biomass heat[25] installations by 2020), and the Renewable Heat Premium Payment (RHPP) for small scale, will allow us to track heat projects, analyse deployment trends and identify barriers to adoption. We will make updated data on heat publicly available.

Pipeline for renewable transport

2.25 The RTFO places an annual obligation on road transport fuels suppliers to supply a percentage of biofuels (subject to "buy out"). This is currently set to achieve 4% by energy (5% by volume) by 2014. However, as biofuel is a globally traded commodity the pipeline does not exist in the same way as it does for the other end use sectors of electricity and heat. Government will come forward with proposals for renewable transport between 2014 and 2020 in order to achieve the 10% transport sub-target.

Local potential for renewables deployment

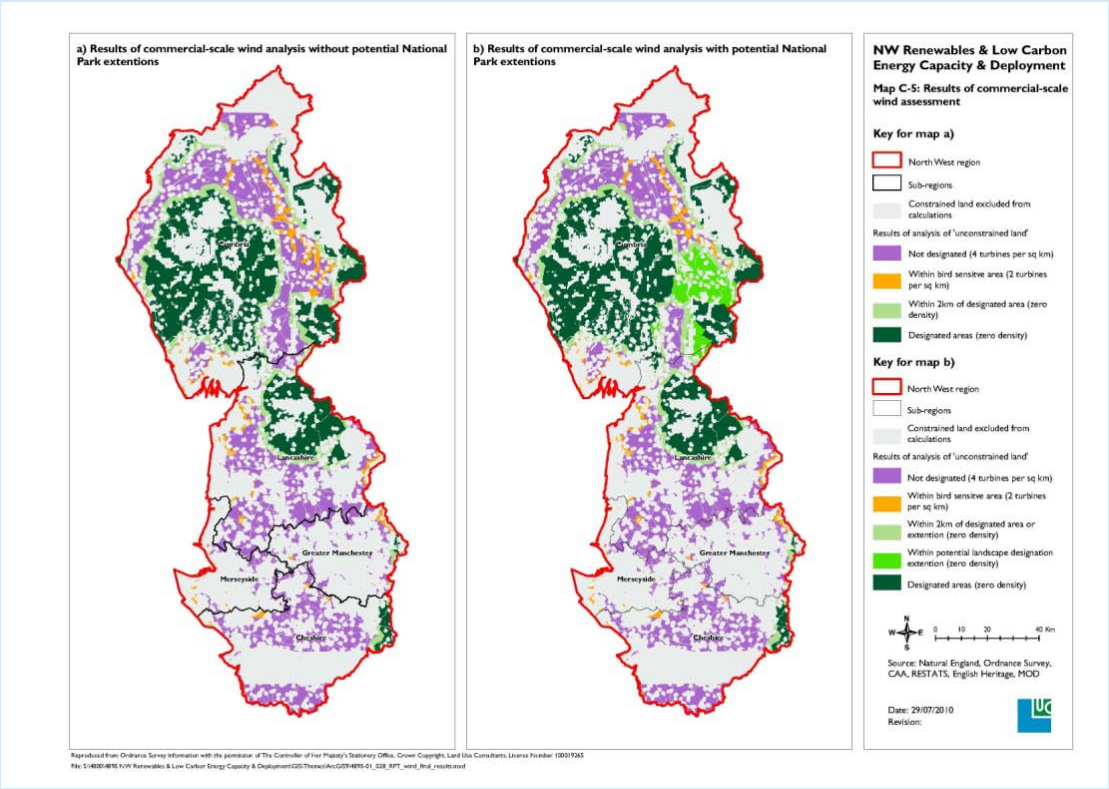
2.26 In addition to developing our understanding of deployment at the national scale, DECC has funded nine studies to help local authorities and local communities in England identify and maximise opportunities for the deployment of renewable and low carbon energy technologies in their area. The Scottish Government has developed a similar assessment of potential in Scotland. Local Authorities and communities will be able to use the results of these assessments to inform development of their local and neighbourhood development plans.

2.27 Seven of the nine assessments for England are now available[26] through the DECC web site. We aim to publish the final two assessments soon.

[25] Biomass heat installations including biomass boilers, biogas injection and biomass district heating installations

[26] http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/ored/ored.aspx

Box 4: Assessment of the potential for renewables energy in the North West of England



The 'North West renewable and low carbon energy capacity and deployment project report' has been developed in conjunction with stakeholders from across the region, according to the energy capacity assessment methodology published by DECC and CLG in 2010.

The study is intended to assist Local Planning Authorities in preparing planning policies on renewables.

The project has produced a comprehensive assessment of the potential accessible renewable energy resources at 2020. The scenarios contained in the report for potential deployment of renewables are only intended to illustrate, given current constraints and trends, how the North West could contribute to national renewable energy deployment targets.

While the focus of the project has been to present the results at sub-regional and sub-national scales, much of the original data can be interrogated down to Local Authority level. This original data is available to Local Authorities to undertake their own analysis.

Cumbria County Council working together with the District Councils and the Lake District National Park has commissioned work building on the North West study to identify the renewables and low carbon energy potential in Cumbria. The study provides a comprehensive evidence base that will facilitate local planning authorities across Cumbria to develop well-founded policies that support renewable energy development

Conclusions from our analysis

2.28 Our analysis suggests the following:

- Even though we are starting from a low level the UK can meet the target to deliver 15% of the UK's energy consumption from renewable sources by 2020 through domestic deployment. Recent 'bottom-up' analysis, based on industry inputs, suggests that there is significant upside potential and downside risk to deployment;

- Based on current information, and taking account of their long term potential as well as their cost effectiveness, 8 technologies are capable of delivering more than 90% of the renewable energy we estimate is required by 2020;

- The pipeline of renewable electricity projects is healthy. Although, allowing for historic dropout rates[27], it puts us on track to deliver approximately 29 GW of capacity by 2020, significant uncertainties remain and we still urgently need new renewable projects to come forward to ensure we meet the 15% target and longer term carbon reduction targets;

- The pipeline for renewable heat projects is less well developed but following the introduction of the world's first incentive for renewable heat could deliver up to an additional 100,000 heat pumps and an additional 24,000 biomass heat[28] installations by 2020;

- Road transport biofuels are proposed to increase to 5% of road transport fuels by 2014. Subject to the results of current consultations, Government will come forward with options in Spring 2012 to stimulate further growth in renewable transport for the period after 2014;

- Costs of renewable energy technologies are currently high and uncertain but are expected to fall over time as supply chains develop, technical challenges are overcome and technologies are demonstrated to be effective.

[27] This figure does not include conversion from coal plant (this is currently not picked up in REPD) or co-firing capacity.

[28] Biomass heat installations including biomass boilers, biogas injection and biomass district heating installations

Chapter 3: Actions

3.1 Government has worked with industry to identify the key challenges to increase the deployment of renewable energy in the UK. The main focus of this Chapter is on each of the 8 technologies that together could deliver more than 90% of the effort required for 2020. A number of actions also apply to a wide range of renewable technologies. These 'cross cutting actions' are described below.

Cross-cutting actions

3.2 Our work with industry indicates that there are at least six cross-cutting barriers to deployment which impact on more than one of the key technologies but that may not apply to all 8. Without alleviating these overarching challenges, the removal of technology-focused constraints could have a limited impact and may fail to unlock the capacity from individual technologies or bring down costs quickly enough. To create the right market conditions we are:

- **Facilitating access to the grid**: Grid access arrangements can delay or prevent renewable electricity deployment on and offshore. Currently, 5.5 GW of renewable electricity projects with planning consent are waiting to be connected to the grid[29]. The construction of an offshore grid is critical for the deployment of offshore wind and also for future deployment of wave and tidal energy. We are taking action to reform the onshore grid and establish the framework offshore necessary to deploy the levels of renewable electricity we anticipate are necessary for 2020.

- **Ensuring long term investment certainty**: Renewables developers and investors require certainty over incentives on which to base investment decisions. The total investment requirement to deliver 15% renewables for 2020 and beyond to 2050 will run into hundreds of billions of pounds. We are putting in place a transparent and long lived financial framework through the introduction of incentives for heat and reforming the electricity market. As part of this we are taking action to ensure a managed transition from the Renewables Obligation, including bringing forward the Banding Review, to secure the 22 GW of renewable electricity capacity currently in the pipeline[30] as well as bring forward additional projects.

- **Tackling pre- and post- consent delays:** We recognise the need to ensure that projects have as many benefits and as few adverse impacts as possible in financial, economic and environmental terms. However, delays in the planning process or difficulties in discharging conditions attached to consents can have a significant impact on deployment. This can impact across the range of technologies both on and offshore. For example, there is currently

[29] National Grid, *Transmission Networks Quarterly Connections Update* – April 2011 http://www.nationalgrid.com/NR/rdonlyres/41AAF4ED-4121-4C4F-B83E-7BF68C0B4FB3/46624/TNQCUApril2011v1.pdf

[30] Renewable Energy Planning Database – May 2011 data - https://restats.decc.gov.uk/app/reporting/decc/datasheet

5 GW of onshore and 7 GW of offshore wind capacity impacted by radar interference. We will ensure a radar replacement programme is rolled out this year. Government is also reforming the planning system for major infrastructure in England and Wales, to replace the Infrastructure Planning Commission with a democratically accountable system, and to ensure that local planning in England[31] supports economic growth and gives local communities a greater say and stake in development.

- **Ensuring sustainable bioenergy feedstock supply**: Bioenergy could, if suitable feedstocks are available, deliver around half of the total generation we estimate will be required to meet our 15% target by 2020. Concerns about the sustainability of bioenergy feedstocks could limit the use of bioenergy in the electricity, heat and transport sectors. We are putting in place sustainability standards, developing a Bioenergy Strategy to be clear about the availability and best use of this resource, and ensuring that sustainable feedstocks are fully exploited.

- **Facilitating development of renewables supply chains:** Most technologies face some degree of supply chain constraint, whether for equipment, installers, or infrastructure, but the severity of these constraints will vary by technology. They will be particularly important, for example, in developing markets such as offshore wind, marine, heat pumps, and ultra low-emissions vehicles. The Government's financial incentives for renewable energy will provide greater market confidence about future deployment levels, helping to stimulate supply chain development. In addition, we are taking specific measures to encourage the development of port and manufacturing facilities for offshore wind, Marine Energy Parks, charging infrastructure for plug-in vehicles, and plans for better certification and assessment of installers for small scale technologies, including domestic heat.

- **Encouraging innovation:** Whilst some technologies needed for the 2020 target are relatively mature, such as onshore wind and biomass boilers, others such as offshore wind and marine are not yet fully developed. By encouraging innovation in these areas Government can help developers overcome the remaining engineering challenges, lower cost, and improve the reliability of technologies used. This will reduce the overall cost of meeting the 2020 renewables target and longer term carbon reduction targets, and the impact on public spending and consumer bills. We are committing an additional £50m over the next 4 years, subject to value for money assessment, to support innovation in offshore and marine technologies, and considering further allocation, including for energy from waste and biomass, details of which will be available in the Autumn.

Technology Action Plans

3.3 While renewable deployment across all technologies will be important, the Roadmap focuses in particular on the 8 technologies which have either the

[31] Some elements of planning are devolved, therefore there are differences across the UK.

greatest potential to help the UK meet the 2020 target in a cost effective and sustainable way, or offer the greatest potential for the decades that follow. This Chapter sets out a plan for each of the 8. Within each plan we have:

- **Estimated changes in capacity and growth rate:** Using the current levels of deployment, an understanding from the market of deployment potential, and where it exists, data about the capacity in the pipeline, we have estimated the increase in capacity and growth rate that is consistent with meeting our 2020 target;

- **Identified challenges to deployment:** We have undertaken work to better understand the journey to deployment, from scoping and application, to consent, development and final operation. Taking a systematic approach in this way enables us to better understand the key constraints and bottlenecks to deployment.

- **Developed a bespoke package of actions:** Combining our understanding of the challenges to deployment with evidence from the pipeline to identify the scale of the risk. This has informed the development of a bespoke package of actions that address the most immediate challenges to deployment for each technology.

3.4 This is the first set of plans. We will continue to gather evidence about deployment to better understand the challenges and will update our approach annually.

Onshore wind

- The UK has more than 4 GW of installed onshore wind capacity in operation (generating approximately 7 TWh of electricity annually) [32].
- The central range for deployment indicates that onshore wind could contribute up to around 13 GW by 2020. Achieving this level of capacity equates to an annual growth rate of 13%[33].
- The existing pipeline for onshore wind contains an additional 11 GW. When taken together with the existing operational capacity, this could contribute a significant proportion of the central range for 2020 given historic planning approval rates although there are concerns with the pace at which capacity can be brought through[34].
- Challenges to deployment include: minimising investment risk; reform the planning system; overcoming radar interference from windfarms; and ensuring cost-effective grid investment and connection.

Priority actions:

- Minimise investment risk: Implement proposed electricity market reform and RO transition measures to secure long term certainty to 2020 and beyond and enable historically strong investor confidence in onshore wind to be maintained.
- Reform the planning system in England and Wales: Set out the national need for new renewable energy infrastructure through ratification of National Policy Statements. Replace the Infrastructure Planning Commission with a fast track process for major infrastructure projects. Reform the local planning system in England to ensure that it supports economic growth, give communities a greater say and stake in development, and help local authorities and communities to identify opportunities for the deployment of renewables using analysis from regional studies. Improve guidance on issues of public concern such as noise impact to ensure high quality planning decisions.
- Overcome radar interference with windfarms: Work with the signatories of a new Memorandum of Understanding to develop, fund and implement radar mitigation programmes over the first half of this decade. Jointly fund, with industry and the Crown Estate, a new early warning radar system for RAF Trimingham.
- Ensure cost-effective grid investment and connection: Work with Ofgem through Project TransmiT to help plan grid investments and the regime for charging new connections to the transmission network. National Grid will consult later this summer on long-term financial security arrangements including Final Sums Liability. Monitor the impact of "Connect and Manage", and take corrective actions if necessary.

Current deployment

3.5 There is currently 4 GW of operational onshore wind capacity in the UK, generating around 7 TWh annually. In capacity terms, this is the single most deployed renewable electricity technology and is most established in Scotland (~2.5 GW), where over 60% of UK wind resource is found, followed by England (~0.9 GW), Wales (~0.4 GW) and Northern Ireland (~0.3 GW).

[32] Source: Energy Trends June 2011

[33] All growth rates are Compound Annual Growth Rates

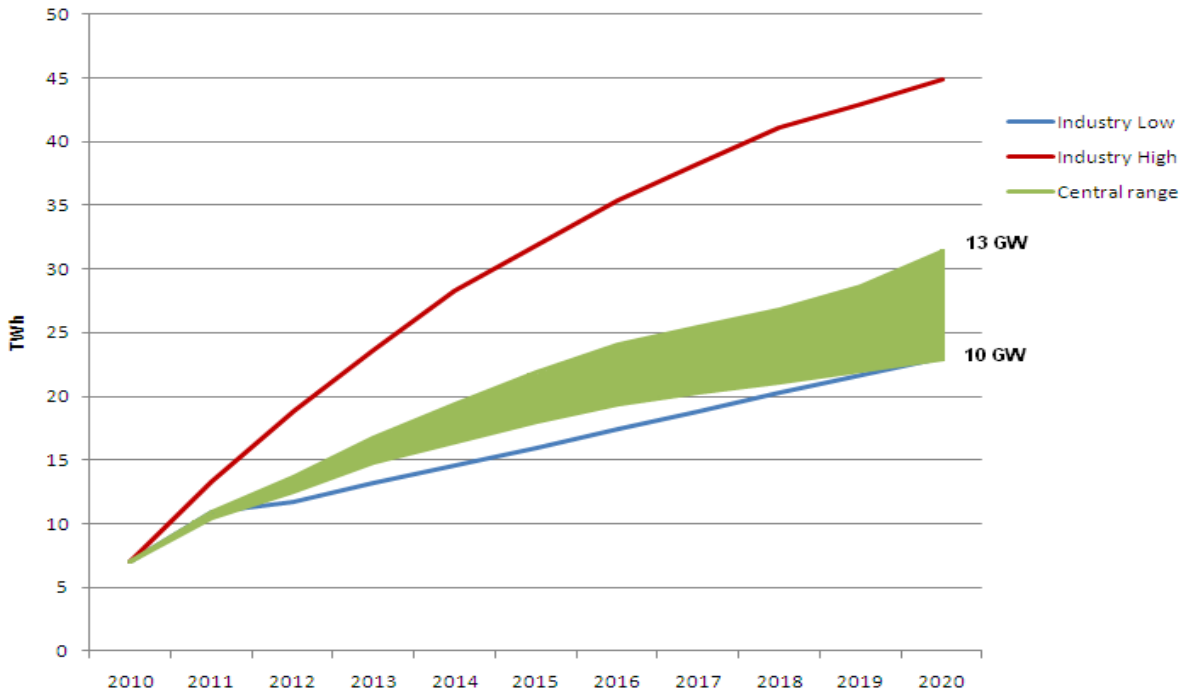
[34] The assumed success rate for pipeline projects is based on observed success rates for projects determined between 2007 and 2011. Nation-specific success rates were calculated for pre-consent projects (to reflect the fact that planning arrangements differ across the UK). For post-consent projects a UK-wide figure was used

Deployment potential

3.6 Figure 10 sets out results of recent analysis of potential growth for onshore wind to 2020. It overlays an industry view of the deployment that could be achieved (the 'industry high' and 'industry low' scenarios) around a model-based central range.

3.7 The central range indicates that we could see up to around 13 GW of onshore wind capacity by 2020. The majority of this would be from large scale projects over 5 MW. Achieving this 9 GW increase would require an annual growth rate of 13% over the next decade, slightly less than the growth rate experienced between 2009-2010[35]. The industry scenarios suggests the potential to bring forward a total of between 10-19 GW of onshore wind by 2020 (equivalent to 23-45 TWh).

Figure 10: Deployment potential to 2020 for onshore wind



3.8 The industry low scenario of 10 GW assumes that the ability to build and install turbines is a limiting factor for deployment. The industry high scenario of 19 GW assumes that build rate is not a limiting factor and that capacity currently in the pipeline is consented and moves rapidly to construction. It also assumes that growth slows after 2015 due to a limit on the number of sites available, growth of competing technologies and cumulative planning impacts.

3.9 Analysis[36] suggests that the levelised cost of onshore wind could range from £71-£122MWh in 2020, down only marginally from £75-£127 in 2010. Cost

[35] Source: Growth rate for onshore wind capacity between 31 Dec 2009 and 31 Dec 2010 was 15.9% (Energy Trends June 2011)

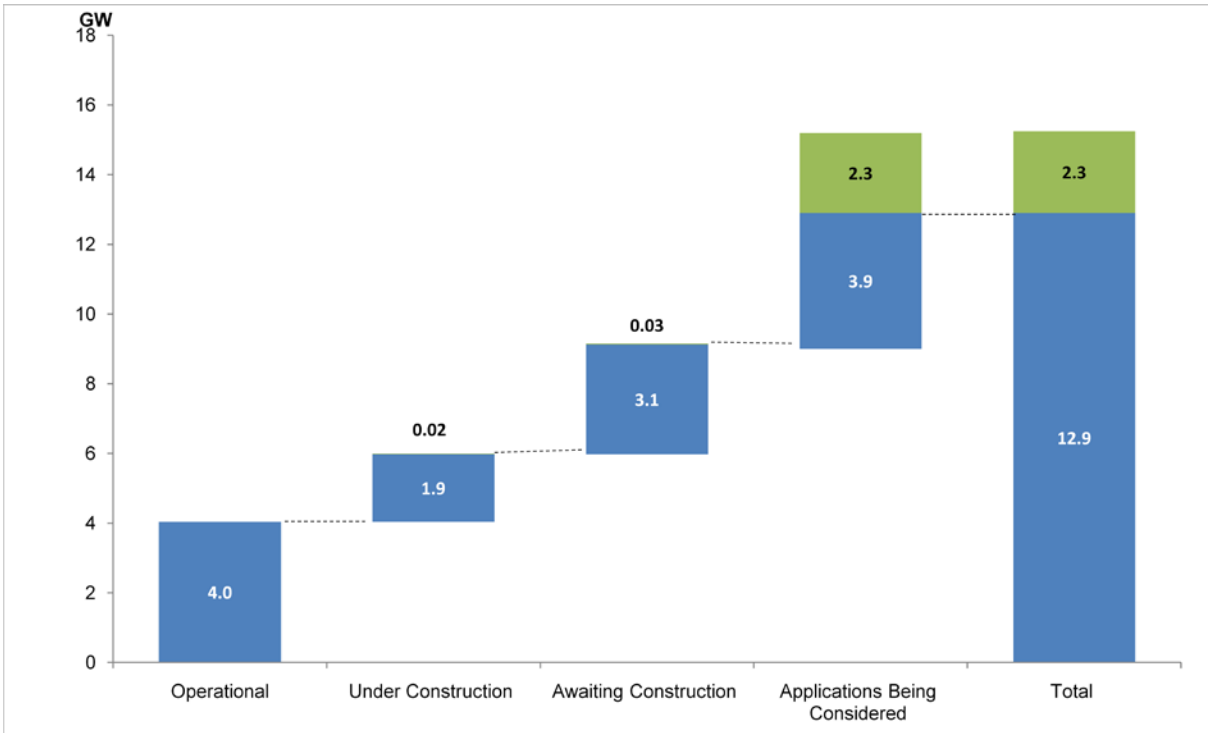
[36] Analysis by Arup and Ernst & Young summarised in section 2.2 of the Roadmap.

reductions are expected to be limited as onshore wind is a mature technology, restricting the scope for further learning or technological progress as deployment increases. Cost ranges are wide however, reflecting variation in stakeholders views about capital cost, driven by project specific factors such as the location of windfarms and scale.

Deployment pipeline

3.10 As illustrated in Figure 11, there is currently over 11 GW of onshore wind capacity currently under construction, awaiting construction, or in planning in the UK.

Figure 11: Capacity of onshore wind projects in the planning pipeline[37]



3.11 Assuming historic consent rates[38] the existing planning pipeline could deliver 8.9 GW which, taken with current capacity, would provide a level of growth consistent with the high end of the central range.

3.12 This pipeline capacity is distributed across the UK with the majority in Scotland (over 6.5 GW), over 2 GW in England, a further 1.5 GW in Wales, and 1.0 GW in Northern Ireland. Of the applications currently awaiting planning consent, over 88% (totalling 2.7 GW) are under 50 MW and will be decided at local level[39]. The remaining 12% of projects (totalling 3.6 GW) are 50 MW or over and are awaiting decision from the Government or relevant Devolved Administration.

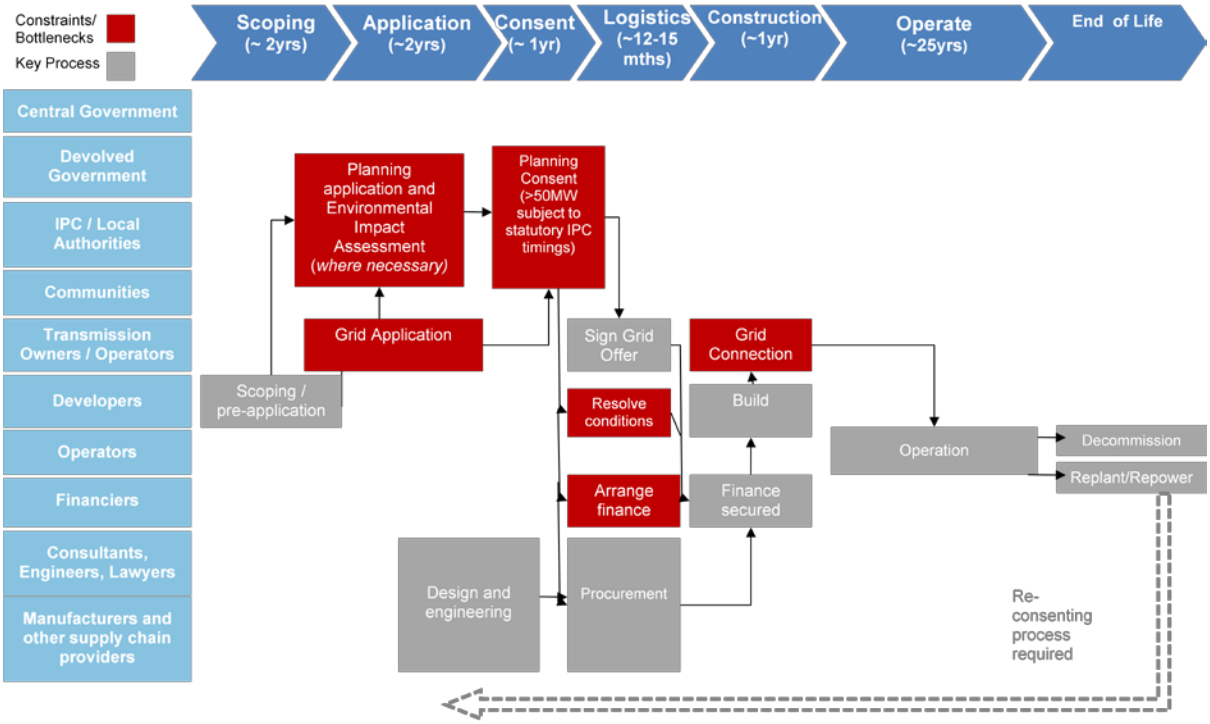
[37] Based on historic consenting rates, the capacity shown in green could potentially be lost from the pipeline
[38] Historic rejection rate based on capacity from 2007-present, weighted by nation in planning stage.
[39] NB. apart from in Northern Ireland, where all projects of all scales are determined by the Planning Service

3.13 By tackling the challenges to deployment outlined below, we will, subject to local consent decisions, help projects which are currently in the pipeline to commission. New proposals will also be required to come forward to meet the 2020 ambition and longer term decarbonisation.

Journey to deployment

3.14 Figure 12 presents a developer journey map for onshore wind. This outlines the stages of the delivery process for onshore wind projects in England and the delivery partners who contribute to it (the process is similar in the rest of the UK, but there are some differences at the planning stages). The average time from identifying a site to exporting electricity to the grid is around five years, although this masks considerable variation by project. The process for developing a larger scale project is illustrated below, with key areas of challenge highlighted in red. To increase the build rates and shorten development time, we must tackle the barriers set out below.

Figure 12: Developer journey map for the deployment of onshore wind projects



Challenges to deployment and actions

3.15 Our discussions with industry and analysis of deployment statistics suggest that developers must overcome at least four main challenges to deploy onshore wind projects.

Minimise investment risk

3.16 Developers require a degree of certainty about returns if they are to make confident investment decisions. Investor confidence in this proven technology is high, though currently tempered by perceived uncertainty about the level and surety of long-term financial support from Government. This has affected both

the quantity of investment utilities can fund from their balance sheets and the quantity and cost of project finance available to developers.

3.17 The Government has set out its plans to reform the electricity market alongside this Roadmap. This will include steps to improve the market's ability to finance the investment in low carbon electricity that is needed over the next decade and beyond. It will put in place a transparent and long-term financial framework for low carbon electricity, including renewable power, structured around a new Feed-in-Tariff with Contracts-for-Difference. Northern Ireland will consider how these proposals can work in their All Island Energy market.

3.18 In implementing this change, the Government will ensure a smooth transition from the Renewables Obligation (RO). In particular, once the new scheme is introduced, new generators will have the choice between the two schemes until 2017 and following the closure of the RO to new entrants, technology payments made under the RO will be grandfathered[40]. In addition, the Government has accelerated the current Banding Review to provide clarity sooner on future support levels under the RO – Government will consult in summer 2011 and publish its decision by the end of the year, one year earlier than originally planned.

3.19 Discussions over the participation of the Devolved Administrations in the new support mechanisms are on-going. All jurisdictions are committed to support renewables and if they propose to close their RO support mechanisms in due course, Scotland and Northern Ireland will consider doing so alongside England and Wales, on the basis of transition arrangements in the EMR White Paper

Actions:

- DECC will consult on new RO banding levels in summer 2011 and publish its decisions by the end of the year. New banding levels for onshore wind will come into force in April 2013.
- DECC will put in place arrangements to ensure a smooth transition from the Renewables Obligation to the new electricity market support mechanism.

Reforming the planning system

3.20 The planning system plays a central role in delivering the infrastructure we need to reduce our carbon emissions, to ensure continued security of energy supply and help our economy to grow. It has a vital role in safeguarding our landscape and natural heritage and allowing individual communities the opportunity to shape their environment.

3.21 UK consent rates for onshore wind projects vary from around 60% in Scotland and Wales, to 80% in Northern Ireland and 54% in England[41]. Developers remain concerned about the time taken to decide applications, a lack of transparency, and apparent inconsistency across the UK in the way decisions

[40] Grandfathering is a policy that support levels should not change once generation has been accredited under a scheme, thereby providing investors greater certainty.

[41] Projects submitted to planning since 2007

are reached. For their part, communities may be concerned about the possible impacts of windfarms and associated grid infrastructure on landscapes and local amenity. This has led to a situation where many developments are approved on appeal - over 50% of UK sub-50MW[42] onshore wind projects rejected by local planning committees are eventually approved through this route.

3.22 These factors increase cost, delay or risk revenue, and could deter developers from making applications in the first place or lead them to drop applications if initially rejected. This risks both the 6GW of onshore wind currently awaiting determination in the UK and projects which have not yet come forward.

3.23 The Localism Bill will reform the planning system for major infrastructure projects over 50MW in England and Wales, once National Policy Statements are ratified. The Government laid its energy National Policy Statements before Parliament on 23 June for approval, setting out the national need for new energy infrastructure in the UK. These will set the decision-making framework for applications for nationally significant energy infrastructure, including renewable energy. The new planning system sets a time limit of nine months for the Infrastructure Planning Commission to determine applications from the start of examination. Under the Localism Bill, the Government has introduced plans to replace the Infrastructure Planning Commission with a new Major Infrastructure Planning Unit within the Planning Inspectorate[43]. The new Unit will consider applications for energy infrastructure and advise the Secretary of State for Energy and Climate Change, who will determine applications. The Government will review the effectiveness of this regime once a range of cases have been through it.

3.24 The Government believes that the current local planning system is too centralised and costly and disempowers communities. It has failed to deliver the development that the country needs. That is why we are introducing fundamental reform to make sure that the planning system, supported by powerful new financial incentives, makes the right land available in the right places for development, and will deliver the development and smaller scale infrastructure that is needed.

3.25 Projects are generally more likely to succeed if they have broad public support and the consent of local communities. This means giving communities both a say and a stake, in appropriately-sited renewable energy projects like windfarms. The Localism Bill is returning decision-making powers on housing and planning to local councils.

3.26 The Government is introducing powerful new incentives to encourage support for new development. We have committed to allowing communities that host renewable energy projects to keep the additional business rates they generate and this is being taken forward through the Local Government Resource

[42] As above

[43] Provision will be made for dealing with applications made to IPC which are already in the system

Review. Renewable energy development can also bring economic growth and new jobs for the UK both locally and nationally.

Case study: Mabey Bridge Ltd

Based in Chepstow, South Wales, Mabey Bridge has a turnover of £80 million and close to 500 employees. The company's history can be traced back to the construction of Brunel's Wye railway bridge in 1849.

Mabey Bridge's UK Division specialises in the fabrication, erection and protective treatment of high quality plated steelwork for bridges, wind turbine towers, monopiles and other heavy steel structures in the UK and Ireland.

The Bevil Mabey Structural Steelworks, opened on 12th May 2011, is part of the company's £38 million investment in the renewable energy sector. The new facility, the UK's only indigenous manufacturer of wind turbine towers and monopiles, has created some 240 jobs in addition to the 400 already employed by the company in Chepstow and Lydney.

The 25,000 square metre facility will make up to 300 wind turbine towers per annum, each up to 120m long. The factory uses the latest manufacturing techniques including computer controlled cutting and rolling, robotic welding, and an automated painting facility and will put South Wales at the heart of the move towards a low carbon economy.

3.27 The Government will shortly consult on a new National Planning Policy Framework for England, to consolidate existing planning policy (including for energy projects below 50MW) into a single document. The framework will include a new presumption in favour of sustainable development.

3.28 In addition, the Government has committed to consulting later this year on a package of measures that will streamline and simplify planning applications in England. Furthermore, in the *Plan for Growth* (March 2011), the Government announced its intention to introduce a 'planning guarantee' that it would take no more than 12 months to reach a final decision on planning applications, including any associated appeal.

3.29 In Wales, Planning Policy Wales (PPW) was updated earlier this year to provide guidance on renewable and low carbon energy projects. This is supplemented by Technical Advice Note 8 Renewable Energy (TAN8), and the Local Development Plan system which enables communities and businesses to shape future development in their areas.

3.30 In Scotland, work is also being coordinated by the Scottish Government to develop good practice in reconciling objectives for the deployment of onshore, and offshore, wind with wider environmental objectives, and actively involving communities in planning and implementation. The GP (Good Practice) Wind

project involves stakeholders from eight European countries and will produce a Good Practice Guide and the "how to" toolkit which will provide valuable online resources for industry, NGOs, policy makers, local and regional authorities, and local communities.

3.31 To inform all planning decision making, DECC will ensure that an up-to-date evidence base is available on the potential impacts of wind turbines, such as noise and shadow flicker (for which DECC published research recently), intermittency, and implications for landscape, habitats and species. It has also helped local authorities and communities to identify opportunities for the deployment of renewables using analysis from regional studies.

3.32 As outlined in the Microgeneration Strategy[44], the Government recognises that community scale generation can provide significant economies of scale as well as benefits to the local community, and will provide more information to support their development through DECC's Community Energy Online web portal.

Actions:

- Set the decision making framework for projects of nationally significant infrastructure, including renewables, through the ratification of the National Planning Statements
- DCLG will consult on the new draft National Planning Policy Framework for England in summer 2011.
- The Local Government Resource Review will publish proposals to allow local retention of business rates, including those relating to renewable energy projects in July 2011.
- DCLG will publish details of a 'planning guarantee' by the end of the year with the intention that it will take no longer than 12 months to reach a final decision on planning applications including any associated appeal.
- The GP Wind Project, coordinated by the Scottish Government, will deliver its good practice guide and a 'how to' toolkit in Spring 2012.

Overcome radar interference with windfarms

3.33 Onshore and offshore windfarms can interfere with aviation radar systems. This leads to planning objections by both civil aviation operators, such as airports and National Air Traffic System (NATS), and by the Ministry of Defence (MOD) for air defence and air traffic control radar. In this case, impact on radar must be mitigated in order for planning conditions to be discharged and construction to proceed.

3.34 This has become one of the most significant non-financial barriers constraining the deployment of wind. We estimate that around 5 GW of onshore and 7 GW of offshore wind projects in scoping, planning, and awaiting construction may be impacted by radar. In addition, there is currently 1.9 GW of onshore wind capacity 'awaiting construction' which was consented over two years ago, and

[44] http://www.decc.gov.uk/en/content/cms/meeting_energy/microgen/strategy/strategy.aspx

industry estimate the majority of this is held up by the need for developers to meet planning conditions related to radar[45].

3.35 DECC has worked with developers and others to fund research and development into technical solutions to upgrade radar and mitigate the problems caused by windfarms. This includes a direct contribution to funding R&D into upgrade solutions for NATS' fleet of radar, which deliver en-route services to aircraft flying over the UK. The Government has also helped facilitate the wind industry's funding for Cambridge Consultants holographic in-fill radar solutions, which can be deployed at specific windfarms to mitigate against interference with terminal radar at airports, and interference with NATS infrastructure. If this R&D results in successful implementation of solutions, it will enable several planning conditions relating to radar interference to be discharged and construction of windfarms to proceed. This will also free-up potential future wind developments in the impacted areas.

3.36 These technical solutions are now beginning to emerge and become available. However, to-date funding into R&D has been managed on a case by case basis, and the next step – moving to implementation of the technical solutions – relies on the ability and willingness of leading developers to fund the upgrades, regardless of how many other developers may benefit in the future. This piecemeal approach has led to uncertainty and additional costs on these developers and can reduce the incentive to invest.

3.37 Today the Government is announcing the signing of a new Memorandum of Understanding, which commits the signatories to move from supporting R&D, to ensuring that the software and hardware solutions identified are implemented, and to begin to look for solutions to other windfarm-related aviation problems, such as navigation and communications services.

3.38 The technological complexity of the radar interference problem means that a single technical solution is not possible, and a suite of different solutions needs to be developed. However, a generic approach to rolling out and applying technical solutions, and support for regional approaches where they are possible, will incentivise investment in the necessary infrastructure, and so enable onshore and offshore wind deployment that would otherwise not be possible. DECC will continue to work with DfT, the MOD, the wind industry and aviation partners to make progress towards this goal.

3.39 An example of the potential impact of radar on deployment of wind can be found in the Greater Wash, where the MOD had concerns about the impact of five large scale projects on defence radar at Trimingham on the Norfolk coast. DECC agreed to contribute £4 million towards development of a new radar that will become operational in November 2011. This will facilitate the development of 2 GW of offshore wind in the Greater Wash and has the potential to free up a further 6 GW.

[45] Source: Renewables UK – December 2010

Actions:

- DECC will work with the signatories of a new Memorandum of Understanding to develop, resource and implement radar mitigation programmes for defence and civilian aviation radar over the next few years.
- DECC is jointly funding, with industry and The Crown Estate, a new early-warning radar system for the MOD based at RAF Trimingham.

Case study: Scottish and Southern Energy's Clyde windfarm

SSE (Scottish and Southern Energy plc) has produced the first electricity from its Clyde windfarm in South Lanarkshire. Once completed the 350 MW windfarm, Europe's biggest single consented onshore windfarm, will comprise 152 turbines and generate enough power for 270,000 homes. The first of the windfarm's three sections should be finished by the end of this year and the whole of the farm in 2012. An agreement between SSE and NATS (en route) plc on arrangements to maintain a safe and efficient air traffic control service over the site has been reached, while the construction of the permanent new primary radar facility is completed.

The windfarm represents an investment of £500 million. More than 200 construction jobs are being created while the windfarm is being built and after it is set up and running a staff of 30 will be employed to operate and maintain the site.

Ensure cost-effective grid investment and connection

3.40 To deliver the quantity of onshore wind for 2020 indicated in the central range, the UK will need to substantially upgrade its onshore transmission capacity – overcoming finance, coordination and planning challenges to do so – and ensure that developers secure timely and cost-effective access to the network.

3.41 Currently, some developers report concerns about the transmission charges they face (particularly in remote locations including some parts of Scotland and Wales) and the 'Final Sums Liabilities' they must provide before new lines are put up[46] .

3.42 Timeliness of connection is much less of an issue than it used to be, with over 1.8 GW of onshore wind projects advancing their connection dates by an average of around four years since 2009 due to the introduction of the 'Connect

[46] To cover the risk that generation plant will fail to go ahead, stranding the grid assets produced

and Manage' arrangements. However, some £4.7bn[47] of investment will be required in the onshore grid in the years to 2020 to maintain progress and accommodate the overall level of renewable electricity needed by 2020. Without investment, much of the additional capacity of up to 13 GW of onshore wind by 2020 anticipated in the central range could be at risk.

3.43 To incentivise the necessary network investment, Ofgem introduced a new framework for approving investment proposals ("RIIO"[48]) and will ensure that Transmission Owners' business plans, approved under this framework, are implemented by Spring 2013. In addition, DECC has asked the Electricity Networks Strategy Group (ENSG) to update its assessment of the transmission network investment required to 2020 and, from June, to put in place a process to monitor delivery of this investment. DECC has, in the National Policy Statements, set out the need for new transmission infrastructure in the UK, providing a basis for the consideration of future planning applications for nationally significant infrastructure. In Northern Ireland the approval of investment proposals is undertaken by the Utility Regulator for Northern Ireland through its Regulatory Price Control process. The Utility Regulator is currently consulting on the price control which will cover the period 2012-2017.

3.44 To ensure timely and cost-effective connection of distributed generation, Ofgem issued an Open Letter requesting views by the end of May 2011 on the challenges to connecting to the distribution network. In addition, it is using Project TransmiT[49] to review the connection and transmission charging regime, with a view to making any appropriate changes by April 2012. Recent reforms have reduced the average level of Final Sum Liabilities required of companies, but in response to continuing concerns from developers National Grid intends to publish a consultation on further proposals on financial security arrangements later this year. It will aim to implement any changes required by April 2012.

Actions:

- National Grid will publish a consultation on proposals for suitable long term financial security arrangements in summer 2011, with implementation of any changes required by April 2012.
- DECC will designate the National Policy Statements in July 2011, subject to their approval by Parliament, setting out the need for new transmission infrastructure
- Ofgem is reviewing the transmission charging regime through Project TransmiT and plans to implement any changes required by April 2012.
- Transmission Owners' business plans – approved by Ofgem through the RIIO framework – will be implemented in spring 2013.

[47] Based on data from the Electricity Networks Strategy Group.

[48] Ofgem's RIIO strategy document was published in March 2011, and will guide network companies to develop well-justified business plans setting out their proposals for future network build. http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=120&refer=Media/FactSheets

[49] http://www.ofgem.gov.uk/Networks/Trans/PT/Pages/ProjectTransmiT.aspx

- The ENSG will update its assessment of the investment needed in the transmission network through to 2020 and, from June, put in place a process to monitor delivery of this.

Offshore wind

- The UK is the global leader for offshore wind energy with 1.3 GW of operational capacity across 15 windfarms (which generated over 3 TWh during 2010)[50].
- The UK is well placed to continue this lead role to 2020 and beyond. The central range indicates that up to 18 GW could be deployed by 2020. Beyond 2020 there is a very high potential for deployment with over 40 GW possible by 2030[51].
- Increasing the rate of deployment to realise this potential will require substantial reduction in costs. This necessitates action over and above what is already planned to help industry minimise investment risk, develop the supply chain, ensure cost-effective grid investment and connection, secure consents, and access finance.

Priority actions:

We are determined to drive down costs and are establishing an industry Task Force to set out a path and action plan to reduce the costs of offshore wind, from development, construction and operations to £100/MWh by 2020. This will be supported by up to £30m, subject to value-for-money assessment, to foster collaboration between technology developers and support innovation in the production of components over the next 4 years. This builds on existing support to increase the rate of innovation and develop the supply chain.

- Innovate to reduce costs: Deliver a coordinated portfolio of investment in offshore wind innovation including support of up to £30m in 2011-2015 to reduce costs through technology development and demonstration. Establish an offshore renewables Technology and Innovation Centre (TIC). The Energy Technologies Institute (ETI) will provide £25m investment in a drive train test facility at the National Renewable Energy Centre (NaREC).
- Develop the supply chain: Provide up to £60m for the development of wind manufacturing facilities at ports; work with high-value added manufacturers to exploit supply chain opportunities. The Scottish Government will provide £70m to strengthen port and manufacturing facilities for offshore wind turbines and components in Scotland.
- Minimise investment risk: Complete accelerated RO Banding Review, implement electricity market reform, and put in place EMR-RO transition arrangements
- Access finance: Offshore wind will be a strong candidate for support from the Green Investment Bank (GIB). Work with developers and investors through the Offshore Wind Developers Forum to identify the investment capital required for offshore wind and whether further Government action is appropriate. Take action to reduce investor uncertainty in relation to oil and gas clause in offshore windfarm leases.
- Ensure cost-effective grid investment and connection: Offshore Transmission Coordination Project review of incentives for coordination to ensure coordinated development of Round 3 offshore transmission assets. Develop long-term position on security requirements for grid connection. Grid actions set out above are also relevant to offshore wind.
- Planning and consenting: Manage the potential impacts of offshore developments on other users of the sea and broader environmental considerations through publication of Offshore Strategic Environmental Assessment. Identify and, where appropriate, manage potential delays to consenting decisions

[50] Energy Trends June 2011
[51] Based on data collected by Arup for their report on the RO Banding review.

Current deployment

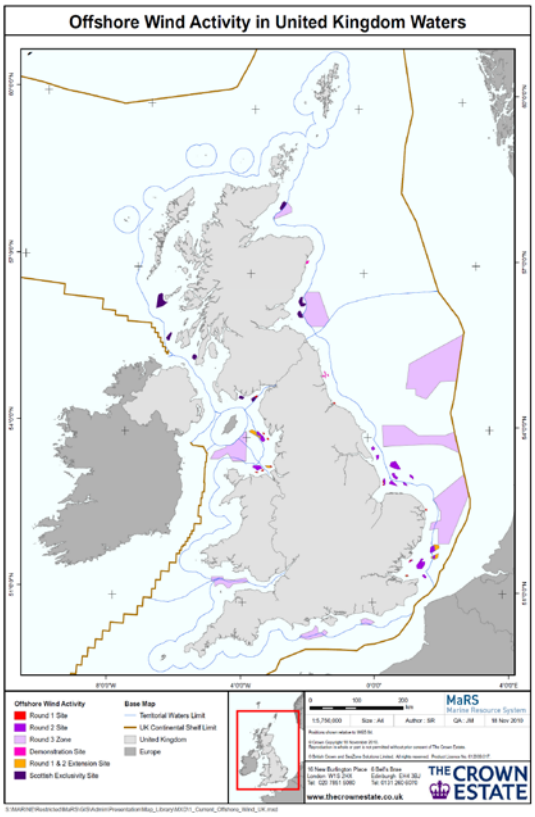
3.45 The UK is the largest market for offshore wind energy in the world with an installed capacity of over 1.3 GW, around 4 GW post-consent, and some 2 GW in the planning system. Current operational capacity is located relatively close to shore in 15 windfarms in the North and Irish Seas and Scottish Territorial Waters (STW).

Figure 13: Offshore wind activity in United Kingdom Waters

The Crown Estate, which owns most of the seabed out to the 12 nautical mile territorial limit, has granted leases to developers in a series of rounds

Round 1 leases are typically close to shore, and have been mostly installed already – they total around 1 GW of capacity. Round 2 identified three strategic areas, totalling 7.2 GW, which are under construction or in development and will be responsible for the capacity additions expected over the next 3-4 years.

Round 3 leases offer up to 32 GW of new generation in 9 zones, which are significantly larger than the areas identified under Rounds 1 and 2 and likely to use larger turbines. Many of the Round 3 zones are in deeper water, further offshore, and are therefore more technically challenging. The Crown Estate also granted exclusivity agreements in 2009 for the development of 6.4 GW in Scottish Territorial Waters. Northern Ireland is considering a leasing round of at least 600MW, subject to consultation.



In order to provide a stable flow of construction projects to the offshore wind industry, in May 2010 the Crown Estate also announced an additional 2 GW capacity by way of extensions to a number of awarded leases.

Deployment potential

3.46 Figure 14 sets out results of recent analysis of the potential for growth in offshore wind generation to 2020. It suggests that industry has the potential to bring forward between 10 and 26 GW by 2020 ('industry low' and 'industry high' scenarios), with a central range of up to 18 GW. Achieving the top of central range would require an annual growth rate of up to 30%.

3.47 The UK has the best offshore wind resources in Europe. Recent independent analysis for DECC suggests that the UK can maintain its place as global leader in offshore wind with the potential to deploy over 40 GW by 2030. Such

significant capacity, enough to power the equivalent of all the homes in the UK, can play a vital role in increasing our energy security and decarbonising power generation.

3.48 The Committee on Climate Change recommended in their recent advice that, unless there is clear evidence of cost reduction, the UK ambition for offshore wind should be limited to 13 GW by 2020. If industry, with Government support, can drive down costs, we will be able to go faster and further, ensuring that the full economic and energy security benefits of our offshore wind resource comes to the UK rather than our competitors. We are determined to achieve these gains, which is why we are:

- Providing a further £30m of direct Government innovation support for offshore wind cost reduction. This is in addition to £28m for offshore wind applications under the Environmental Transformation Fund (ETF), the £30m already committed to NaREC, the recently announced £25m by the ETI, and £60m provided for the development of manufacturing facilities at port sites;

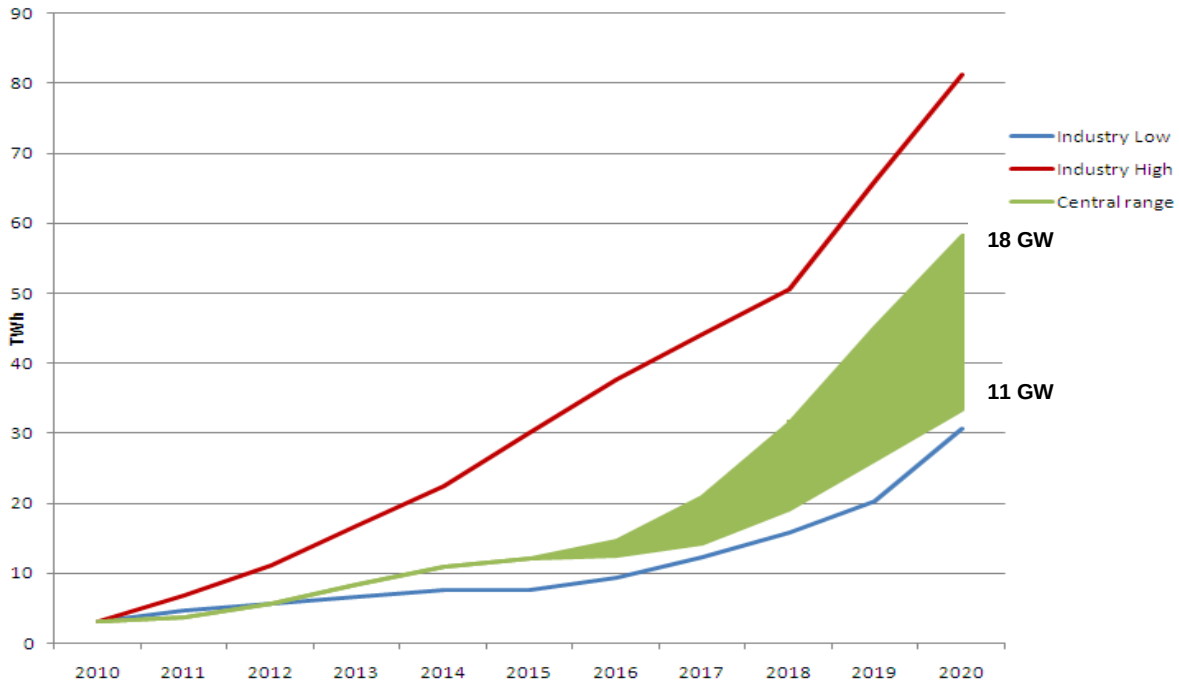
- Establishing a Task Force with industry to set out an action plan for cost reduction to 2020. The Task Force will drive the work necessary to realise the vision of reaching £100/MWh for offshore wind, making it cost competitive with a large proportion of the 30-40 GW of low carbon generation which will be necessary in the 2020s to deliver the 4th Carbon Budget. The group will be chaired by a senior industry figure and will involve industry, Government and the Crown Estate. The Crown Estate will play a key role in facilitating this work through the analysis it has initiated on cost reduction pathways.

3.49 Industry indicate that cost reductions of this challenging level can be achieved over the next decade through a combination of technology progression, industrialisation and greater supply chain competition, combined with favourable exchange rate and other external conditions.

3.50 The Task Force will consider evidence from The Crown Estate, industry and others on present and future costs, the key determinants of cost at each stage of the value chain, and which of these should be targeted for action. Its recommendations, which will be jointly developed by industry and Government and reported to Minsters, will be used to inform future iterations of the Roadmap, including the deployment potential for offshore wind.

3.51 Significant cost reductions of this kind would see much greater levels of growth towards the end of the decade. For example, if costs were to fall to £100/MWh, then the cumulative offshore wind deployment in 2020 could increase deployment a further 5 GW by 2020 above the level set out by the CCC. It would enable industry to unlock the full potential of the UK's offshore resources and provide contingency should the levels of large scale renewable energy anticipated from other technologies fail to be realised.

Figure 14: Deployment potential to 2020 for offshore wind



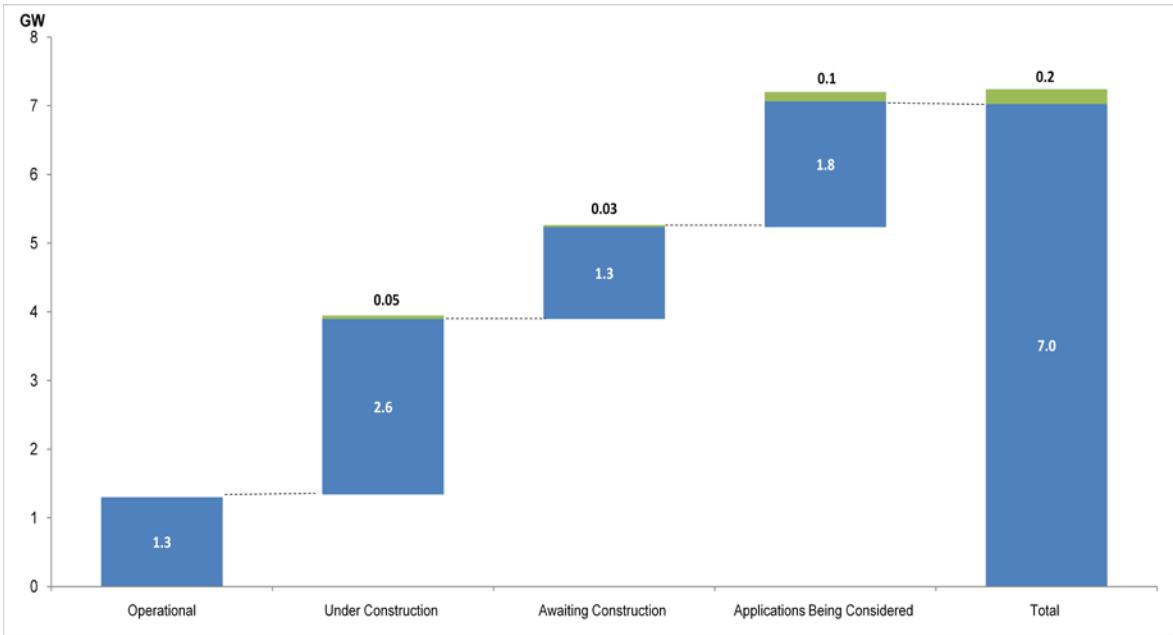
3.52 Being able to deploy at scale and at reduced cost would also position the UK strongly to exploit commercial opportunities for greater generation in the North Sea. We have abundant wind resource and should explore the possibility of exporting energy generated in UK waters to mainland Europe. This could mean, for example, that our European neighbours fund the deployment of additional capacity in UK waters for their own consumption leading to even greater business benefits for the UK. We will take powers as early as practicable to enable the "two-way" trade in renewable energy with other Member States where this can secure the greatest benefit for the UK.

Deployment pipeline

3.53 Figure 15 provides a breakdown of the current offshore wind planning pipeline and the effect of current drop-out rates on final development. Offshore wind has historically benefitted from a very low dropout rate with only 7% of projects being lost from the pipeline[52]. Taking historic dropout rates into account, there are almost 6 GW of Round 1 and 2 offshore wind projects currently in construction, awaiting construction, or in planning. When the deployment pipeline is taken together with the capacity currently in operation this represents 7 GW

[52] Planning and post-consent success rate based on capacity from 2007-present.

Figure 15: Capacity of offshore wind projects in the planning pipeline[53]



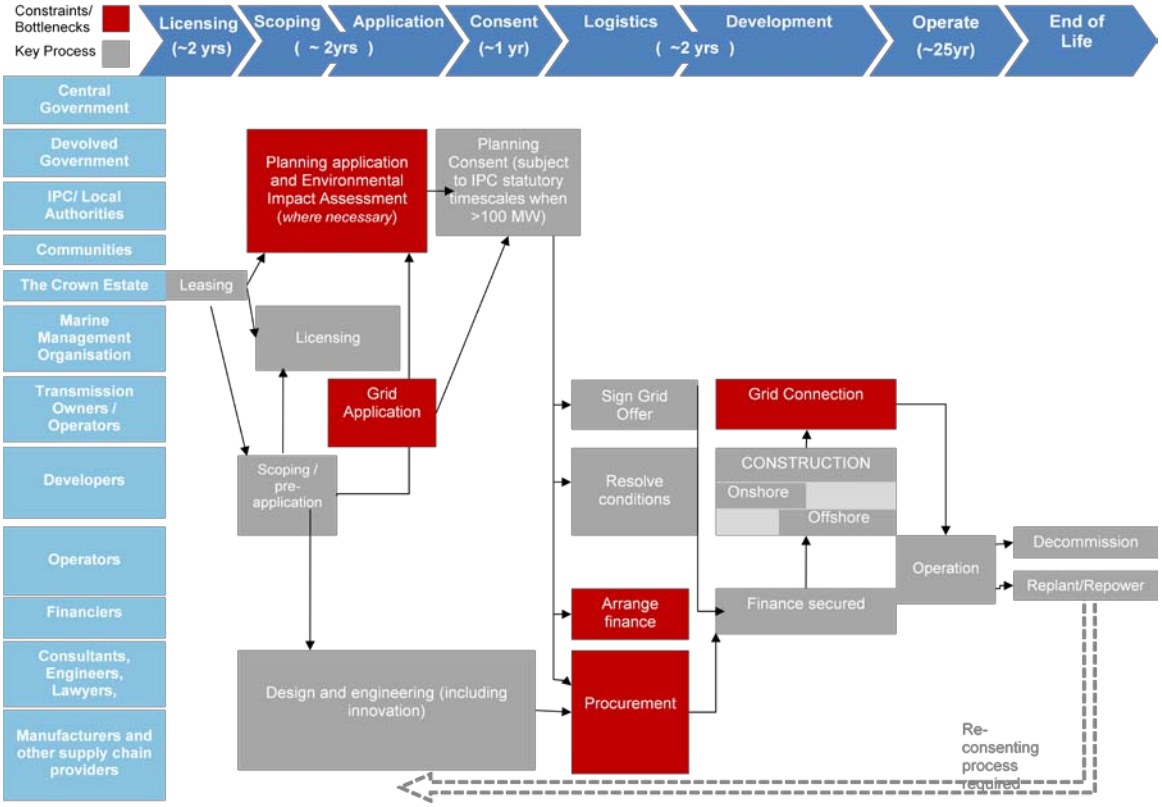
3.54 To deliver further deployment, projects will also need to come forward from Round 3 zones and extensions awarded, STW sites, and the forthcoming Northern Ireland leasing round. Individual projects within the Round 3 zones are at the pre-application stage, and are likely to enter the planning and consenting process from late 2012 onwards.

Journey to deployment

3.55 Figure 16 below is a developer journey map for offshore wind projects. It outlines the delivery system for offshore wind developments in UK waters. Up to now the average time for progressing to operation is 4-6 years. The chart below shows the development process and likely timings for a typical offshore wind project and highlights the greatest risks to deployment in red. To increase the build rates, shorten development time, and reduce costs, we must tackle the barriers set out below.

[53] Based on historic consenting rates, the capacity shown in green could potentially be lost from the pipeline

Figure 16: Developer journey map for the deployment of offshore wind projects



Challenges to deployment and actions

3.56 We recognise the importance of offshore wind to the achievement of our renewables target, and the long term potential to contribute to the decarbonisation of the energy sector necessary under the 4th Carbon Budget.

3.57 In addition to the specific challenges and actions set out below, we also need to prioritise the driving down of costs of offshore wind energy to the make the technology sustainable in the longer term. Government is already supporting work to increase the rate of innovation to bring down costs, including by supporting test facilities and deciding to establish an offshore renewables TIC. The ETI has recently announced that it will invest £25m into an open access wind turbine drive train test rig to be sited at NaREC in Blyth. DECC is announcing today that it will provide up to £30m over the next 4 years to foster collaboration between technology developers and to support innovations in the production of components.

3.58 We will prioritise work with the industry and The Crown Estate to identify where efforts can be focused to reduce the costs of offshore energy throughout the value chain from development, construction and operations. As set out above, we will establish a Task Force with industry to set out an action plan for cost reduction to 2020. We will also work though the Offshore Wind Developers

Forum (OWDF) and its supply chain sub-group to support the development of the UK supply chain.

Innovate to reduce costs

3.59 Offshore wind is at an earlier stage of development than onshore, with designs that are still evolving and costs which are significantly higher – driven in part by the need for greater reliability, given the harsher operating environment and the difficulty in gaining access for maintenance and repair.

3.60 To deploy at the scale suggested by our analysis it will be crucial to reduce costs – for manufacturing, installing, operating and maintaining offshore windfarms. Innovation, to improve efficiency and decrease installation costs will have a significant role to play in reducing the cost of energy, which will in turn support increased deployment and help boost the UK supply chain. Some Round 3 zones will also require innovation to develop larger turbines, foundations in deep water sites, and drive train technologies.

3.61 To help address that challenge the members of the Government's Low Carbon Innovation Group[54] are working together and with the Devolved Administrations and others to provide a coordinated and broad portfolio of support to innovation in offshore wind. Key parts of that portfolio include:

- UK Government support to the development of shared industry testing and proving facilities – such as the new 100-metre blade testing facility and offshore wind turbine testing sites at NaREC in Blyth;
- The ETI recent announcement that it will invest £25m into an open access wind turbine drive train test rig based at NaREC.
- The Technology Strategy Board's funding to establish an offshore renewables TIC;
- The ongoing offshore wind innovation programmes of the ETI, which focuses on reliability, cost reduction, and supply-chain development of technologies optimised for the offshore wind sector;
- The work of the Carbon Trust, which has committed in the region of £4m this financial year to continue the Offshore Wind Accelerator;
- The Research Council's Offshore Wind Supergen programme with the principal objective of the current phase being to undertake research to achieve an integrated, cost-effective, reliable and available Offshore Wind Power Station.

3.62 Testing facilities have been recognised as having a key role to play in the offshore wind sector. Demonstration of what in many cases will be cutting edge new technology in a controlled environment is required before mass deployment can take place, and will support cost reduction and provide

[54] The Low Carbon Innovation Group core membership includes: the Department of Energy and Climate Change (DECC), the Department of Business Innovation and Skills (BIS), the Carbon Trust, the Research Councils, the Energy Technologies Institute (ETI) and the Technology Strategy Board.

investment confidence. We will support the development of the shared industry testing and proving facilities where possible to help lower technology costs and improve reliability.

3.63 The recently announced wind turbine test rig funded by ETI will be capable of testing complete drive trains and nacelles for prototype turbines up to 15 MW, in a purpose built, onshore test facility. Accelerated lifetime testing of turbines will help reduce the technical and commercial risks of mass production and deployment before moving to challenging offshore conditions. It will provide both a lower cost alternative to deploying and testing turbines offshore, and will accelerate the development of new prototypes for low cost, more reliable machines, increasing the speed of deployment. It should be available for commercial testing from June 2013.

3.64 To complement those investments, DECC will set-aside up to £30m over the next 4 years for offshore wind innovation which, subject to satisfactory value for money assessments, will be used to fund schemes to drive cost reductions in components and technologies for offshore wind systems and to foster collaboration between offshore wind developers to address common challenges.

Actions:

- Delivery of a coordinated portfolio of support to offshore wind including: the establishment of an offshore renewables TIC; the continued development of offshore wind energy testing facilities; and, subject to value for money assessment, DECC will be providing up to £30m over the next four years which will support innovation to reduce costs.

Case study: Belfast Harbour Development as Offshore Renewables Hub

Belfast Harbour, a deep water port with no tidal restrictions offering year-round access, gives offshore energy investors the ability to build the robust supply chain solutions they need. Already host to Harland and Wolff Heavy Industries' logistical supply base, in February 2011,

Belfast Harbour announced plans with DONG Energy, which are now being finalised, to develop a new £50m, 50 acre offshore logistics hub as a base for its Irish Sea construction operations.

This marks a significant investment and creates a large number of jobs in Belfast, during the construction phase and its subsequent use as a pre-assembly facility. A further 100 acres of available development land nearby is part of plans to develop a Marine Energy

Park at Belfast Harbour, focusing on both offshore wind and marine energy technologies.

DONG Energy, alongside Scottish Power Renewables, have also recently reached financial closure on the construction of the 389MW West of Duddon Sands offshore windfarm in the Irish Sea and it is expected that the installation and pre-assembly operations shall largely be run out of Belfast Harbour. Work will commence in early 2012, initially with construction of the required onshore connections. The partners have also commissioned two purpose built installation vessels to be used in the construction of the project, allowing work to be undertaken in all seasonal conditions. Offshore construction for West of Duddon Sands is expected to commence in early summer 2013 with the project expected to be fully completed by the end of 2014.

Develop the supply chain

3.65 The equipment and construction supply chains for offshore windfarms are still at the development stage. Although there are a number of players who are making good progress, there is still a lack of capacity and competition overall, particularly in the production of key components such as large bearings, electrical equipment, export (including HVDC) cables, and the vessels required to install them. Investment is also needed in manufacturing sites and port infrastructure to facilitate deployment, stimulate the associated supply chain, and lowers costs.

3.66 The UK will need to overcome supply chain barriers to lower costs and deploy at scale for both 2020 and beyond.

3.67 DECC's approach is to focus on a small number of key supply constraints where Government can have a particular material impact. These include the development of manufacturing facilities at port sites, for which DECC will make up to £60m of support available by 2015. This money will help leverage large private investment to develop the facilities necessary to produce heavy turbine components.

3.68 The Scottish Government has also introduced a £70 million National Renewables Infrastructure Fund, designed to strengthen port and manufacturing facilities and supply chain provision for manufacturing offshore wind turbines and related components. The Fund will leverage significant private sector investment over the next four years and help deliver an estimated 28,000 jobs and £7.1 billion in value to Scotland's economy over the coming decade.

3.69 DECC is working with the OWDF to support the development of the UK supply chain by:-

- setting a long-term vision for the industry,
- providing confidence and visibility on future build schedules,
- learning and implementing relevant lessons from other sectors, such as oil and gas, to support cost reduction and supply chain development

Actions:

- DECC will provide up to £60m over the next 4 years for the development of new offshore wind manufacturing facilities at port sites in assisted areas in England.
- The Scottish Government will provide £70m through the National Renewables Infrastructure Fund to strengthen port and manufacturing facilities for offshore turbines and related components.
- DECC is working with the OWDF and other key stakeholders to support development of the supply chain.

Case study: MTL Group[55]

MTL Group is a UK contract manufacturing specialist in the metal sector. Founded in 1995 they have grown to become a partner of choice for many major global original equipment manufacturers (OEMs).

They have recently been awarded a multimillion pound contract to supply 97 Boat Landing Systems to a leading European foundations manufacturer for a German offshore windfarm in the North Sea.

MTL Group has worked closely with DECC, receiving £250,000 of grant funding to 'Develop increased supply of jacket and monopole sub-assemblies' to increase assemblies for the offshore wind sector. With this DECC support MTL Group has invested in state of the art machinery that meets the requirements of this growing sector.

The contract which is its largest export contract to date, will use all of MTL Group's processing equipment which includes large format high definition plasma & laser cutting, robotic tube cutting, automated robot welding and large CNC machining.

25 MTL employees will be working on the project at the groups advanced manufacturing facility in Rotherham. Work is due to commence in July 2011 with the final delivery of boat landings by March 2012.

Minimise investment risk

3.70 Developers report perceived uncertainty about the level and surety of Government financial support for offshore wind, factors which reduce their ability and willingness to secure finance.

[55] Photograph credits: 'Found Ocean'

3.71 This is a key issue for offshore wind given the scale and cost of projects involved and could affect any project which has not yet achieved financial close, in particular the 3 GW of capacity currently in the pipeline awaiting planning approval or construction (mainly Round 2 projects). Scoping work on Round 3 and STW projects could also be affected as well as forthcoming projects in the Northern Ireland leasing round, although we do not anticipate that these projects will need to achieve financial close imminently.

3.72 Electricity Market Reform will put in place a transparent and long-term financial framework for low carbon electricity, including offshore wind. Government will ensure a smooth transition from the RO. As part of this, once the new scheme is introduced, new generators will have the choice between the two schemes until 2017 and following closure of the RO to new entrants, technology payments made under the RO will be grandfathered[56]. In addition, the Government has accelerated the current Banding Review to provide clarity sooner on future support levels under the RO – Government will consult in summer 2011 and publish its decision the end of the year, one year earlier than originally planned.

Actions:

- DECC will consult on new banding levels in summer 2011 and publish its decisions by the end of the year. New banding levels for offshore wind will come into force in April 2014
- DECC will put in place arrangements to ensure a smooth transition from the Renewables Obligation to the new electricity market support mechanism.

Access finance

3.73 Deploying offshore wind capacity for 2020 will require investment in the order of tens of billions of pounds. Individual Round 3 projects are likely to cost more than £1bn and some zones more than £10bn. At present, only the utilities and state-backed independent companies are leading the construction phase of offshore windfarms.

3.74 There are a limited number of banks willing to consider funding the construction phase of offshore wind, partly due to the size of the lending required and the difficulty in mitigating construction risk. In addition, banks are constrained in their ability to lend to offshore wind projects as there is a limited possibility of de-risking their positions over time, whether through the debt syndication market or by refinancing in the debt capital market. This constraint will become more important over time, as new banking reforms (Basel III) are likely to make long-term lending less attractive.

3.75 Moreover, any projects developed by utilities using project finance will typically be viewed by rating agencies as on-balance sheet debt for the utility. As a result, utilities prefer to fund projects on their own balance sheet, thereby avoiding the higher cost, limited availability, and more stringent conditions

[56] Grandfathering is a policy that support levels should not change once generation has been accredited under a scheme, thereby providing investors greater certainty.

attached to non-recourse project debt funding. But it is unlikely they will be able to deliver all of the investment required in this way, given their desire to protect credit ratings and make other investments in the UK or overseas.

3.76 These barriers could affect any project which has not yet reached financial close, including the 3 GW which is in the pipeline at present but not yet under construction.

3.77 Uncertainty about additional risks can also affect the financing of projects, such as the perception that the value of an offshore wind investment could be diminished because offshore windfarm leases from the Crown Estate can be amended or terminated in order to allow an oil or gas development to proceed. To reduce this perceived risk, DECC will formalise its existing policy that no offshore windfarm lease will be terminated or amended without appropriate compensation, and work with the offshore wind and oil & gas industries to set out guidance on how to resolve conflicts.

3.78 BIS is setting up the Green Investment Bank (GIB). The GIB's mission is proposed to be providing financial solutions to accelerate private sector investment in the UK's transition to a green economy. In looking to achieve this mission the GIB will offer a range of financial products to increase investment in low carbon infrastructure.

3.79 Although no decisions have been taken on the sectors and technologies that the GIB will focus on, the market failures facing offshore wind are indicative of the challenges which the GIB will seek to address. It is therefore likely that offshore wind will be a strong candidate for support from the GIB, which could play an important role in freeing up utility balance sheets as well as reducing project finance costs by helping to place debt in the capital markets and de-risking project finance.

3.80 In May BIS announced an incubation phase for the GIB from April 2012, under which the Government will make direct investment in the green economy (taking account of advice from finance professionals) until State Aid approval is achieved. Following State Aid approval the GIB will be established as a stand-alone institution and from April 2015 will be given powers to borrow[57].

3.81 DECC is working with developers and investors in the OWDF to identify the quantity and type of investment capital required for offshore wind and identify whether further Government action is needed and appropriate. To reduce risk DECC is clarifying its financial incentives for renewables, as discussed above.

Actions:

- Government will, from April 2012 and prior to obtaining state aid approval to establish the GIB, pursue financial interventions that do not require specific approval using the £775m of commitment from 2012/13 made available in the Budget. These are likely to be investments on market terms or under existing state aid approvals.

[57] Subject to public sector net debt falling as a percentage of GDP

- Government will aim to achieve state aid clearance as soon as practical in order to pass legislation to enshrine the GIBs independence in statute.
- Government will take action to ensure that no offshore windfarm lease will be terminated or amended without appropriate compensation to allow oil and gas development to proceed, and will work with industry to set out more detailed guidance before the end of 2011.

Ensure cost-effective grid investment and connection

3.82 To deliver the increase in offshore wind generation expected by 2020, the UK will need significant and timely investment in the grid, both to bring electricity ashore and to strengthen the onshore transmission network. The Crown Estate estimate, for example, that around £10bn of investment will be required to connect all Round 3 projects to shore.[58] Investment will need to be well coordinated to ensure it is deliverable and cost-effective.

Box 5: Offshore Transmission Operation (OFTO)

The competitive approach to granting offshore transmission licences is expected to have a number of advantages including encouraging innovation and new entrants. Connections for nine offshore projects (with 2 GW of capacity and connections worth £1.1bn) were tendered by Ofgem in the first OFTO tender round. Ofgem has forecast savings of £350m from these nine grid connection projects compared to onshore grid costs[59].

The first tender round has shown strong evidence of investment appetite and new sources of finance, attracting almost £4bn of investment for £1.1bn of assets. Preferred bidders have been announced for the transmission assets of eight of the nine offshore windfarms in this round:

- Transmission Capital Partners (a consortium of Transmission Capital, Amber Infrastructure and International Public Partnerships) is the preferred bidder for Barrow, Gunfleet Sands, and Ormonde.
- Balfour Beatty Capital Ltd is the preferred bidder for Thanet.
- A consortium of Balfour Beatty Capital Ltd, Equitix Ltd and AMP Capital Investors Ltd is the preferred bidder for Greater Gabbard.
- Macquarie Capital Group as part of a consortium including Barclays Private Equity and NIBC Infrastructure Partners is preferred bidder for Sheringham Shoal, Walney I and Walney II.

The first OFTO licence was granted in April 2011, to Transmission Capital Partners, for the Robin Rigg offshore windfarm.

The second tender round has been launched for projects with a capacity of 2.8 GW and an estimated connection asset value of £1.9 billion. Ofgem recently announced a shortlist of four bidders competing to own and operate transmission links (with 1.4 GW of capacity) for three offshore windfarms. Preferred bidders will be announced in Autumn 2011.

[58] 'Round 3 Offshore Wind Farm Connection Study'

[59] http://www.ofgem.gov.uk/media/pressrel/Documents1/AugustOffshorePressNotice.pdf

3.83 To facilitate investment, DECC commenced the new offshore transmission regulatory regime in July 2010 for certain offshore transmission projects from the point of transfer of constructed transmission assets from the generator to the Offshore Transmission Owner (OFTO), appointed by virtue of a tender exercise run by Ofgem. In response to feedback from developers, codes and licences were amended in December 2010 to extend the generator-build option for the future alongside the OFTO build option.

3.84 To improve investment planning, DECC and Ofgem set up the Offshore Transmission Coordination Project in March 2011, leveraging industry involvement to examine whether any further changes are needed to the offshore transmission regime to ensure coordinated development of Round 3 offshore transmission assets. The project will report at the end of 2011, followed by a consultation in 2012 if further measures are considered necessary.

3.85 To manage the costs of connection, National Grid have extended the interim financial security arrangement until April 2012, whereby developers are only required to provide security for local connections rather than wider reinforcement. To help inform National Grid's analysis to identify suitable long term arrangements, DECC is consulting with the OWDF and the marine energy industry. National Grid intends to publish a consultation later this year with the aim of implementing any changes by April 2012.

Box 6: The ISLES Project

The ISLES project is a collaboration between the Scottish Government, the Northern Ireland Executive and the Government of Ireland to drive forward the delivery of grid infrastructure for 2020 and beyond and connecting up markets.

The project, funded by the European Union's INTERREG IVA Programme, is assessing the feasibility of creating an offshore interconnected transmission network and subsea electricity grid to garner and transport electricity created from renewable energy sources in the northern coastal waters linking Scotland, Northern Ireland and Ireland and in the Irish Sea. The results of ISLES first major initiative will have been disseminated to stakeholders by the end of 2011.

3.86 The Northern Ireland Executive is working closely with stakeholders to ensure that there is significant and timely investment in the grid to facilitate offshore technologies. Northern Ireland is currently developing an Onshore Renewable Strategic Action Plan which will also examine the impact of bringing electricity ashore and its associated impact on Northern Ireland's onshore transmission network.

Actions:

- DECC and Ofgem will publish the conclusions of the Offshore Transmission Coordination Project by the end of the year, followed by a consultation in 2012 if further measures are considered necessary.

- Several of the actions described in onshore wind regarding the transmission network (see section beginning paragraph 3.39 above) are also relevant to offshore wind.

Planning and consenting

3.87 New National Policy Statements clarify the national need for new energy infrastructure, including for offshore wind, and how the impacts of development should be mitigated to safeguard sustainability.

3.88 Offshore wind projects can face delay in securing consent, while potential impacts on the marine environment and other users of the sea are considered and resolved. In some cases, there may be specific site-related issues, leading to loss of the project, whilst in others it will take time to measure, resolve, and mitigate impacts. Early engagement between developers and the appropriate statutory consultees as part of the reformed approach to marine licensing, as well as in the implementation of the new marine planning system should avoid some delays, which are costly for developers and delay their revenues from generation.

3.89 Failing to resolve these tensions could, in theory, impact the 1.9 GW of new capacity currently in planning and the additional capacity we anticipate will come forward through the decade. Round 3 projects, in particular, will be larger in size and more complex than Rounds 1 and 2, suggesting greater potential cumulative impacts on marine ecology in particular as projects grow in number and greater demands on the statutory advisors and regulators who assess applications.

3.90 To clarify the impact of environmental legislation on offshore wind, DECC is working[60] to understand, and where appropriate manage, the implications of Marine Conservation Zones (MCZs) and the Marine Strategy Framework Directive (MSFD). DEFRA will consult on proposed MCZ boundaries in summer 2012. In accordance with the MSFD, the UK's determination of Good Environmental Status, and associated targets and indicators, has to be submitted to the EU Commission by July 2012. The Welsh Government will be responsible for designating Marine Conservation Zones in Wales.

3.91 To build the evidence base and fill gaps which can hamper the planning process, DECC is undertaking research on the likely impacts of offshore wind on the environment and other sea users through its rolling programme of Strategic Environmental Assessments (SEAs). The post-consultation report for the Offshore SEA 2 will be published in summer 2011.

3.92 To tackle the issues and resource constraints that consenting and regulatory bodies face in response to an increasing volume of applications, the Marine Management Organisation (MMO) has established an Offshore Renewable Energy Licensing Group. This will look at strategic issues such data gaps,

[60] With Defra, Devolved Administrations, JNCC, Natural England and other stakeholders, as well as the Crown Estate

cumulative impact and the survey methods used. The group includes all bodies involved in the licensing and consenting of marine renewable energy and met for the first time in June 2011.

Actions:

- DECC is working to understand the implications of MCZs on offshore projects. DEFRA will consult on MCZ zones in summer 2012, with designations by December 2012. The Welsh Government will be consulting separately in 2012.
- DECC will publish a post-consultation report in summer 2011 identifying gaps in its evidence base for Offshore Energy Strategic Environmental Assessments.
- MMO has established an offshore regulators group, which met for the first time in June 2011 to tackle the challenges that regulatory bodies face and manage consenting delays.
- Northern Ireland will publish its final Offshore Renewable Energy Strategic Action Plan by December 2011.

Marine Energy

- Wave and tidal stream technologies are still at an early stage of development with around 4 MW of prototypes currently undergoing testing in the UK.
- Commercial deployment of wave and tidal stream has yet to begin but the central range suggests up to 300 MW (approximately 0.9 TWh) could be deployed in the UK by 2020. Much larger scale deployment is anticipated in the period beyond 2020.
- While tidal range technologies are largely proven, they need to be deployed through commercial-scale construction projects to be successful. Developers are currently evaluating a number of specific projects but these are unlikely to be operational and making a significant contribution before 2020 given the high costs and lead times for construction.
- Challenges to deployment include: managing the risks and costs of RD&D; securing the investment required for commercial deployment; developing supply chain infrastructure, securing consents.

Priority actions:

- Manage the risks and costs of RD&D: Deliver a co-ordinated, targeted programme of marine innovation support over the next four years, including up to £20m of support from DECC for pre-commercial array demonstration. Establishment of an offshore renewables Technology and Innovation Centre, and new programmes to support R&D that will reduce the cost of marine energy. Scottish Government will announce details of their joint funding programme by the end of 2011.
- Secure the investment for commercial deployment: Work through the UK Marine Energy Programme to assist the sector in obtaining investment funding. Work with the Crown Estate to create a knowledge sharing network to support development.
- Development supply chain infrastructure: Work with the sector to develop Marine Energy Parks through the publication of guidance by March 2012.
- Planning and consenting: Finalise outcome of the Strategic Environmental Assessment (SEA) consultation and input to policy on use of the sea. Work with marine regulators to better understand and overcomes key barriers to planning and consenting process for marine renewables.

Current deployment

3.93 Wave and tidal stream technologies are still at a relatively early stage of development. There is currently one operational 1.2MW tidal stream turbine in Strangford Narrows in Northern Ireland. In addition, a number of tidal stream and wave energy devices, ranging up to 1MW, have been deployed at the European Marine Energy Centre (EMEC) in Orkney for testing. There are no tidal range schemes in the UK at present.

Case study: UK Marine Energy Testing Infrastructure

The UK has long been viewed as a focus for activity for the development of wave and tidal energy technologies, with the majority of leading developers based here and planning to deploy commercially in UK waters. This has been underpinned by the UK Government's investment to create a unique testing and innovation infrastructure.

Pelamis P2 testing at EMEC

The European Marine Energy Centre (EMEC) in the Orkneys was created through a mixture public sector funding in 2003 when the wave testing site was opened, followed by a tidal testing site in 2007. The Centre provides grid connected berths for testing both large scale wave and tidal energy devices. All bar one of the full scale prototypes funded under DECC's Marine Renewable Proving Fund will be deployed at EMEC. DECC has recently funded an £8m expansion of the EMEC test site with the installation of three additional grid connected cables (2 tidal,1 wave) and the creation of a "nursery" testing site which will allow developers to test part-scale wave and tidal devices in more benign marine conditions or to practice deployment and maintenance operations prior to operating at the main testing sites. The "nursery" site has also already been attracting interest from other sectors which would benefit from testing components and structures in the marine environment (providing a potential revenue source between marine energy tests).

The Wave Hub wave array testing facility was deployed off the coast of Cornwall in 2010 and will provide facilities to demonstrate small arrays of wave energy devices, up to a total of 20MW. The first devices, produced by Ocean Power Technologies are due to be deployed at Wave Hub next year.

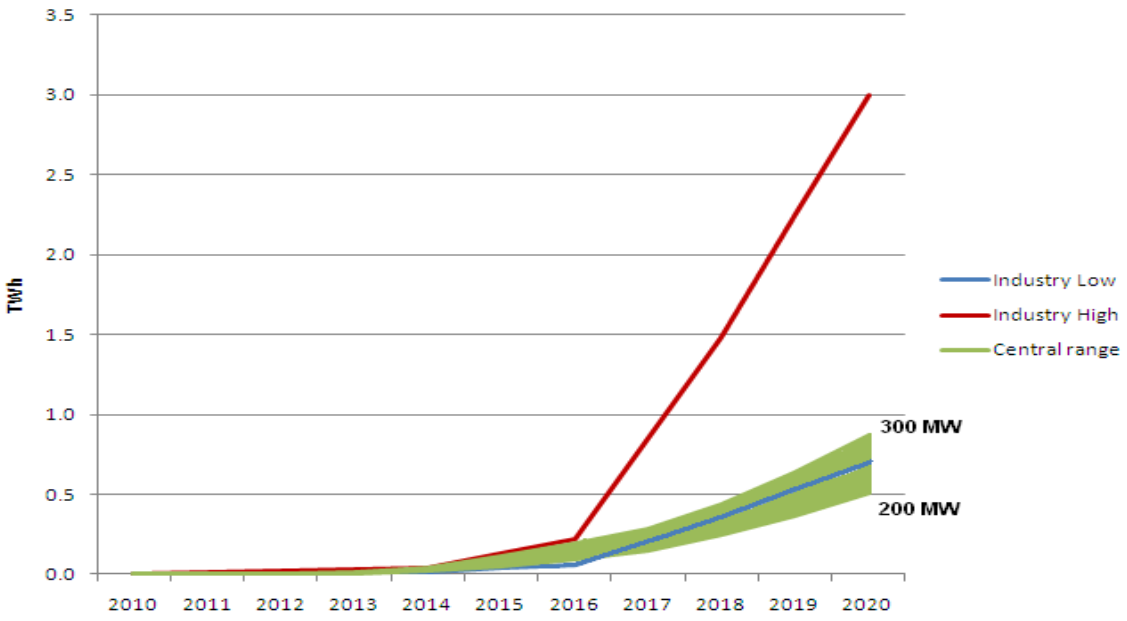
Aquamarine Oyster testing at EMEC

Alongside the facilities at EMEC and Wave Hub the Government has also funded an onshore tidal drive train testing facility at the National Renewable Energy CentreS in the North East of England. This will be completed next year and allow the onshore testing of tidal devices prior to deployment, reducing costs of development and leading to enhanced reliability.

Deployment potential

3.94 Figure 17 presents the results of recent analysis of the potential growth of wave and tidal stream generation to 2020. It overlays an industry view of the deployment that could be achieved (the 'industry high' and 'industry low' scenarios) around a central range.

Figure 17: Deployment potential to 2020 for marine energy



3.95 In the central range pre-commercial wave and tidal stream array demonstrations will be carried out between 2013 and 2015, with commercial deployment increasing through the second half of the decade. The Welsh Government believe that by 2025 up to 4 GW of marine energy could be installed and operating around its coast. A range of studies have suggested that given continued development of the sector, wave and tidal energy could expand through the 2020s to achieve some 27 GW[61] by 2050.

3.96 The central range does not assume a contribution from tidal range by 2020 given the long lead times of these projects. However, although the UK and Welsh Governments' Severn Tidal Power Feasibility Study did not see a strategic case for public investment at the present time, developers are currently assessing a number of potential future projects in the Severn area and elsewhere (e.g. the Mersey and Solway Firth).

3.97 Analysis[62] suggests considerable variation in the levelised cost of marine technologies, ranging from £162 to £340MWh in 2020[63]. This reflects cost differences between the individual technologies considered, uncertainty about anticipated levels of learning, global deployment, and technology risk. Capital costs are expected to fall as projects move from prototype stage to commercial deployment, but the scale of the decrease is hard to predict and depends, for example, on the intensity of the marine resource exploited.

[61] Source: 2050 DECC, PIRC Offshore Valuation 2010, Carbon Trust TINA & Green Energy Growth April 2011, Ernst & Young 2010

[62] Analysis referenced by Arup and Ernst & Young, which is summarised in section 2.2 of the Roadmap.

[63] Data is not available for 2010 as some marine technologies have yet to be deployed commercially. Data for 2020 refers to wave, tidal stream and tidal range.

Deployment pipeline

3.98 At present there is no firm planning pipeline for wave and tidal stream. Progress has been made in pre-commercial deployment in recent years, with several large scale prototypes now in testing and active plans from the industry to deploy small arrays in the next four years.

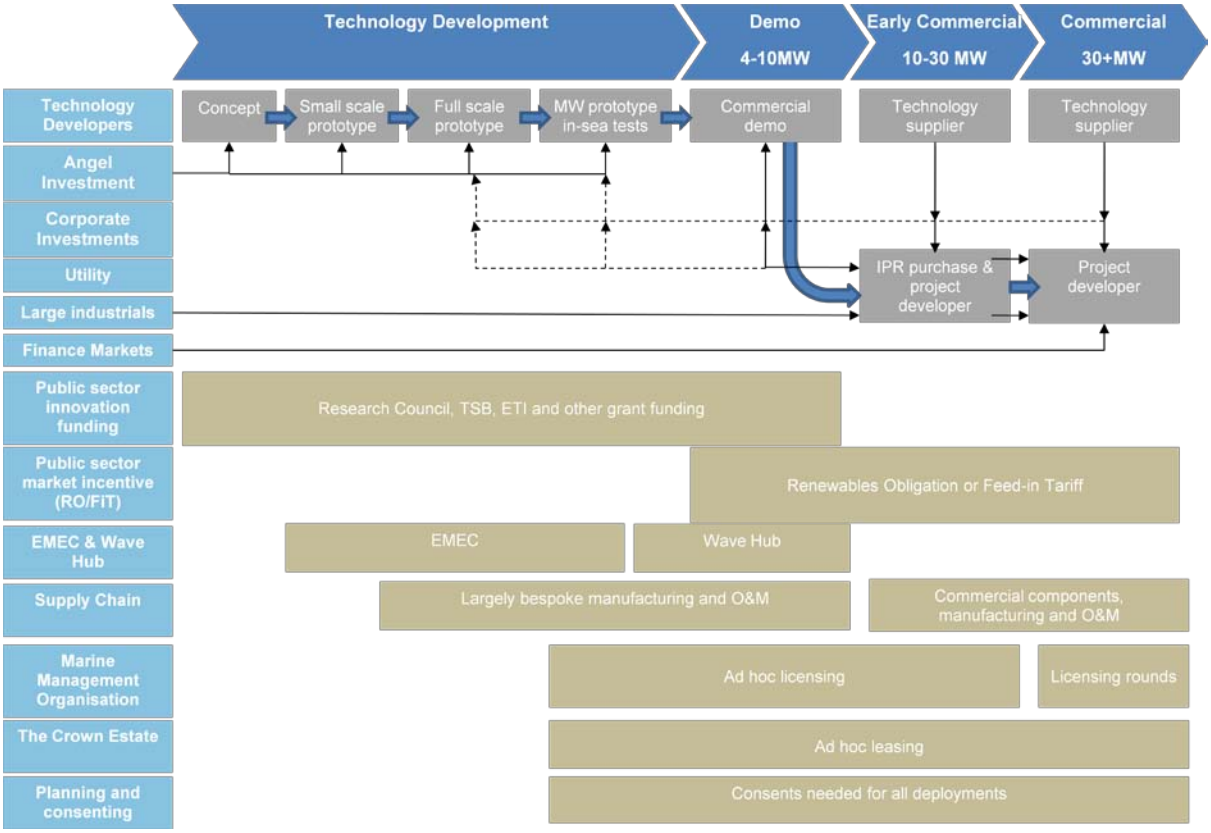
3.99 In preparation for this wider deployment, several Strategic Environmental Assessments (SEAs) have been recently produced or are under development across the UK. The Offshore Energy SEA for English and Welsh waters should be completed this summer and will complement the existing SEAs for Scotland, Northern Ireland, and the SEAs prepared for the Severn Estuary. This should open up the whole of the UK waters for the potential deployment of marine energy devices.

3.100 Following the SEA of Scottish waters, the Crown Estate awarded commercial leases in the Pentland Firth and Orkney Waters for 1.6 GW of marine generation, the first of its kind anywhere in the world. Further leasing rounds for other parts of Scotland have since been set in motion, a Marine Energy Infrastructure Study will be undertaken shortly within Welsh waters to identify waters suitable for the deployment of prototype to commercial scale devices, and The Crown Estate recently launched a discussion process with the renewable energy industry on the design and development of offshore wind and tidal energy in Northern Ireland.

Journey to deployment for wave and tidal stream

3.101 The technology development map set out below in Figure 18 outlines the way in which wave and tidal stream technologies progress from concept through prototypes and commercial trials to full-scale deployment. The map shows the next critical stage in deployment is the pre-commercial demonstration of small scale arrays of devices, which we anticipate will be over the next four years. This will require, in particular, further support for innovation, securing the investment funding for commercial demonstration, development of the supply chain and securing the planning and consenting required for these demonstrations.

Figure 18: Technology development through to commercialisation for the period to 2020



Challenges to deployment and actions

3.102 Our analysis of deployment and discussions with industry suggest that there are at least four main challenges to the deployment of marine technologies in the UK. DECC have established a UK Marine Energy Programme to address these key challenges, bringing together Government across the UK and the private sector to accelerate development of the marine renewables sector.

Manage the risks and costs of RD&D

3.103 Demonstration projects are a crucial step towards commercial deployment but are viewed as high risk due to their uncertain success rates and considerable cost[64]. In addition, where demonstration projects are successful, further innovation will often be required, so that the reliability, performance and durability of devices can be improved, before companies can move to commercial deployment.

3.104 To underpin innovation, the Government has provided support to the UK's marine testing facilities at the NaREC, the European Marine Energy Centre

[64] A survey carried out for RenewableUK (*Wave and Tidal Energy in the UK: State of the industry report,* March 2011) suggested capital costs of £42m-£84m for the first 10MW wave and tidal energy projects.

(EMEC), and the Wave Hub. In particular, DECC has recently funded an £8m expansion of EMEC (which included the provision of three more wave and tidal testing berths and the creation of a 'nursery' testing site) and will work with BIS to facilitate commissioning the 'Nautilus' drive testing facility at NaREC. The Welsh Government has also allocated over £20 million to marine research and development.

3.105 To facilitate demonstration projects, DECC will set-aside up to £20m of its innovation budget over the next 4 years to support innovation in marine energy technologies, subject to value for money assessments. This will support the demonstration of up to 2 tidal and wave arrays. In addition to this, there may be an opportunity for funding from the EU New Entrants' Reserve Fund 300 (NER300). DECC recently submitted one wave and three tidal stream array projects to the European Commission for consideration.

3.106 DECC funded schemes will be part of a coordinated programme of support provided by the members of the Government's Low Carbon Innovation Group[65] and the Devolved Administrations. Details of a number of schemes are being developed and will complement existing commitments which include:

- Energy Technologies Institute: has a marine programme which focuses on reliability and cost reduction through design and testing of prototypes under relevant conditions.
- Technology Strategy Board (TSB): ongoing marine projects supporting cost reduction and improve performance through innovation. Announcement in May 2011 to start the competition to form an Offshore Renewable Energy Technology Innovation Centre.
- Research Councils: continue with the Marine Supergen programme with its aim being to increase knowledge and understanding of device-sea interactions of energy converters from model-scale in the laboratory to full size in the open sea.
- Capital and revenue funding via EU convergence fund monies, administered by the Welsh European Funding Office (WEFO). The Welsh Government is engaged with WEFO and the EU Commission to consider a structural fund programme post 2013 and how it might support the sector.

Actions:

- DECC will provide up to £20m of its innovation budget over the next 4 years, subject to value-for –money assessment, to support demonstration of marine energy technologies. The application process is expected to be launched in early 2012 (subject to State Aid approval).
- BIS will commission the 'Nautilus' marine energy testing facility at NaREC in early 2012.
- Scottish Government will announce details of their joint innovation funding programme with the TSB by the end of 2011.

[65] The Low Carbon Innovation Group core membership includes: DECC, the Department of Business Innovation and skills (BIS), the Carbon Trust, the Research Councils, the Energy Technologies Institute (ETI) and the Technology Strategy Board.

Secure the investment for commercial deployment

3.107 Many of the companies developing marine energy technologies in the UK are relatively small, start-up businesses with limited financial resources. As a result industry evidence suggests they often struggle to secure the significant levels of up-front investment and working capital needed to move projects from demonstration to large scale commercial deployment. Access to finance has been further affected, the industry indicate, by perceived uncertainty about the long term level of Government revenue support available for marine energy. This is currently provided through the Renewables Obligation (RO) which varies from 2 ROCs/MWh in England, Wales and Northern Ireland for wave and tidal energy to 3 ROCs/MWh in Scotland for tidal stream and 5 ROCs/MWh for wave. Northern Ireland has recently consulted on support levels for marine power.

3.108 Although Original Equipment Manufacturers (OEMs) and utilities may choose to invest once technologies and devices are proven at prototype scale, action is needed to improve access to finance in the more immediate term. Some utilities have already made a substantial investment in the development of wave and tidal projects, whilst OEM's are gradually increasing their interest and some are starting to take a significant position in the wave and tidal sector.

3.109 To provide clarity on financial incentives, the Government has a Banding Review in place to consider the levels of support provided under the RO for all renewable electricity technologies, including marine. The Government will now consult in Summer 2011 and publish its decision by the end of the year, one year earlier than originally planned. DECC is working with the Finance Working Group of the UK Marine Energy Programme to feed evidence from the sector into this Banding Review.

3.110 Given the timing of large scale marine energy deployment, the support mechanisms in the Electricity Market Reform White Paper published alongside this Roadmap are likely to be more relevant to the technology than the RO scheme as this will provide the long-term signals the sector requires.

3.111 To reduce deployment costs for marine energy projects and unlock investment, DECC and The Crown Estate are developing a sector-wide knowledge sharing network, including an open access database which will be ready by the end of 2011. It will look to work alongside the development of the Marine Energy Parks and the Offshore Renewables Technology Innovation Centre, and will help to increase the level of information exchange in order to accelerate the level of marine energy deployment.

Actions:

- DECC is reviewing the levels of support available under the RO, including for marine energy, and will publish its decisions in Autumn 2011.
- DECC and The Crown Estate are developing a sector wide knowledge network, and detailed plans for this will be presented to the Marine Energy Programme Board by the end of 2011

Develop supply chain infrastructure

3.112 Potential manufacturers need a degree of certainty about which of the currently unproven marine technologies will be deployable by 2020 before they can commit to entering the market and ramping up supply. Inherent uncertainty about technology development has constrained the development of the supply chain to date.

3.113 DECC is working with the sector to ensure that adequate supply capacity is in place to support commercial deployment later in the decade. For example, we are helping to develop Marine Energy Parks, which aim to accelerate deployment by encouraging a favourable business environment for marine energy. By clustering key manufacturing and related activities and personnel, it will help to ensure that network benefits and economies of scale are realised.

3.114 Where possible the Government's work will build on the considerable expertise already available in the UK maritime, offshore wind and technology sectors, and on similar work which is underway to stimulate the supply chain for offshore wind.

Actions:

- DECC will publish guidance by March 2012 for organisations developing sustainable Marine Energy Parks on a regional basis which will support the growth of the sector.

Planning and consenting

3.115 Developers have expressed concern that the measures to protect the marine environment could place a financial burden on them and unduly limit the level of offshore resource available for development. They indicate that deployment could be particularly affected by the designation of a network of Marine Conservation Zones under the Marine and Coastal Access Act 2009 and possible limits on underwater noise levels under the Marine Strategy Framework Directive.

3.116 Government is working to ensure that policy balances effectively its twin priorities to exploit the UK's natural resource in offshore renewable energy and to protect the marine environment from unacceptable damage and for other users. Planning reform, including the introduction of the marine planning and consent regime, is intended to enable sustainable development and provide greater certainty through a clear and simplified regulatory framework.

3.117 To support the evidence base for policy making, the UK Offshore Energy SEA 2 for wave and tidal energy in English and Welsh waters was published for consultation in February 2011. This sets out the likely impacts of offshore deployment on sea users and the environment. DECC will publish its response on wave and tidal elements of the document by the end of the year.

3.118 The Welsh Government has published a Marine Renewable Energy Strategic Framework identifying the exploitable resource by device type and mapping development constraints. The Welsh Government has recently given development consent to a 1.2MW tidal device demonstration in Ramsay Sound. The “deploy and monitor” approach under which this device will be deployed will increase understanding of the impacts of such devices on the marine environment. Welsh Government will shortly start work on its Marine Energy Infrastructure Study to identify specific sites for deployment, and the Northern Ireland Executive will publish Regional Locational Guidance over the summer.

3.119 As part of the UK Marine Energy Programme, DECC is working with the Marine Management Organisation and Marine Scotland to establish a working group to consider the approach to planning and consenting for marine renewable energy. In addition, to help inform work on the designation of appropriate Marine Conservation Zones, DECC undertook research in 2011 on the implications of the proposed Zones on offshore energy deployment.

Actions:

- DECC will publish its response to feedback on wave and tidal energy elements of the second SEA for Offshore Energy by the end of 2011.
- Welsh Government will identify specific sites for marine energy deployment through the development of a Marine Energy Infrastructure study.
- Northern Ireland Executive will publish Regional Local Guidance on the deployment of marine power in September 2011.
- DECC will set up a working group under the Marine Energy Programme Board in coordination with the MMO, Welsh Government, and Marine Scotland to consider how to address barriers to planning and consenting process for marine renewables. The group will report to the Programme Board by the end of 2011

Biomass Electricity

- Biomass electricity is a predictable and non-intermittent technology. In 2010 the UK had 2.5 GW[66] of capacity in operation (generating approximately 11.9 TWh)[67].
- The central range for deployment indicates that biomass electricity could contribute up to 6 GW by 2020[68]. Achieving this level of capacity equates to an annual growth rate of 9%. The breadth of the central range reflects uncertainty about the availability of sustainable biomass for electricity given competing demands from heat, transport and non-energy sectors.
- Conversion of coal plant to biomass is a major new development. In addition to this and co-firing, the existing pipeline contains an additional 4.2 GW, taking into account historic planning approval rates[69]. When taken together with existing operational capacity this could deliver the central range for 2020 if projects are brought through the pipeline in a timely manner. There is also scope for new projects to enter the pipeline.
- Challenges to deployment include: minimising investment risk and de-risking the supply of sustainable feedstocks, planning and consenting, and regulatory framework. Advanced conversion technologies may, in addition, struggle to secure finance if they are viewed as commercially untested.

Priority actions:

- Minimise investment risk: Accelerate RO banding review and implement proposed Electricity Market Reform to improve revenue certainty for projects. Publish a UK Bioenergy Strategy later this year articulating a clear vision for the growth of sustainable biomass energy in the UK.
- De-risking the supply chain of sustainable feedstocks: Align incentives to feedstock availability and from 2013 make payment of incentives dependent on meeting these. Make available for public use by the end of the year a Greenhouse Gas Lifecycle Assessment Tool for biomass heat and electricity generation.
- Planning and consenting: Work with Defra, the Welsh Government, the Environment Agency and stakeholders to ensure that environmental legislation does not have an unintended impact on the development of renewable energy plant, including energy from waste. Government will work with industry to develop cost effective fuel monitoring and sampling to accurately measure renewable content of waste. Planning reform in England and Wales is set out in the onshore wind section above.
- Access long-term waste fuel contracts: Expand supply chains for waste wood and solid recovered fuel and provide improved information on available waste. Consult on measures to divert waste from landfill including possible landfill restrictions for waste wood.
- Access to finance: Government has provided support for Advanced Conversion Technology demonstration projects and has created the Green Investment Bank which could play a role in supporting these technologies. DECC will announce details of potential funding to support innovation, in areas such as the advanced conversion of waste, subject to value for money assessments and conclusion of innovation needs work.

[66] Includes 0.4 GW of co-firing capacity
[67] Energy Trends June 2011
[68] Excluding capacity for co-firing.
[69] Planning and post-consent success rate based on capacity from 2007-present, weighted by nation in planning stage

Current deployment

3.120 At the end of 2010 there was 2.5 GW of biomass electricity capacity operating in the UK, accounting for 11.9 TWh of generation. This is the single largest contribution to UK's total renewable electricity generation.

3.121 The majority of generation comes from waste (62% – predominantly landfill gas), although co-firing and dedicated biomass plant are also significant (21% and 17%). Anaerobic Digestion (AD) and other advanced conversion technologies are less well established, particularly at scale. Biomass electricity is more prevalent in England and Wales than in other parts of the United Kingdom, although Northern Ireland is also seeing a steady increase. Box 7 provides background information on the key fuels types and conversion technologies available for biomass electricity.

Box 7: Biomass electricity – characteristics, fuel types and conversion technologies

The term biomass refers to both virgin material, such as wood residues, agricultural crops and farming residues, and the biogenic fraction of waste material, such as municipal solid waste, other biodegradable waste including food and landfill and sewage gas.

Biomass can be used in a wide range of conversion technologies, including (for dry material) dedicated combustion, co-firing with fossil fuels, and waste combustion, and (for wet material) anaerobic digestion to produce a flammable biogas. All of these technologies can be used to produce heat and electricity together in a combined heat and power (CHP) plant, where heat is recovered from the electricity generation process and put to further use. A number of advanced technologies are also under development, including gasification and pyrolysis.

Dedicated plant are typically built from scratch (*new build*), although it is also possible to convert existing fossil fuel power stations to run on 100% solid biomass (*conversion*) and a number of such projects are under consideration by developers. Co-firing is usually possible within existing plant subject to technical limits on the proportion of biomass used.

Biomass electricity has the advantage that it is both predictable and controllable and so can be used for baseload or peakload generation. Energy from waste has the added advantages that it extracts value from biomass at the end of its useful life and reduces the amount of waste otherwise sent to landfill and thus reduces methane emissions.

Deployment potential

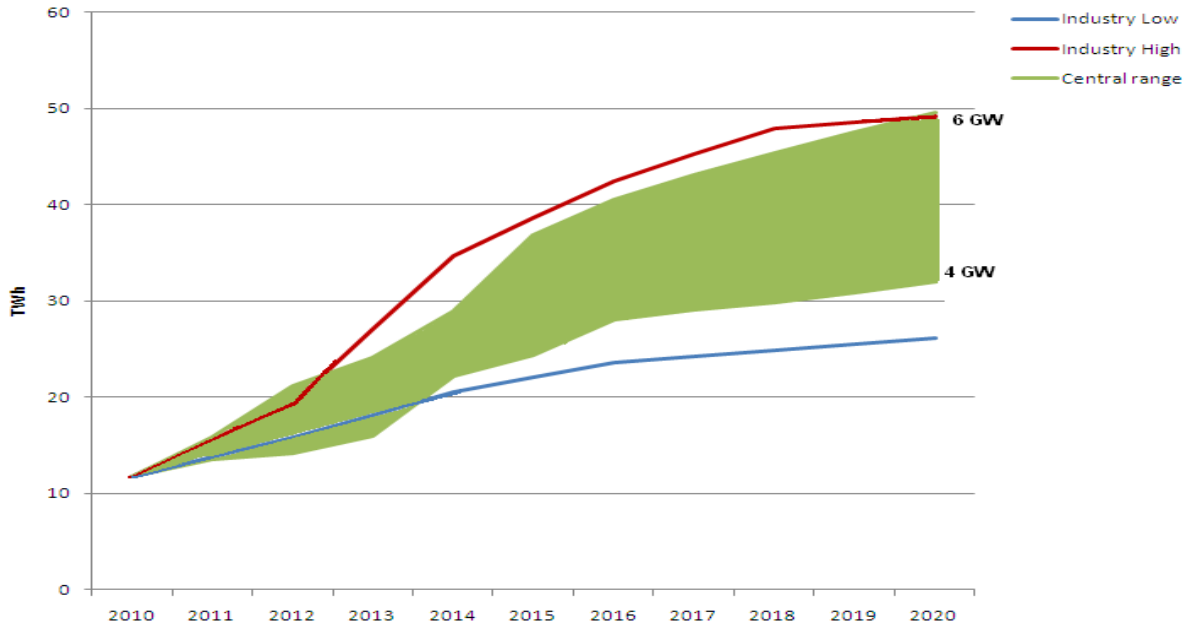
3.122 Figure 19 sets out the results of analysis[70] of the potential for growth in biomass electricity generation to 2020. The breadth of the central range reflects the dynamic potential of the large-scale biomass sector and the key issue of whether the global supply of sustainable feedstocks can fuel it, given that supplies are finite and there are competing uses in the bio-economy. The

[70] These figures include electricity generation from CHP technology.

low and high scenarios reflect initial views from industry on the upside potential and downside risks.

3.123 The analysis indicates that under the central range the market has the potential to deploy up to 6 GW[71] of biomass electricity by 2020 (equivalent to around 50 TWh). Achieving this 3.5 GW increase will require an annual growth rate of 9% for the next decade. We anticipate that the majority of this growth will be met from conversion of coal plant, dedicated biomass generation, biomass waste combustion and anaerobic digestion. Landfill and sewage gas – which are significant in the baseline – have already been largely exploited. The upper end of the central range has a peak in 2011-2013 reflecting the short-term conversion of specific plants to biomass usage during this period.

Figure 19: Deployment potential to 2020 for biomass electricity



3.124 Biomass electricity has significant upside potential and could feasibly exceed the industry high, helping to meet the 15% target cost effectively. However, the projections can only be achieved if sufficient sustainable feedstocks are available. The industry high scenario assumes that build rates and sustainably-sourced feedstock supply are not limiting and that the capacity currently in the pipeline is not subject to delays. The industry low scenario assumes that landfill and sewage gas will not increase whilst waste is deployed at a low build rate. It also assumes that there are constraints to the deployment of dedicated biomass plants, meaning that growth in new build is delayed until 2016.

3.125 Analysis for DECC[72] suggests wide ranges for levelised cost of biomass electricity – £70-£173/MWh in 2020, down only slightly from £75-£194/MW in

[71] Without taking into account the potential for increased co-firing.
[72] Analysis by Arup and Ernst & Young, summarised in section 2.2 of the Roadmap.

2010. Ranges are wide due to the large number of individual technologies considered[73] (co-firing is generally least expensive, followed by conversion, and then dedicated biomass), uncertainty about AD, and the wide of range of project-specific factors affecting plant (fuel type, scale, the proportion of biomass used). Cost reductions are small due to minimal learning rates assumed for the relatively mature combustion technologies, although AD is projected to benefit from falling hurdle rates as the technology is demonstrated to work. There is significant innovation and cost reduction potential for bioenergy more widely, using technologies such as gasification and pyrolysis, as well as agri-innovation to increase feedstock yields.

Case study: Dalkia Biomass Plant

Dalkia's £40million Biomass Plant at Chilton near Durham is expected to begin generation in July. The 18MW new plant has been designed to be fuelled on locally sourced waste wood and, when completed, the plant will generate renewable electricity and heat.

The plant can generate sufficient electricity for around 20,000 homes and there is an opportunity to provide renewable heat via district heat networks.

The Chilton plant will process waste wood on site and use around 120,000 tonnes of wood biomass thus removing this from the waste stream and reducing the landfill burden. Dalkia estimate that the plant will also provide around 50 new local jobs during the construction phase, a further 17 jobs on the site and additional jobs in the supporting infrastructure for the site.

Deployment pipeline

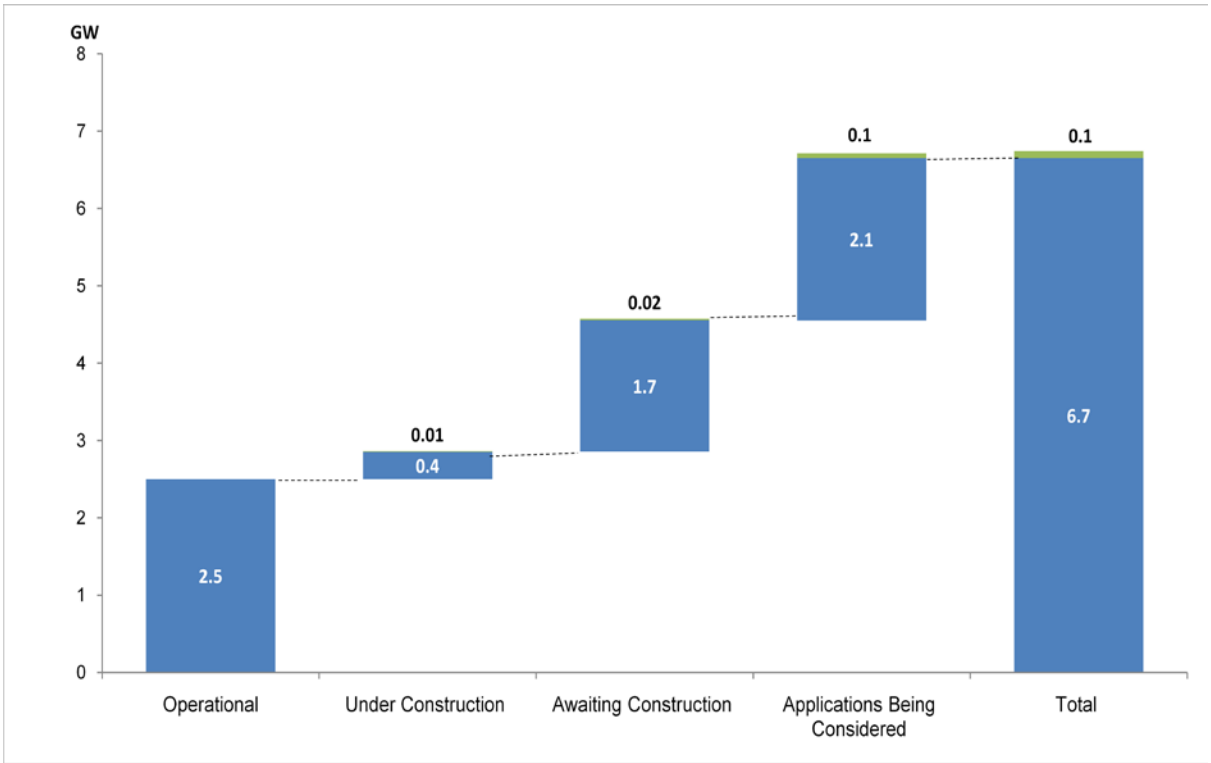
3.126 Figure 20 illustrates that the existing pipeline – excluding conversion and increased co-firing[74] – contains 4.2 GW of capacity taking into account historic planning approval rates[75]. Taken with what is currently operational, this could deliver the central range for 2020 if projects are brought through the pipeline in a timely manner.

3.127 The majority of the existing pipeline is from large scale dedicated plant (3.3 GW), with Energy from Waste (EfW) projects accounting for a smaller

[73] This range includes dedicated biomass, biomass co-firing, biomass conversion and AD of less than 5 MW. It does not include bioliquids, landfill and sewage gas or the combustion of municipal solid waste.
[74] REPD does not currently pick up conversion from coal plant.
[75] Planning and post-consent success rate based on capacity from 2007-present, weighted by country in planning stage.

proportion (0.9 GW). Of the applications awaiting consent, 78% are under 50MW and will be decided at local level.

Figure 20: Capacity of biomass electricity projects in the planning pipeline[76]



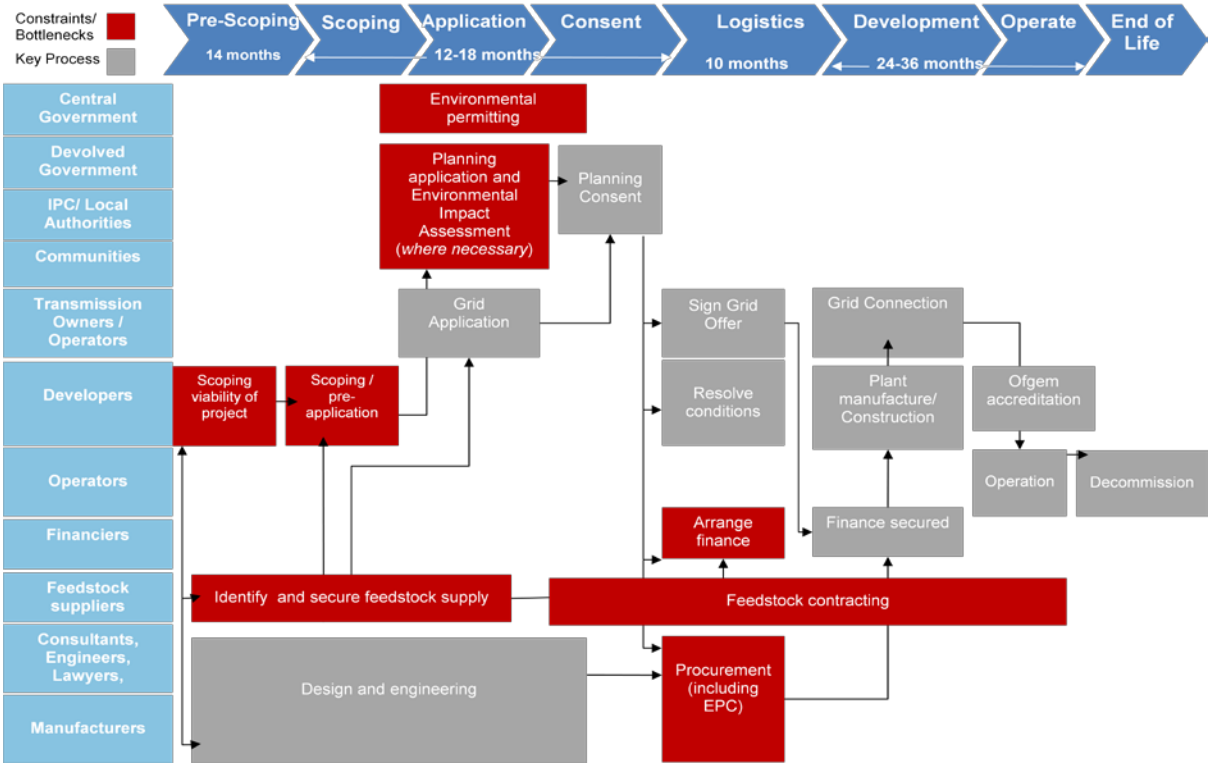
3.128 Figure 20 does not account for the possibility that generators will convert existing plant to biomass or make greater use of co-firing. These options offer considerable scope for additional generation, which we are quantifying in the RO Banding Review.

Journey to deployment

3.129 Figure 21 presents a 'developer journey map' for new-build dedicated biomass plant. The map outlines the key stages of the deployment process and the parties who contribute. Key challenges are highlighted in red. From scoping to operation, the process can take in the order of 5-8 years depending on the complexity of any planning conditions and the need to secure an Engineering Procurement Contract (EPC) in order to obtain finance.

[76] Based on historic consenting rates, the capacity shown in green could potentially be lost from the pipeline

Figure 21: Developer journey map for new-build, dedicated biomass electricity projects



3.130 To shorten this process, increase build rates, and bring forward capacity in the pipeline, we must tackle constraints at each stage. Some of these challenges differ according to the type of fuel and conversion technology used, so we have outlined actions separately for waste and dedicated biomass plant.

Challenges to deployment and actions

Generation from non-waste fuels

3.131 Our analysis of deployment statistics and discussions with industry suggest that developers must overcome at least two main challenges to deploy dedicated and co-firing plant in the UK:

Minimise investment risk

3.132 Historically, investor confidence in large scale biomass electricity projects has been limited by the lack of completed projects which can be held up to potential investors as evidence that similar projects have been successful. Consequently, the financial sector has been cautious, looking to offset risk through EPCs and long term feedstock contracts.

3.133 Confidence has been further weakened by perceived uncertainty about Government policy, including the level and surety of long term financial support. In particular, developers have found it difficult to obtain project

finance for plant which, given the relatively long lead times for biomass electricity projects, may not be operational before new Renewables Obligation (RO) banding levels come into force.

3.134 Our work with industry suggests that these uncertainties could impact the 4 GW of projects in the pipeline but not in construction. DECC is taking various actions to improve investor confidence.

3.135 In 2010 the Government "grandfathered"[77] the level of support available for most dedicated-feedstock and energy from waste plant under the RO from the point of full accreditation, subject to the 2037 end date of the scheme. In addition, it accelerated the timetable for the 2013 Banding Review to provide clarity by the end of the year, one year earlier than previously planned about future support levels for new projects. The Review will address the issue of grandfathering remaining biomass technologies.

3.136 Electricity Market Reform is designed to improve the market's ability to finance the huge investment in low carbon electricity that is needed over the next decade and beyond. In implementing this change, the Government is aware of the need to ensure a smooth transition from the Renewables Obligation.

3.137 In addition, the Government is developing a Bioenergy Strategy for publication by the end of the year. This will provide clarity on our ambition for biomass electricity in the context of the other uses for biomass, including non-energy uses. It will set out an expectation of sustainable biomass from domestic sources and imports, taking into account all available evidence on the full life cycle carbon impact of biomass, including Indirect Land-Use Change (ILUC) effects. The Scottish Government is committed to ensure impacts on existing biomass users are mitigated as demand continues to grow, including a forthcoming review of support for large-scale electricity-only biomass under the Renewables Obligation Scotland.

Actions:

- DECC will consult on banding levels for biomass electricity, including co-firing and conversion of fossil plant, in summer 2011, in order to publish finalised levels by the end of the year.
- DECC is publishing its EMR White Paper alongside this document, setting out details of the new support mechanism and the transition from the RO.
- The Government will publish its UK Bioenergy Strategy by the end of the year.

<u>De-risk the supply of sustainable feedstocks</u>

3.138 Dedicated biomass electricity offers great potential for cost effective renewable electricity generation, provided that it is generated from sustainable feedstocks. As noted above, the Government's ambition for biomass electricity depends on the availability of suitable feedstocks. The Government considers that sustainable biomass should be cultivated, processed and

[77] Grandfathering is a policy that support levels should not change once generation has been accredited under a scheme, thereby providing investors greater certainty.

transported in a way which delivers real and significant greenhouse gas savings compared to the fossil fuel it is replacing. In particular, forest and woodlands must be sustainably managed to ensure continuing supplies in future years. There would also be significant public concern to projects delivering unsustainable generation.

3.139 To safeguard sustainability, the Government has ensured that from April 2011 RO support is only available for bioliquids that deliver at least 35% greenhouse gas savings and do not use materials sourced from land important on carbon or biodiversity grounds, such as primary forest, peatland and wetland[78]. For solid and gaseous fuels we have introduced standards based on a 60% reduction in GHG. Generators are required to report against criteria for solid and gaseous fuels from April 2011, in preparation for a requirement to meet them from April 2013 in order to receive RO support[79].

3.140 At present, RO sustainability standards do not take into account the possible carbon impacts generated by ILUC. The European Commission is expected to come forward with proposals in July 2011 for sustainability standards on the indirect emissions from bioliquids, which the UK will consider as a matter of priority.

3.141 The supply chain for biomass feedstocks is currently too immature and must expand to support the level of biomass electricity generation we envisage given competing uses for the fuel. There is potentially a huge global capacity if properly exploited, with possibly 10% of the net international market available to the UK[80]. The introduction of sustainability standards will facilitate the rapid development of the supply chains.

Actions:

- To safeguard sustainability, DECC will under the RO, introduce mandatory sustainability standards for all solid, liquid and gaseous biofuels used for electricity generation in the UK by April 2013.
- To improve the consideration of planning applications, DECC will make a 'GHG lifecycle assessment tool for biomass heat and electricity generation' available for public use by December 2011, and will develop a communications plan with industry and NGOs on opportunities and risks associated with the technology.

[78] There are exceptions, including for wastes.

[79] There is a de minimis threshold of 1MW for the requirement to meet the standards for solid and gaseous fuels.

[80] Report by AEA Technology for DECC, 'UK and Global Bioenergy Resource – Final report', available at http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/renewable%20energy/policy/1464-aea-2010-uk-and-global-bioenergy-report.pdf

Case study: Tilbury Power Station

Tilbury Power Station in Essex began full operation as a coal-fired power station in 1969. The plant burnt its last coal in May 2011 and is expected to be fully operational as a biomass plant by the end of 2011, continuing until closure due to Large Combustion Plants Directive opt-out by 2015 at the latest.

Once conversion is complete, Tilbury is expected to have a capacity of around 750MW, and will use approximately 2m tonnes of sustainable biomass over its operational life.

Compared to continuing to burn coal, the use of biomass at Tilbury should save at least 2.6M tonnes of CO_2, as well as reducing SOx emissions by over 80%, NOx emission by half, and particulate emission by around 90%.

In addition to the power generated and the associated environmental benefits, Tilbury has enabled lessons to be learnt to improve the process of biomass conversion. In particular, Tilbury has made progress on supply chains and the logistics of shipping and storing biomass pellets, and will provide evidence for the reliability and stability of wood pellet combustion as an energy source over a sustained period.

In addition to the energy generated by the plant, the conversion has the potential to make Tilbury – on the banks of the Thames – a hub for the import of biomass into the UK. The jetty at Tilbury has capacity to import 4m tonnes of biomass every year which can be used to generate heat, electricity or both. These imports are nearly double what is required by the plant.

Generation from waste feedstock

3.142 Our analysis suggests that developers must overcome additional challenges in relation to securing consents and permits, accessing long-term waste fuel contracts, and securing finance in order to deploy more innovative biomass electricity from waste. Key actions are summarised below for waste combustion and advanced thermal technologies, drawing on the recent Waste Review which outlines the Government's ambition for Energy from Waste (EfW); Anaerobic Digestion (AD) is considered in the Biomass Heat section.

Planning and consenting

3.143 EfW projects, particularly combustion plant, can face strong opposition from local communities, driven by concerns about potential impacts on a range of issues from health and traffic generation, to whether waste will be diverted from recycling. The Government will ensure that a transparent and robust evidence base is available on the opportunities and risks posed by EfW.

3.144 Approximately 80% of the 0.9 GW of electricity from waste projects in the pipeline are under 50MW and so will be decided at local level. Reform of the local and infrastructure-scale planning systems in England are discussed in the onshore wind section above, alongside measures to give local communities a greater stake in renewables development.

3.145 Our work with industry suggests that EfW projects suffer from perceived uncertainty about the Government's commitment to the use of waste for electricity generation, and the level and surety of long term financial support which will be provided for this. There are concerns too about the burden of monitoring and sampling work required to measure the biogenic (the renewable component) content of mixed waste fuels under the RO.

3.146 To address uncertainty, the Government has set out its commitment to the role of EfW within the waste hierarchy as part of the Waste Review and has accelerated the timetable for the RO Banding Review. In addition, Government has grandfathered support for biomass electricity from waste under the RO where this is generated through CHP plant or advanced conversion technologies. To facilitate the use of mixed fuels, the Government is working with stakeholders to develop a more reliable and cost effective fuel monitoring and sampling approach for application across EfW technologies.

3.147 Wider concerns relate to the burden of regulation, particularly for Advanced Conversion Technologies (ACT). The novel nature of the technologies can make it challenging for the industry to navigate the Environment Agency guidance and environmental permitting rules which do not always recognise technical differences between these and standard combustion processes. The ACT industry suggest, for example, that applying criteria intended for incinerators make some gasification projects technically infeasible and might add up to £1m to a small pyrolysis project. Our analysis indicates that resolving these issues could facilitate the deployment of up to 140 MW[81] of ACT projects currently in the planning pipeline and around a further 20 MW of pyrolysis projects.

3.148 It is essential that EfW plants are regulated to provide confidence that they are operating safely. Government is taking action to ensure this is done in a way that does not create unnecessary barriers to deployment.

Actions

- Defra will deliver the actions outlined in the recently published Waste Review, which aim to overcome barriers to growth in Energy from Waste markets and help facilitate community acceptance of waste infrastructure. These include publishing a guide to the full range of energy from waste technologies available to help decision-makers, and identifying commercially viable routes by which communities can realise benefits from hosting recovery infrastructure.

[81] Based on data collected by Arup for their report on the RO Banding review.

- DECC will work with Defra, Welsh Government, EA, and industry on an ongoing basis to ensure that waste management legislation does not have unintended consequences on development of the energy recovery industry.
- DECC will work with Defra, Welsh Government, industry and delivery partners to develop cost-effective fuel monitoring and sampling systems for accurately measuring the renewable content of mixed wastes and waste derived energy. Ofgem will announce a decision on the use of methodologies based on carbon-14 dating by summer 2011.

Accessing long-term waste fuel contracts

3.149 Many EfW projects are financed on the basis of securing long-term waste supply contracts with local authorities. However, by the nature of their long duration, as the use of EfW increases developers could find it increasingly difficult to source appropriate feedstock through this route alone. This is because significant quantities of the waste required currently goes to landfill, especially commercial and industrial (C&I), and construction and demolition (C&D) wastes, including waste wood, which do not usually fall under Local Authority control. As a result, contracts for such waste are usually offered on a short term basis, which can be a much more challenging environment for developers when seeking investment but also represents a significant opportunity in terms of the volumes of wastes available.

3.150 To address this issue, the Government is focussing on measures to divert waste from landfill including the introduction of possible landfill restrictions for waste wood, improved information on the location of C&I and C&D waste and the quantities available, and supply chain development.

Actions

- Defra will seek to expand capacity to treat C&I and C&D waste through improved information on waste supply and composition and developing further the supply chains for waste wood and solid recovered fuel.
- Defra will consult by autumn 2012 on possible measures for landfill restrictions for waste wood.

Access to finance

3.151 EfW projects often struggle to secure finance, particularly if they involve the use of advanced technologies, which are often untested at commercial scale and therefore viewed as high risk. Historically, Private Finance Initiative (PFI) has been a key funding model for waste infrastructure, but many other facilities are entirely funded by the market. Investment in combustion plant is better established but has been hit by the economic downturn.

3.152 To tackle this problem, Government has provided support for a number of ACT demonstration projects and is considering how best to target any funding available in future years. In addition, it has created the Green Investment Bank which could play a role in supporting innovative technologies.

3.153 DECC is working with fellow members of the Low Carbon Innovation Group to identify the key innovation needs in a range of technologies, including the generation of energy from waste and biomass, to determine how Government's innovation funding can best address them. Subject to the conclusion of this work and value for money assessments, funding from DECC's Innovation Programme budget will be available, if needed, to support innovation in key technology areas such as the advanced conversion of waste.

Actions

- Over the next 12 months DECC will continue to consider measures to explore ways to reduce the commercial risk of new technologies
- DECC is expecting to announce details of potential funding to support innovation in Autumn 2011, subject to conclusion of innovation needs work and value for money assessments.

Biomass Heat

- In 2010 the UK generated 12.4 TWh[82] of renewable heat from biomass, 12.1 TWh of this from biomass boilers and 0.3 TWh from Energy from Waste[83].
- The central range suggests that non-domestic biomass heat could contribute up to 50 TWh by 2020. The majority of this would come from biomass boilers (including some from district heating and CHP), with a smaller contribution from biogas injection to the gas grid. This central range requires an annual growth rate of up to 17%.
- The Government does not currently collect pipeline data for renewable heat on a routine basis but will do so from the end of 2011.
- Constraints on deployment include: technology cost, supply chain for sustainable fuel, air quality regulation, planning and environmental permitting, investor confidence, and the costs associated with biogas injection into the gas grid.

Priority actions:

- Technology costs: Implement the RHI in Great Britain to make renewable heat from biomass boilers, municipal solid waste and onsite biogas combustion competitive with fossil fuel generation. Consult on a scheme to support renewable heat in Northern Ireland from April 2012 subject to the agreement of the Northern Ireland Executive.
- Supply chain for sustainable fuel and qualified engineers: Introduce reporting criteria in 2011 for the sustainability of biomass used under the RHI and put them on a mandatory basis from 2013. Ensure that installations of 45 KWth or less are certified and have been installed by MCS (or equivalent) registered engineers.
- Air quality regulation: Introduce emission performance standards for biomass boilers as a condition for receiving RHI to ensure air quality impacts are effectively managed.
- Planning and environmental permitting: The Environment Agency in 2011 will vary the 'Standard Rules' to enable more AD plant to benefit from this type of environmental permit, which are usually easier, quicker and cheaper to obtain than a bespoke permit.
- Investor confidence: Government is supporting four AD demonstration projects to illustrate the effectiveness of this technology in practice and will make RHI available for biomethane injection into the gas grid and heat generated by biogas produced from AD. Increase the level of support for AD under FITs for projects up to 500 kW subject to state aids.
- Costs associated with biomethane injection into the grid: RHI will include support for biomethane injection; review permitting and planning processes with a view to reducing compliance requirements if appropriate.

Current deployment

3.154 The UK generated 12.4 TWh of biomass heat in 2010, 12.1TWh of this from biomass boilers and 0.3 TWh from Energy from Waste (EfW). The majority of heat generation from biomass boilers is in the non-domestic sector[84]. Most installations are large scale (for example, it is estimated that 74% of

[82] The government does not currently have data on installed capacity for biomass heat. We collect data on the quantity of fuel used which is reported in DUKES, but not on the number or size of heating units installed

[83] Source: Energy Trends June 2011. Measured on Gross Calorific Value basis (as opposed to Renewable Energy Directive methodology)

[84] Source: AEA 'Biomass Boilers - Market size and direction' – April 2011

renewable heat output in Scotland in 2008/09 was from plant of at least 1MW) and run on forestry-derived fuel[85].

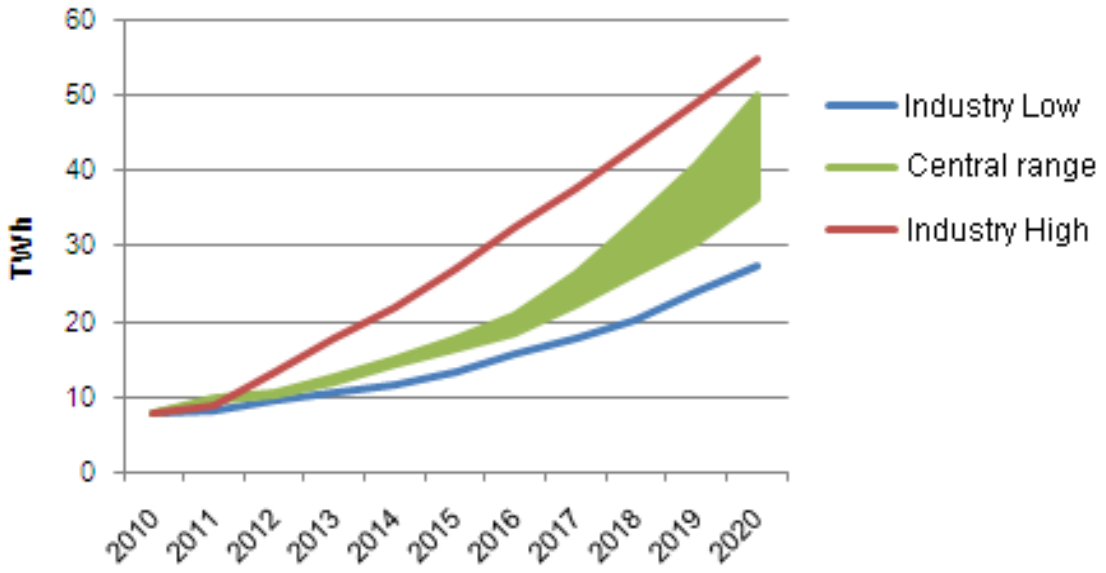
3.155 In terms of EfW, the UK generates heat by the combustion of biogas and municipal solid waste (MSW). At the end of 2010, the UK had 46 generating on-farm or commercial AD biogas sites, plus a further 146 plants at sewage treatment works. These use the decomposition of wet organic material to produce methane rich 'biogas', which can be burnt on-site to generate heat or electricity or cleaned and injected into the distribution gas network.

Deployment potential

3.156 Figure 22 presents the results of recent analysis of the potential for growth in the deployment of non-domestic sector biomass heat[86] to 2020. It overlays an industry view of the deployment that could be achieved (the 'industry low' and 'industry high' scenarios) around a central range.

3.157 The central range indicates that non-domestic biomass heat could contribute up to 50 TWh of renewable energy by 2020. The majority of this would come from biomass boilers (including district heating & CHP) and biogas injection to the gas grid. This central range requires an annual growth rate of up to 17%. The industry scenarios suggests that the market has the potential to bring forward 27-55 TWh of non-domestic biomass heat by 2020.

Figure 22: Deployment potential to 2020 for non-domestic biomass heat



[85] The 74% figures comes from the *Scottish Government Renewable Heat Action Pla*n, 2009. All but one of the large scale plant identified operate on forestry derived biomass.

[86] The analysis includes non-domestic biomass boilers, biomass district heating, and biogas injection to the gas grid. It also includes the heat output from CHP technology.

3.158 The industry low scenario reflects factors such as a low assumed take-up of biogas to heat in the industrial sector and low take-up of AD by the livestock waste and energy crop industries. The high scenario is based on a set of more optimistic assumptions on these variables and our level of success if removing barriers to the deployment of biomass boilers.

3.159 Analysis by DECC[87] suggests that the levelised cost of non-domestic sector biomass heat could vary from £22-£159 per MWh in 2020, largely unchanged from £22-£156 in 2010. The large ranges reflect variation in the energy efficiency of the buildings being heated[88], and the fact that the levelised cost is higher on average for biomass district heating than biogas. Costs changes over time are muted due to offsetting effects on capital, installation and operating costs. Capital and installation costs are projected to fall slightly due to learning effects, whilst operating prices are projected to rise with increasing feedstock prices.

Deployment pipeline

3.160 At present, the Government does not routinely gather data on the pipeline for renewable heat projects. However, we are looking at doing so from later in 2011. In addition, we will be collecting deployment data on projects that benefit from the RHI and RHPP scheme, including information from preliminary accreditations. We will use this data to provide greater insight into deployment trends and barriers and intend to make this information publicly available.

Journey to deployment

3.161 Biomass heat covers a range of technologies, feedstock and distribution techniques, all of which face different development and deployment challenges. The process for developing two types of biomass heat project is illustrated below, with key areas of challenge to deployment highlighted in red.

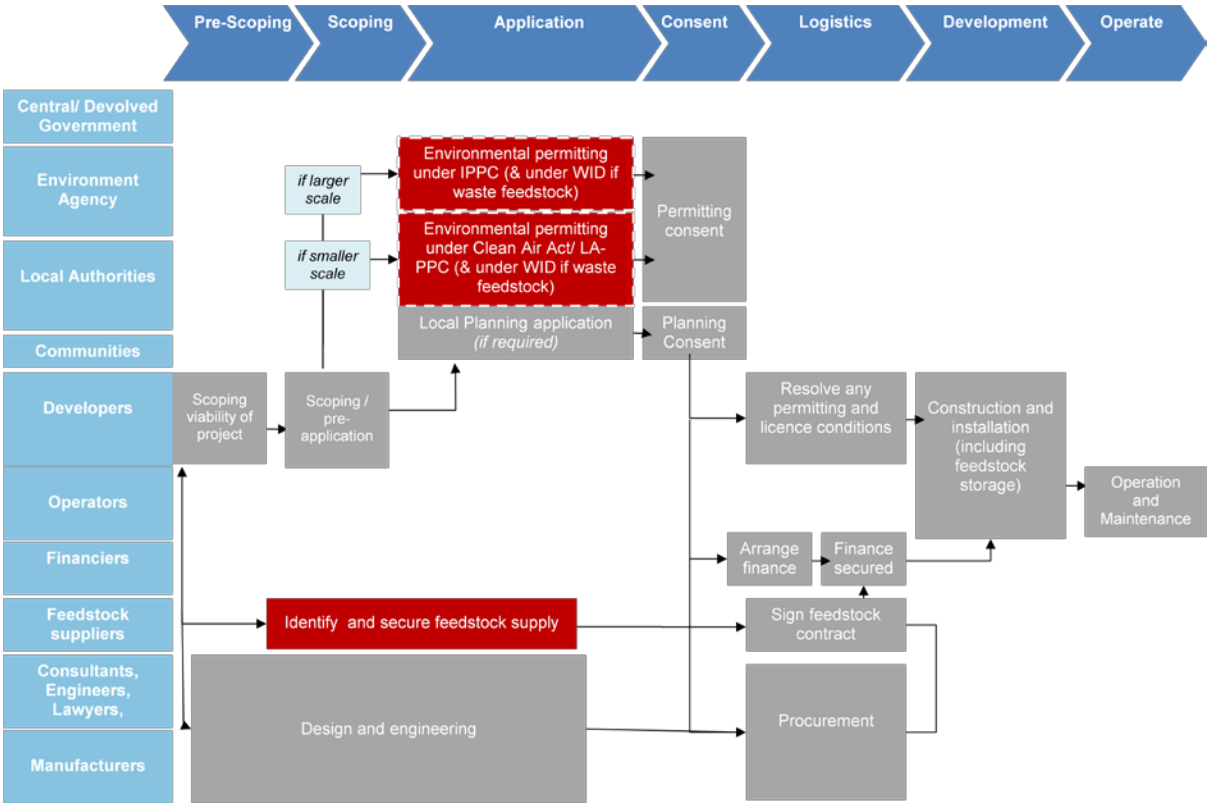
Non-domestic biomass boilers

3.162 Discussions with industry suggest that it can take anywhere between 1 month and several years to bring a non-domestic biomass boiler from scoping to operation. In particular, timing will depend on the specific challenges to deployment, the scale of installation and whether it is linked to the development of transport infrastructure and buildings e.g. for fuel storage, which requires planning permission. Figure 23 outlines the journey for a larger scale non-domestic biomass boiler in England.

[87] Based on work by AEA Technology, summarised in section 2.2 of the Roadmap. Due to a lack of reliable data we assume that costs for biogas are fixed over time.

[88] This affects the total quantity of heat required in the building, across which the fixed costs of the technology are spread.

Figure 23: Developer journey map for the deployment of non-domestic boilers

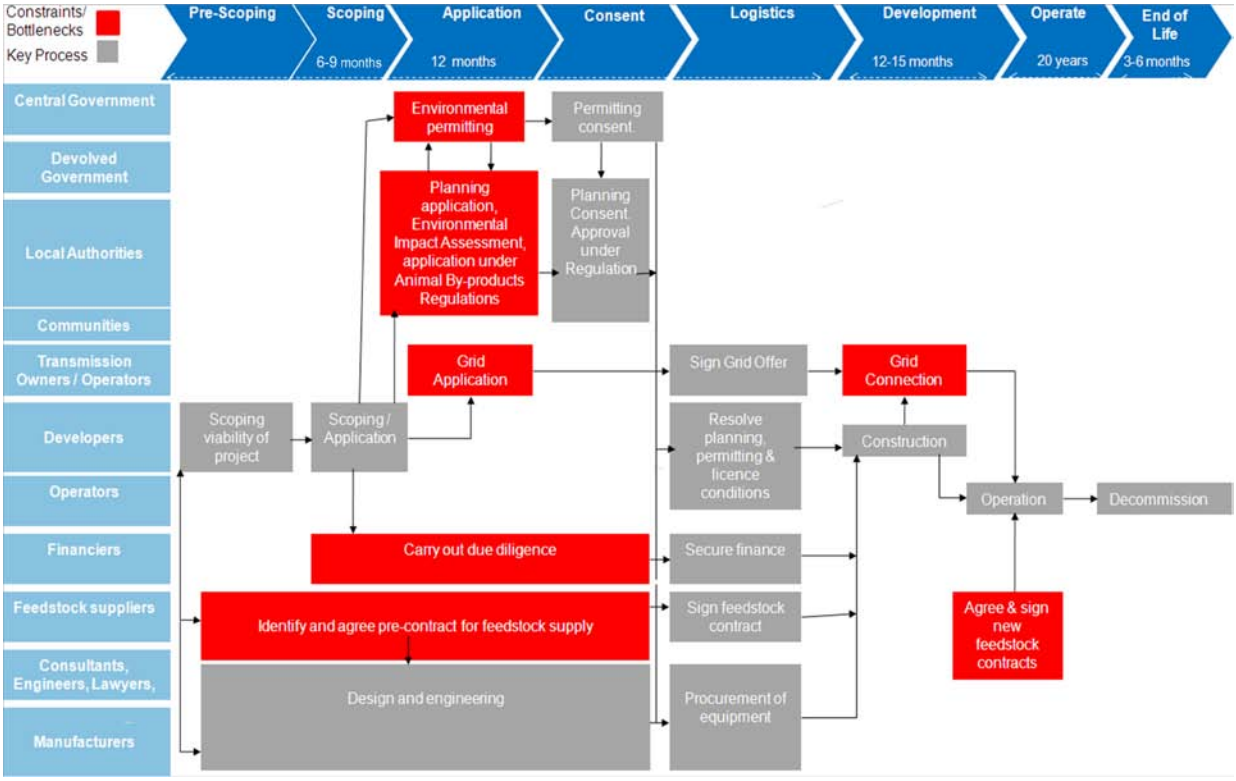


3.163 In general, planning permission is not required for a boiler unless it is in a conservation area, but it may be required for the boiler house, fuel silo and flue (if exceeding roof height by 1m). If there is likely to be an increase in large vehicle movement to deliver and transport fuel, planning permission is more likely to be required. The size of installation and type of fuel used dictate which permissions and regulators are involved.

Anaerobic digestion to produce biogas

3.164 Biogas projects generally takes around two years from scoping to operation, as illustrated in Figure 24 below, although this can vary from six months for small on-farm plant to five years for a large municipal installation. Biogas from AD plant can be combusted to produce heat for use on-site or cleaned to produce biomethane for injection into the gas grid.

Figure 24: Developer journey map for deployment of anaerobic digestion to produce biogas



Challenges to deployment and actions

Non-domestic biomass boilers

3.165 Our analysis of deployment statistics and discussions with industry suggest that there are at least three main challenges to deployment for non-domestic biomass boilers in the UK:

Higher cost than fossil fuel alternatives

3.166 Although fuel costs can be lower for biomass boilers than fossil fuel generation, equipment and installation costs are significantly higher – not least because biomass units need to be larger than typical fossil fuel systems and require additional fuel storage and feeding systems. In addition, hurdle rates are increased by the dependency on a new fuel source, which raises the risk of supply interruption, and for projects exporting heat, by the risk that the customer will go out of business. These are all factors which increase the implicit cost of investment.

3.167 Without action to tackle cost, it is unlikely that deployment will increase much from current levels. This puts much of the additional 11-21 TWh[89] of heat from biomass boilers anticipated in the central range at risk.

[89] Central range for biomass boilers within composite central range for biomass heat.

3.168 To address this, the Government is introducing the RHI in Great Britain to provide support to organisations installing eligible renewable heating systems, including standard and CHP biomass boilers, biomass energy from MSW and biogas combustion. The RHI will provide a stream of payments over a 20 year period, covering its additional cost in comparison to the fossil fuel alternative and a rate of return on investment.

3.169 The Government is considering the case for supporting bioliquids under the RHI from 2012. For Combined Heat and Power – where at present the renewable heat element is recognised by an uplift to the RO – DECC will use the Banding Review to clarity the relative roles of the RO and RHI in supporting this form of generation. This will give biomass electricity producers greater clarity about the benefits of exploiting waste renewable heat from their electricity generation. Northern Ireland is currently considering the introduction of a scheme to encourage uptake of renewable heat.

Action:

- DECC have laid the regulations for establishing the RHI for Parliamentary approval in July 2011.
- DECC will use the 2011 Banding Review to clarify the relative roles of the RO and RHI in supporting Combined Heat and Power schemes.
- Northern Ireland Executive will consult over the summer with the goal of having a scheme in place by 1 April 2012 subject to agreement by the Northern Ireland Executive.

Supply chain for sustainable feedstock and qualified engineers

3.170 Although national and global markets for sustainable biomass are developing rapidly, they are still less mature than markets for conventional fossil fuels. As a result, prospective generators of biomass heat sometimes struggle to secure a long-term source of sustainable feedstock, either from within the UK, the EU or beyond. In addition, although UK companies are increasingly focusing on installation, operation and maintenance, developers still report a lack of qualified engineers to install and maintain biomass boilers. These factors could constrain progress in deploying the additional 11 – 21 TWh of biomass boilers anticipated in the central range[90].

3.171 To facilitate the development of a sustainable supply chain the RHI will require generators of 1MWth and above, including biomethane producers, to provide quarterly reports on the biomass they use, including the quantity, type, form and country of origin, and whether an environmental accreditation has been met. It will use this information to inform the development of mandatory criteria, which generators must meet from 2013 onwards to qualify for support under the RHI.

[90] Central range for biomass boilers within composite central range for biomass heat.

3.172 The RHI will help too in stimulating the supply chain for engineers in the UK, encouraging more installers to apply for the relevant competent persons scheme required to meet Building Regulations. In the domestic sector, installers will need to belong to the Microgeneration Certification Scheme (MCS) [91] or equivalent if homeowners wish to claim the Renewable Heat Premium Payment (RHPP).

Action:

- To facilitate development of sustainable feedstock the Government will introduce reporting criteria in 2011 for the sustainability of biomass used under the RHI and make these criteria mandatory from 2013 for the receipt of RHI.
- To stimulate the supply chain for qualified engineers, the Government will ensure that certain installations of 45 kWth or less must be certified under MCS or equivalent and must have been installed by MCS certified engineers (or equivalent) to receive the RHI or RHPP.

Air quality regulation

3.173 Biomass boilers generate particulate matter and nitrogen oxides, which fall under our legally binding EU air quality targets. However, whilst there is regulation to control these emissions from biomass boilers of 20 MWth or more, there is no similar framework for smaller units. Uncertainty over approval rates results from a lack of clear regulation on air quality impacts for boilers under 20 MWth.

Action:

- DECC is planning under phase 2 of the RHI to introduce emission performance standards for particulate matter and nitrogen oxides as a condition for biomass boilers of less than 20MWth to be eligible for support.

Anaerobic Digestion to produce biogas

3.174 Whilst many of the barriers to generating heat from waste are similar to those for biomass electricity from waste (discussed in section 3.1.4 above), there are a number of challenges which are specific to AD and biogas injection that also require attention. The Government published its Anaerobic Digestion Strategy in June 2011[92] outlining a joint programme of work with industry on barriers to AD. Action is under way in a number of areas already.

[91] MCS is a UK wide scheme and any Northern Ireland renewable heat incentivisation programme will also require installers to be registered with MCS.

[92] http://www.decc.gov.uk/en/content/cms/news/gb_anaerobic/gb_anaerobic.aspx

Case study: BV Dairy Anaerobic Digestion Plant

BV Dairy in Dorset has installed a £2.3million innovative anaerobic digestion plant. This uses 50,000 tonnes a year of liquid waste from their dairy and food processing plant to generate renewable heat and electricity. The biogas from the AD plant is fed to a 190kWe combined heat and power engine which generates 2.1 GWh of electricity and 1.7 GWh of heat per year.

The electricity is used in the food manufacturing operation, and the surplus is exported to the national grid. Some of the heat is used to keep the digester at the correct temperature and the rest is used in the manufacturing operation to replace heat that was previously generated by oil burning boilers. BV Dairy will cut its carbon footprint by about 60% - reducing its output of carbon by about 1,200 tonnes per year.

Planning and environmental permitting

3.175 Industry indicate that in their view, environmental permitting rules place an undue burden on AD projects given the typical size of plant and the limited risks they pose. The factors increase development cost, introduce delays, and threaten some of the projects that could be built by 2020.

3.176 To reduce regulatory burdens, the Environment Agency (EA) will this year amend the relevant Standard Rules to enable more AD plant to benefit from this type of environmental permit, which are usually easier, quicker, and cheaper to obtain than a bespoke permit. The Government is reforming the planning system in England to ensure that the sustainable development needed to support economic growth is able to proceed as easily as possible. This embraces a range of measures which should make it easier to obtain planning permission for appropriately-sited AD plants.

Action:

- The EA will, in 2011, amend the relevant Standard Rules to enable more AD plant to benefit from this type of environmental permit.

Investor confidence

3.177 Large AD projects – particularly those at commercial scale or for which the biogas produced is intended for the gas grid – are at a very early stage of development in the UK and as such are perceived as high risk by investors.

3.178 To boost investor confidence, DECC and Defra are supporting four AD demonstration projects. These projects will help demonstrate the effectiveness of AD plants working in practice.

3.179 In addition, the Government will, from the start of the RHI scheme in 2011, make RHI payments available for biomethane injection into the gas grid and the generation of heat from biogas produced from all wastes through AD. This will ensure a stream of payments for projects over a twenty year period, improving their financial attractiveness to investors. In June 2011 the Government announced that it will also be increasing the level of support for AD of up to 500kW for new entrants to the Feed-in Tariff. This change is due to take effect from 1st August 2011[93], bolstering the level of financial support available for farm-scale AD in the UK.

Action:

- Government will publish findings from its four AD demonstration projects in spring 2012 to increase the availability of information about AD to the market.
- DECC will provide support for biomethane injection and all wastes used to create biogas through AD under the RHI from 2011.
- DECC, subject to state aid clearance, will increase the level of support available under the FIT scheme for new AD projects of up to 500 kW from 1 St August 2011.

Costs associated with biogas injection into the gas grid

3.180 Biogas must be cleaned and transported before it can be injected into the gas grid on health and safety grounds. Therefore, injection is currently a more costly option than using biogas onsite for heat generation. These costs relate for example to the need to reduce the concentration of oxygen and contaminants, and to obtain grid injection equipment and a gas transporter licence. They serve as a disincentive to deployment and could risk much of the addition 3-6 TWh anticipated from biogas injection in the central range.

3.181 In addition to providing RHI for biogas injection, the Government is working with range of delivery partners to consider whether it is appropriate to amend some of the regulations which currently apply to biogas injection from AD plant.

Actions:

- The Health and Safety Executive is working with network companies to assess whether the maximum permissible levels of oxygen and contaminant matter in grid gas can be increased safely to reduce the costs of cleaning biogas for injection.
- DECC is scoping the possibility of providing a gas transporter licence exemption for those, including AD plant, who produce gas onshore. We hope to have this in place by the end of 2011.

[93] subject to EU State Aid clearance

Case study: Thames Water Biogas to the Electricity Grid

In October 2010, Thames Water's Didcot sewage treatment works in Oxfordshire became the first UK site to feed renewable gas into the national gas grid, so helping to de-carbonise the grid. Sludge, the solid part of sewage, is treated in an anaerobic digester to produce biogas. This is then cleaned to remove impurities.

The resulting biomethane is of a suitable quality to be fed into the gas grid as a replacement for natural gas. The whole process - from flushing a toilet to the gas entering the grid - takes around 20 days The biomethane output is sufficient to meet the needs of up to 200 homes. The project was a joint venture between Thames Water, British Gas and Scotia Gas Networks. It took six months to complete and cost £2.5m.

Ground source heat pumps and air source heat pumps

- There are approximately 37,000 air and ground source heat pumps installed across the UK. This equates to around 0.6 GWth in terms of installed capacity, generating 0.7 TWh at the end of 2010[94].
- The central range suggests that non-domestic heat pumps could contribute up to 22 TWh by 2020, 14 TWh of this from ground source heat pumps and 9 TWh from air source. This central range requires an annual growth rate of up to 41%.
- Constraints on deployment include: technology cost; planning & licensing processes; thin installer base; demands on the electricity grid; and performance & technical issues.

Priority actions:

- Technology costs: Introducing the RHI and the RHPP for eligible heat pumps from 2011 and 2012 respectively.
- Planning and licensing processes: Introducing permitted development rights for air source heat pumps on domestic properties in England, confirmation of details expected very shortly.
- Availability of good quality installers and engineers: Developing national occupational standard and competences for installers, and consulting on extending the Microgeneration Certification Scheme (which covers heat pumps up to 45kW$_{th}$) to ensure equipment meet high standards.
- Demands on the electricity grid: Monitoring usage patterns and the grid impact of existing installations, whilst setting Government's strategy for the future of our distribution networks.
- Performance and technical issues: Ensure that RHI is only available to eligible heat pumps with a Coefficient of Performance of greater than 2.9. Undertaking UK studies and field trials to gain data on the variation in performance of heat pumps across installations to ensure efficiency.

Current deployment

3.180 Initial analysis for DECC suggests that the UK has around 37,000 units[95] (equating to around 0.6 GWth of capacity), 28,000 of which are in the domestic sector (0.2 GWth) and 8,500 in the non-domestic sector (0.4 GWth).

3.181 Most of those in the domestic sector are installed in newly built housing. The retrofit market is currently quite small but the RHPP, domestic RHI, and actions set out in the Microgeneration Strategy will help the market to expand further.

Deployment potential

3.182 Figure 25 presents the results of recent analysis of the potential for growth in the deployment of non-domestic air and ground source heat pumps to 2020.

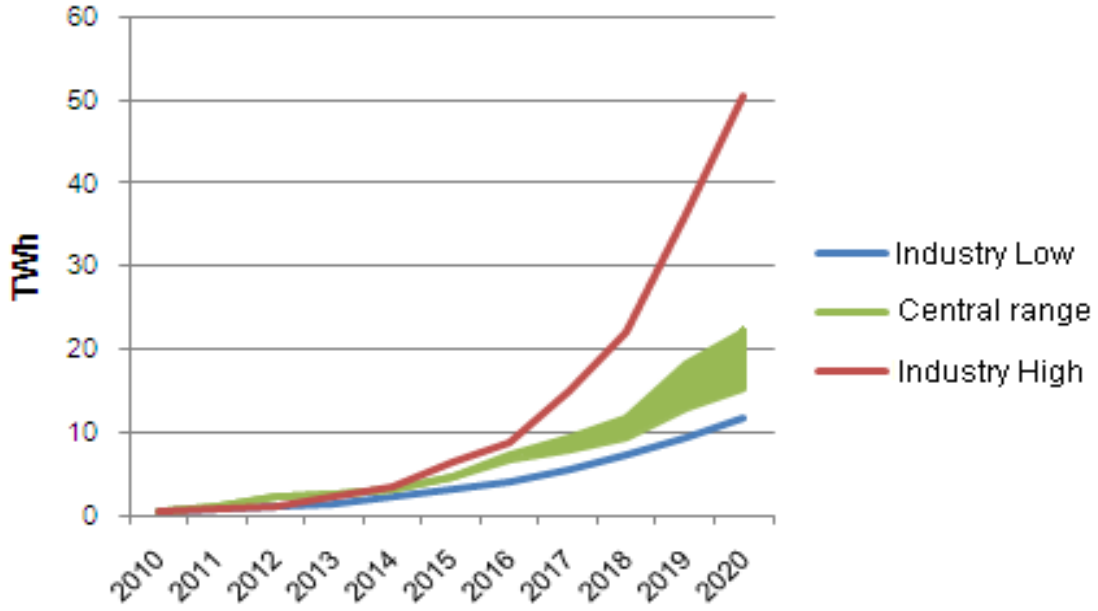
[94] Source: Energy Trends June 2011
[95] Source: AEA heat pump baseline survey information for DECC

It overlays an industry view of the deployment that could be achieved (the 'industry low' and 'industry high' scenarios) around a central range.

3.183 The central range suggests that non-domestic heat pumps could contribute up to 22 TWh (equivalent to around 100,000 installations). Of this, ground source heat pumps are expected to contribute 14 TWh, with a contribution of 9 TWh from air source heat pumps. This central range requires an annual growth rate of up to 41%. The industry scenarios suggest that the market has the potential to bring forward 12-51 TWh of non-domestic heat pumps by 2020.

3.184 The exact generation and installation levels will depend on the relative demand for different renewables heat technologies, including the mix between domestic heat pumps and larger, commercial units.

Figure 25: Deployment potential to 2020 for non-domestic heat pumps



3.185 The industry low scenario is based on the assumption that annual growth rates tail off slightly from 2010 to 2020, the high projection on the assumption that growth rates increase considerably. The large spread between these trajectories is reflective of the opportunities and risks associated with new technology markets. Key uncertainties for heat pumps include the rate of innovation to improve technology performance, demand response to the RHI, the speed at which the installer base grows, and likely public perceptions.

3.186 The industry high scenario implies a substantial increase in peak load electricity demand, which would require reinforcement of local grid networks. DECC monitors electricity usage patterns and has published a strategy for the future of our distribution networks alongside the EMR white paper. The high

trajectory is demanding but, as analysis for the IEA[96] shows, similarly high rates of deployment have been achieved in other EU Member States in recent years.

3.187 Analysis by DECC[97] suggests that the cost of non-domestic sector heat pumps could range from £42-£67 per MWh for 2020, down slightly from £44-£75 in 2010. These ranges reflect variation in the energy efficiency of the buildings being heated[98], and the fact that capital cost is lower on average for air-source than ground-source heat pumps. Cost reductions over time are muted due to conflicting changes in capital, installation and operating costs. Whilst capital and installation costs are expected to fall in response to learning effects, operating costs are expected to rise with increasing electricity prices.

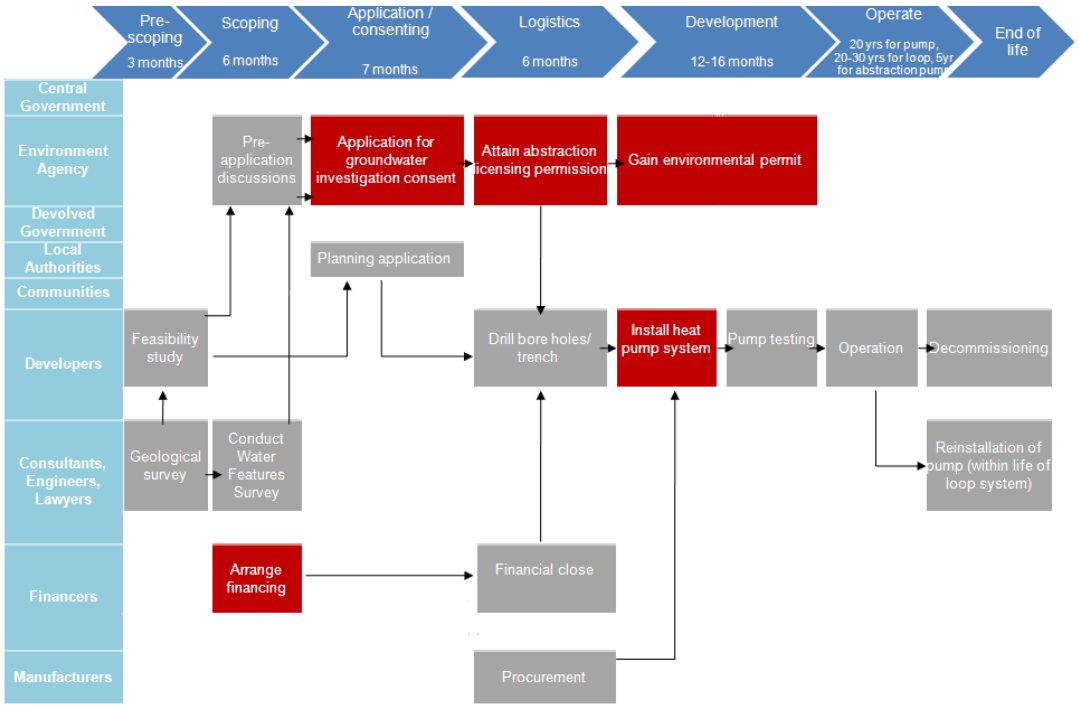
Deployment pipeline

3.188 Government does not currently gather statistics on the deployment pipeline for new heat pump installation. We will also be collecting data on heat pumps deployed under the RHI and RHPP. We will use this information to provide greater insight into deployment trends and barriers, and intend to make this publicly available.

Journey to deployment

Figure 26: Developer journey maps for non-domestic sector heat pumps

Ground source heat pump, open loop system

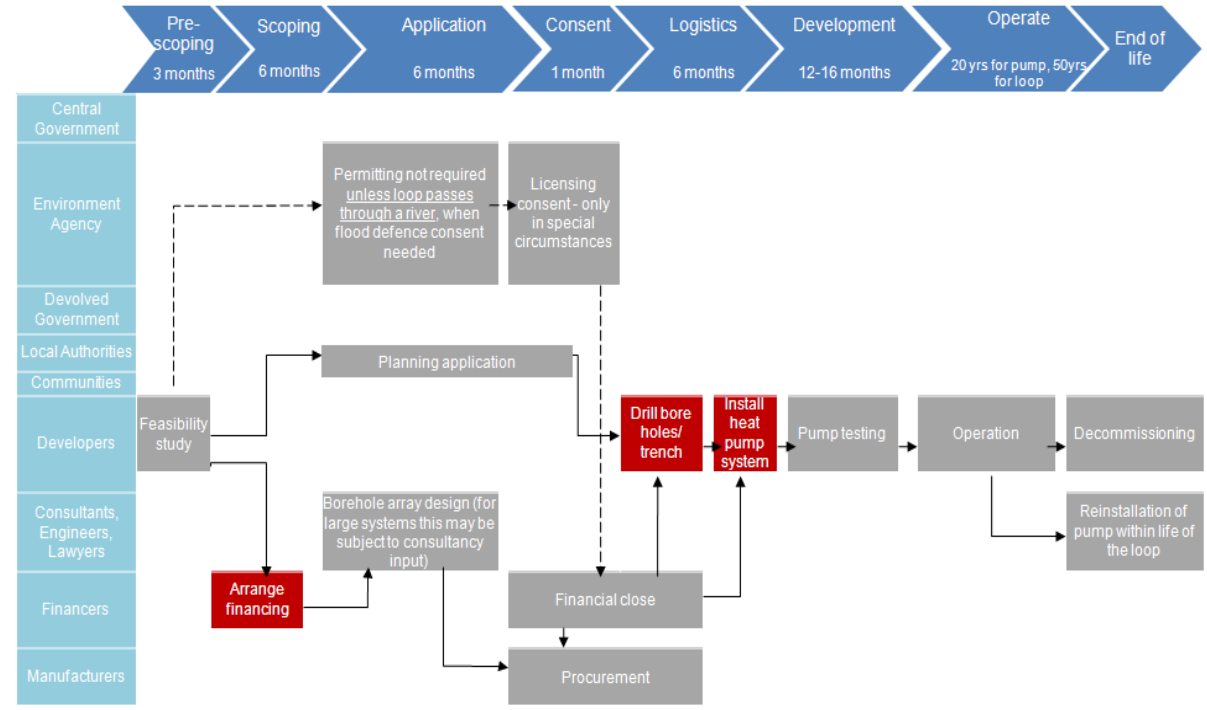


[96] IEA Heat Pump Centre Newsletter Volume 28 – No. 3/2010

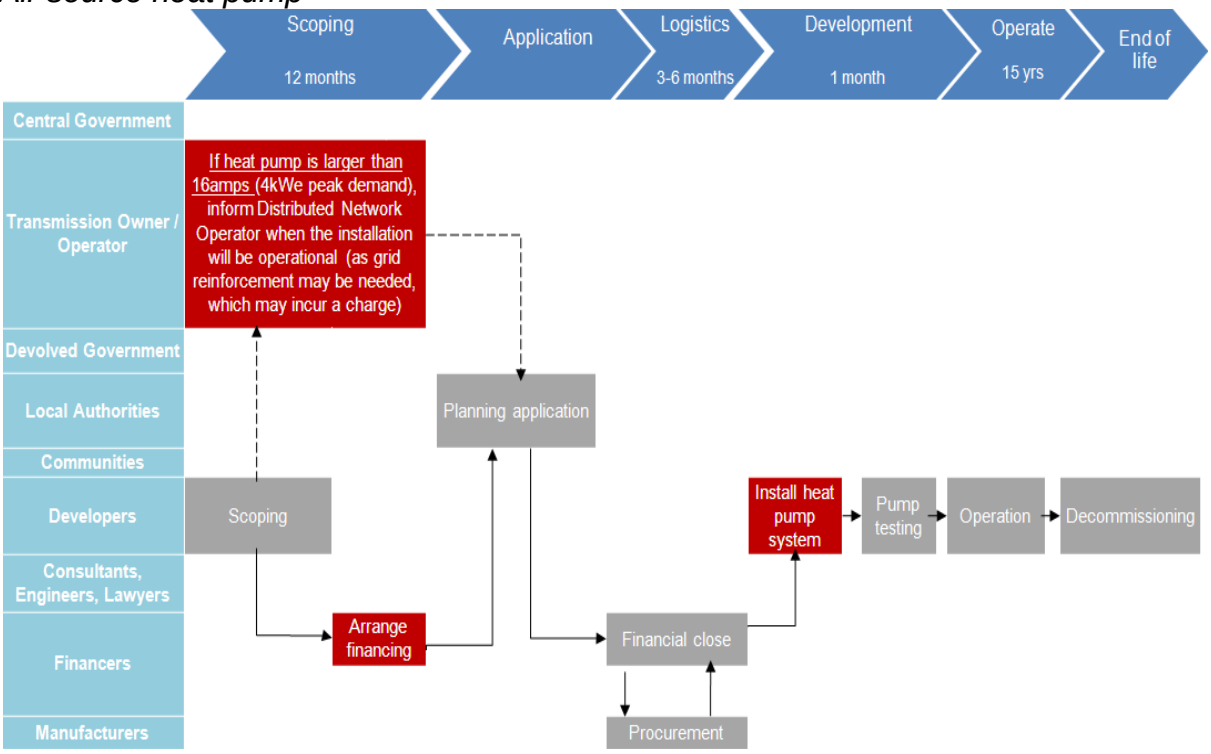
[97] Based on work by AEA Technology, summarised in section 2.2 of the Roadmap.

[98] This affects the total quantity of heat required in the building, across which the fixed costs of the technology are spread.

Ground source heat pump, closed loop system



Air source heat pump



3.189 Figure 26 above outlines the process for deploying large ground and air source heat pumps, and the groups and bodies involved, with key challenges to deployment highlighted in red.

3.190 Our analysis suggests that for a non-domestic air source heat pump the average time from scoping to operation is around five months. Lead times are

harder to interpret for ground source heat pumps[99] as these are usually installed as part of wider civil or building works, but preliminary analysis suggests that this can take around six months if planning permission and environmental permitting are not required. If consents are needed, the process is longer with environmental permitting usually lasting at least a year.

Challenges to deployment and actions

3.191 Our analysis of deployment statistics and discussions with industry suggest that developers face challenges relating to cost, performance, market infancy (on the demand and supply side) and regulation in deploying heat pumps. Some factors impact differently for domestic and non-domestic customers and for ground- and air-source technology.

Technology cost

3.192 Heat pumps are more expensive to purchase and install than conventional fossil fuel heating. Fuel bill savings are often insufficient to recoup these costs in the short to medium term, particularly for domestic customers and those who were previously served by gas. Cost is a barrier for both air and ground source technologies and could risk most, if not all, of the central deployment range of 16-22 TWh by 2020.

3.193 The RHI will provide support for the deployment of eligible non-domestic heat pumps. The scheme will cover ground and water source heat pumps, and is due to be launched later in 2011. Air source heat pumps are not covered at present, but DECC is looking to include air source heat pumps from 2012, subject to feasibility, affordability, and a value for money assessment. The scheme will be extended to include the domestic sector alongside the Green Deal. Northern Ireland is currently considering the details of their renewable heat incentive programme.

3.194 In addition, DECC is providing up to £15million of support to households under the RHPP, which will include air source and ground source heat pumps, and will be launched this Summer.

Action:

- The RHI for the non-domestic sector will be open for application from Autumn 2011.
- Northern Ireland Executive will consult over the summer with the goal of having a scheme in place by 1 April 2012 subject to agreement by the Northern Ireland Executive.

Planning and licensing processes

3.195 Developers report that there are delays in the planning process for air-source heat pumps and the environmental permitting process for ground source heat pumps.

[99] Open or closed loop

3.196 Open-loop ground source heat pumps must be licensed by the EA to ensure that they do not have an adverse effect on the environment. The EA indicate that this process can take up to a year to complete, including time to drill a borehole. These factors add to the cost and timing of developments, and could prevent deployment rates from rising as anticipated in the central deployment range.

3.197 The EA is working to streamline the licensing process for open-loop ground source heat pumps, including through the publication of guidance for developers making applications. The Government is working to deliver permitted development rights in England for some air source heat pumps installed on domestic properties, and to consider doing the same for installations on non-domestic premises. This will remove the requirement for express planning permission from the local council for some installations.

Action:

- The EA have issued guidance advising developers of best practice when applying for an environmental permit for open-loop ground source heat pumps.
- DCLG will report to Parliament on the introduction of permitted development rights for air source heat pumps on non-domestic land in England.

Performance and technical issues

3.198 Field trials[100] indicate that the performance of heat pumps in the domestic sector can vary considerably across installations. There is concern too that heat pumps can require more maintenance than standard boilers.

3.199 Variation in performance is a particular issue for the domestic sector where installations are not yet commonplace (installation quality is crucial to determining performance), customers are inexperienced in using their heat pumps efficiently, and it is common to rely on off-the-shelf units which may not be ideally sized. Underperformance must be tackled. Under EU rules only heat pumps with a coefficient of performance[101] (CoP) of 2.9 or more are eligible to count towards the 15% target. It could also impact public attitudes and limit demand.

3.200 Together these factors could substantially limit the level of progress possible towards the central deployment range of 16-22 TWh by 2020.

3.201 To improve data on performance, DECC has asked the Energy Saving Trust to use the second round of the heat pumps field trial to monitor modifications to poorly performing sites and gather further data. Government will also consider emissions of hydrofluorocarbons (HFCs) used as heat pump refrigerants to ensure consistency with existing regulations and ongoing discussions on phasing down of HFC production and consumption. DECC will be closely monitoring heat pumps and other technologies receiving support

[100] http://www.energysavingtrust.org.uk/cym/Generate-your-own-energy/Heat-pump-field-trial
[101] The coefficient measures the ratio of heat output to electrical input for the technology.

under the RHPP scheme through metering and through survey responses, to understand better how the systems perform in a variety of different situations and how actual performance measures up against manufacturer and installer claims. In addition, DECC has commissioned laboratory experiments on heat pump performance and Thermostatic Radiator Valves.

3.202 To ensure that only good quality equipment and installers are incentivised, DECC will ensure only eligible heat pumps with a CoP of 2.9 or greater will be eligible for support under the RHI. Under the RHPP, households support will only be available for households using an installer who is accredited under the Microgeneration Certification Scheme (MCS) or equivalent. To maximise the impact of the MCS, DECC will tighten its standards on training and the technical abilities of installers and will extend the scheme to heat pumps of more than 45kWth.

Action:

- DECC will ensure that, from the inception of the RHI scheme in 2011, it is only available for heat pumps with a CoP of 2.9 or greater.
- DECC will ensure that, from the inception of the RHPP scheme, it is only available for households using an MCS certified installers or equivalent.
- DECC will in 2011-12 use laboratory research, the RHPP, and the second round of the EST heat pump field trial to collect data on how best to improve heat pump performance.

Availability of good quality installers and engineers

3.203 The Heat and Hot Water Task Force[102] indicates a lack of good-quality heat pumps installers in the UK. In particular, it suggests that the UK will need in the order of 8,000-10,000 heat pump installers to deliver the estimation levels of generation required by 2020. Installers will need to have appropriate skills to ensure high quality installation. In addition, as illustrated in the developer journey charts above, ground source heat pumps will require specialist input from drilling and bore hole engineers.

3.204 Without an increase in the availability of skilled installers and engineers, it is unlikely that heat pumps will be deployed at the rates required to meet the 21TWh upper end of the central deployment range.

3.205 The Government is taking action to stimulate the supply chain directly and indirectly by stimulating the demand for renewable heat technologies.

3.206 The RHI and RHPP will stimulate demand for renewable heat technologies by lowering their effective cost for those wishing to install. We anticipate that this will encourage additional training and R&D in the British renewables industry, ultimately increasing the availability of skilled installers. RHI will be launched for the commercial and industrial sector in 2011, and we will monitor its impact on both deployment and underlying development of the market

[102] http://www.beama.org.uk/en/news/index.cfm/hhwt_pathways_2020_report

3.207 The Sector Skills Council (Summit Skills) is developing a national occupational standard and competence framework to encourage upskilling more directly in the heat pump industry. Details of the scheme, which will initially apply to the domestic sector, are set out in the Microgeneration Strategy, published in June 2011.

3.208 In addition, the Microgeneration Strategy sets out a full action plan for on-site renewable heat technologies. This covers the range of non-financial barriers to deployment developed together with the industry and to be taken forward by them including: certification; assessment; warranties; technology; information.

Action:

- DECC will establish the RHI from 2011 onwards to stimulate the demand for renewable heat and with it the supply chain for high quality installers.
- The Sector Skills Council (Summit Skills) will, by the end of 2011, revise the national occupational standard and competency framework for heat pump installers.

Renewable Energy in Transport

- In 2010 the UK met 14.1 TWh of its energy demand for transport from renewable sources, equivalent to 3.6% of road transport energy demand and up from 0.2% in 2005[103].
- The Government is committed to meeting the transport sub-target in the Renewable Energy Directive (RED).
- Proposed biofuel usage to 2014 was set out in the Department for Transport's recent consultation on transport elements of the RED and the greenhouse gas savings requirements of the Fuel Quality Directive (FQD). Currently, the levels as set in the Renewable Transport Fuel Obligation are for 4% in 2011/12, 4.5% in 2012/13 and 5% for 2013/14 and onwards.
- For the period beyond 2014 the Government is continuing to develop its evidence base on sustainability and deployment and, subject to the outcome of the recent consultations, will consult in Spring 2012 on possible trajectories for biofuels supply beyond 2014, with a further consultation on proposed legislative changes in late 2012.
- Challenges to the increased usage of renewable energy in transport include: potential sustainability issues around biofuel supply and considerations for best deployment across modes and sectors; the need for investment in infrastructure; the current additional up-front cost of ultra-low emission vehicles in relation to fossil-fuel alternatives; and support for innovation.

Priority actions:

- Biofuel sustainability and deployment: DfT's recent consultation on the RED and the FQD include proposals to introduce mandatory sustainability criteria for biofuels. In addition, DfT will examine proposals due from the EU in July 2011 for action on Indirect Land Use Change impacts and will shortly publish work on the best use of biofuels across modes.
- Plug-In Vehicle Infrastructure: DfT, BIS and DECC (through the Office of Low Emission Vehicles – OLEV) are supporting the Plugged-In Places programme. Eight areas are installing charging infrastructure for plug-in vehicles and in June 2011, OLEV published a strategy for plug-in vehicle infrastructure in the UK.
- Financial support for the purchase of ultra-low emission vehicles: OLEV launched the Plug-in Car Grant in January 2011 providing a 25% subsidy (up to £5000) for the purchase of eligible ultra-low emission cars which meet safety, environmental and performance standards.
- Support for innovation: Funding to support further development of low carbon vehicle technologies by identifying priority technologies for innovation, and funding through the SET Plan initiatives.

Current deployment

3.209 In 2010 the UK met 14.1 TWh of its energy demand for transport from renewable sources, equivalent to 3.6% of road transport demand and up from 0.2% in 2005[104].

[103] Under the Renewable Energy Directive measure, all renewable transport contributed 13.3 TWh, or 2.9% towards capped transport target (excluding air). Source: Energy Trends June 2011

[104] As above

3.210 Renewable energy is more widely used at present in road transport than in rail, shipping, or aviation. The vast majority of usage in the road transport sector has been in biofuels, driven by the Renewable Transport Fuel Obligation, which requires that suppliers of fossil fuel for road transport to source a proportion of their supply from biofuels.

3.211 The RFTO target level for the financial year 2009-10 was 3.25%, against which 3.33%[105] was delivered – 71% of this from biodiesel, 29% from bioethanol and under 1% from biomethane. Around 15% of the feedstock for this fuel was waste material.

3.212 At the end of 2010 there were 11,500 low-emission (including electric) vehicles in the UK, used in road transport[106].

Deployment potential

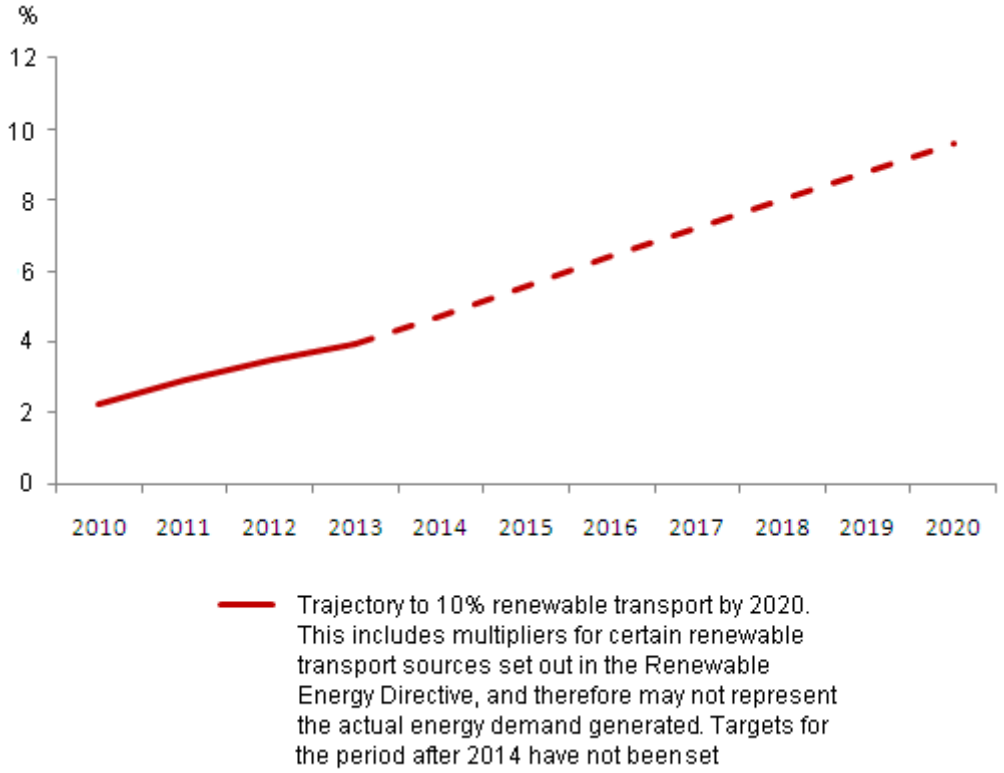
3.213 The Renewable Energy Directive (RED) sets a target for the UK to source 10% of its energy used for all forms of transport[107] from renewable sources by 2020. Biofuels made from wastes, residues and ligno-cellulosic material count double towards the 10% target, and electric vehicles by a factor of 2.5. Biofuels used must meet sustainability standards on biodiversity and embedded emissions from growth and processing (discussed in more detail below).

3.214 Figure 27 presents a trajectory delivering up to 48 TWh of renewable energy in transport by 2020. As described below, it illustrates that while there is certainty over the level of deployment expected to 2014, Government has not yet finalised the pathway for renewable transport for the period between 2014–2020 including the role of wastes, advanced biofuels and electric vehicles.

3.215 Whilst renewable energy in transport is vital to help meet our ambitions for renewable energy and carbon reduction, it must be from sustainable sources. There are concerns that the mandatory RED sustainability criteria for biofuels do not address key issues such as Indirect Land Use Change (ILUC), and this has implications for the 10% transport sub-target. Until these are resolved we must take a cautious approach to the level of biofuels used in transport.

[105] Calculated on a by volume basis – not directly comparable with the Renewable Energy Directive 10% target.
[106] Source: DVLA/DfT http://www2.dft.gov.uk/pgr/statistics/datatablespublications/vehicles/licensing/all-new/veh0170.xls
[107] For the purpose of calculating the percentage of renewable energy consumed in transport, aviation is included in the numerator only; for the denominator, road and rail transport only are taken into account.

Figure 27: Trajectory for deployment of renewable energy in transport to 2020



3.216 Government is currently undertaking extensive analysis and engaging with stakeholders to consider these issues. The recent consultations on the transport elements of the RED and the greenhouse gas (GHG) savings requirements of the FQD, set out a proposal to place a legal obligation on the Secretary of State for Transport to consider what additional measures will be required to ensure that the UK delivers the requirements of the RED and FQD in the period 2014 to 2020. Subject to the results of this consultation, DfT will consult in 2012 on the possible approach for renewable transport for the period between 2014–20, including the contribution from biofuels, and will make the required legislative changes in 2013.

Analytical work to define pathway beyond 2014

3.217 A key element of our work to define a pathway beyond 2014 is the Bioenergy Strategy which Government is developing with the Devolved Administrations. This will examine the likely supply of sustainable bioenergy to the UK from domestic and international sources to 2050 given competing demand from abroad and other sectors, and will look at how best to apportion this resource between transport, heat and electricity in the UK considering issues of cost-effectiveness and potential GHG savings. It will consider the importance of exploiting UK feedstocks such as waste, which do not present obvious sustainability concerns.

3.218 For the transport sector specifically, DfT has commissioned analytical work to produce scenarios for the cost-effective deployment of biofuels across UK aviation, rail, shipping, and various form of road transport out to 2050. This will

look at the relative cost-effectiveness of using the available resource in different modes given, for example, the availability – or not – of other options for reducing emissions. DfT will publish a suite of research reports from this work in summer 2011.

3.219 On aviation, DfT published a call for evidence document[108] in March 2011 outlining the proposed scope of its work to develop a long term, sustainable framework for UK aviation. The call for evidence, which closes on 30th September 2011, outlines the range of issues which DfT propose to consider, including the potentially crucial role of biofuels in this sector given the lack of other options available for reducing emissions.

3.220 The Government will use these pieces of work and advice from the Committee on Climate Change on the best use of bioenergy in the UK (expected in November) to inform its strategy for renewable transport.

Challenges to deployment and actions

3.221 The UK will need to overcome four main challenges in order to increase the usage of sustainable renewable energy in transport in line with the 10% transport sub-target.

Assuring the sustainability of biofuel supplies

3.222 For biofuels to be beneficial they must be produced sustainability. It particular, their production should not place undue pressure on areas of high biodiversity, and they must deliver real emissions savings in comparison to the fossil fuels they are replacing.

3.223 The RED and FQD contain mandatory sustainability criteria for biofuels. These criteria include that biofuels, with some exceptions, must deliver greenhouse gas savings of at least 35% when compared to fossil fuels and that biofuels must not be sourced from areas of high biodiversity, or from high carbon soils (e.g. rainforests or wetlands). DfT consulted on the implementation of these criteria, proposing that only biofuels meeting the required standards would count towards Renewable Transport Fuel Obligation[109]. The consultation closed on 2 June.

3.224 On the issue of ILUC, where the cultivation of biofuel feedstock on existing agricultural land results in the displacement of production on to previously uncultivated land, the European Commission will bring forward proposals by the end of July 2011. The UK will examine these proposals as a matter of priority in the light of its own analytical work on this issue.

[108] Developing a Sustainable Framework for UK Aviation: Scoping Document – http://www.dft.gov.uk/consultations/open/2011-09/consultationdocument.pdf

[109] The exception is biofuels produced from waste and residues (other than agricultural, aquaculture, fisheries and forestry residues), which are treated differently. As these are not derived from crops, they are viewed as prima facie sustainable and must only meet the criterion of delivering a GHG savings of at least 35%.

3.225 Consideration also needs to be given to the role of advanced biofuels and those produced from waste that count twice towards targets under the RED.

Actions:

- Government will assess the European Commission's proposals due to be published in July 2011. We will consider whether the proposals are appropriate with a view to ensuring effective standards on Indirect Land Use Change.

Infrastructure and supply chain development

3.226 Investment will be needed in infrastructure and the UK supply chain to support the increased usage of plug-in vehicles to 2020 and beyond. For plug-in vehicles, investment in charging infrastructure may be needed so that motorists can charge their plug-in vehicles safely and conveniently across the country.

3.227 The Plugged-In Places programme provides match-funding to consortia of business and the public sector for eight schemes across the UK (London, Milton Keynes, the North East of England, Northern Ireland, Scotland, Greater Manchester, the Midlands and the East of England), to support the installation of a critical mass of charging points in each area.

3.228 The Office of Low Emission Vehicles have recently published *Making the Connection: the Plug in Infrastructure Strategy* drawing on evidence generated about driver behaviour from the Plugged-In Places programme and other trials taking place in the UK and overseas.

Actions:

- Government has made available up to £30m available for to support the Plugged-in Places programme.

Upfront cost of Ultra Low Emission Vehicles

3.229 Ultra low-emission vehicles such as electric vehicles are still an emerging technology and are not yet produced in large numbers. As a result, their upfront cost to customers is currently higher than that of conventionally fuelled vehicles.

3.230 The Government believes that ultra-low emission vehicles have an important role to play in the long term decarbonisation of UK transport. It is taking action to create a more level playing field between the cost of new and existing technologies, until scale effects drive the cost of new technologies down to a more competitive level.

3.231 In its 2011 Spending Review the Government confirmed more than £400m of support for the Ultra Low Emission Vehicles (ULEVs) for the lifetime of this Parliament. This includes funding for the 'Plug-in Car Grant' scheme which was launched in January 2011 to provide customers buying an electric, plug-

in hybrid, or hydrogen-fuelled car with a grant equal to 25% of the vehicle purchase price, up to a value of £5,000. The scheme is available for private and business customers, and cars bought must comply with performance, environmental and safety standards in order to be eligible.

Actions:

- In the 2011 Spending Review, the Government confirmed more than £400m of support for Ultra Low Emission Vehicles (ULEVs) over the lifetime of this Parliament.
- In January 2011 DfT launched the 'Plug-in Car Grant', providing a 25% grant – up to £5000 – for the purchase of electric, plug-in hybrid, or hydrogen-fuelled cars.

Case study: Supporting the take-up of ultra-low emission cars

The Government announced the first nine electric and ultra-low emission cars eligible for the Plug-In Car Grant in December 2010. These are: the Mitsubishi i-MiEV; Smart fortwo electric drive; Peugeot iOn; Nissan Leaf; Tata Vista; Citroen CZero; Vauxhall Ampera; Toyota Prius Plug-in Hybrid; and the Chevrolet Volt. The Renault Fluence joined the list in June 2011.

The scheme began on 1 January 2011, reducing the cost of vehicles by 25%, up to £5,000.

The Plugged-In Places scheme supports eight projects around the country. These projects have successfully bid for a share of a £30 million fund aimed at encouraging a new network of plug-in vehicle recharging points in streets, homes and sites such as car parks and commercial retail and leisure facilities. The successful Plugged-In Places consortia are based in: the Midlands; Greater Manchester; East of England; Scotland; Northern Ireland; London; Milton Keynes; and the North East.

Support for innovation

3.232 Ongoing research and development work is required to support the development and deployment of the emerging generation of new ultra low carbon vehicles. Government provides funding to support specific programmes of work in this area, including the development of new engines for plug-in hybrid cars to improve vehicle performance and materials that reduce vehicle weight. This funding includes supporting the Technology Strategy Board's Low Carbon Vehicle Innovation Platform which invests jointly with industry in research and

development to help UK-based businesses maximise the economic benefits associated with a developing ULEV market.

3.233 Recent studies[110] commissioned by Government indicate that advanced technologies may be an important element of meeting our needs to 2020, and increasingly valuable post 2020 as we move towards a low carbon transport system. Key areas already identified as potential routes include thermochemical conversion which can produce mid-distillates such as biodiesel and jet fuel. Developing these fuels will reduce the use of agricultural land needed for food, and increase the use of wastes for energy, as well as generating high lifecycle greenhouse gas savings.

3.234 DfT's recent consultation proposed introducing double rewards for biofuels made from wastes, residues and non-food cellulosic and ligno-cellulosic materials. The UK are involved in securing key future funding routes, such as the EU's Strategic Energy Technology (SET) Plan. The SET Plan outlines what needs to be done from an EU perspective to achieve its 2020 energy and emission targets and 2050 vision. Its objectives are: sustainability; security of supply; and retaining EU competitiveness. The UK is a strong supporter of the SET Plan and DECC is engaged with the UK funding organisations (Research Councils, TSB, Carbon Trust, ETI); multiplier organisations; and individual companies and research organisations, to promote and encourage SET Plan engagement.

3.235 DECC is working with fellow members of the Low Carbon Innovation Group to identify the key innovation needs in a range of technologies, including the generation of energy from waste and biomass, to determine how Government's innovation funding can best address them. Subject to the conclusion of this work and value for money assessments, funding from DECC's Innovation Programme budget will be available, if needed, to support innovation in key technology areas such as the advanced conversion of waste.

Actions:

- The Government has made provision of around £80 million to support a programme of research and development of programme research and development in ultra-low carbon technologies. The most recent competition is aimed at highly innovative collaborative R&D technologies, feasibility studies of disruptive technologies and the feasibility of automotive battery recycling and re-use.
- Government has contributed to a total award of £24 million for six projects through which large vehicle manufacturers will help to grow the supply chain for a low carbon vehicles industry within the UK by working together with small to medium sized enterprises to provide support and a potential route to a growing market.

[110] Draft DfT "modes" Study and National Non-Food Crops Centre Study – 'Advanced Biofuels: The Potential for a UK Industry

- DECC will be announcing details of potential funding to support innovation in Autumn 2011, subject to conclusion of innovation needs work and value for money assessments.

Chapter 4: Supporting delivery

A Process for Delivery

4.1 The development and publication of this Roadmap is the first step in an ongoing process. We will publish a revised document annually to update on progress, and to reflect any new additions to our evidence base which arise from collaborative working with stakeholders.

Figure 28: Annual Roadmap cycle

4.2 Through the course of Chapter 3 we have set out actions against a range of renewable technologies from the electricity, heat and transport sectors. Future editions of the Roadmap will report progress against these activities and analyse their impact in alleviating the barriers to deployment.

Monitoring and Reporting Progress

4.3 We will be monitoring several key areas as indicators of progress and to support our evidence base:

- consumption of renewable energy;
- renewable energy deployment and pipeline;
- reasons for project failure and barriers to delivery;
- impact of policy activity;
- changes to technology costs.

4.4 The level of overall renewable energy consumption in the UK is the key indicator for reporting progress to the European Commission for both the interim targets and against the 15% target to be achieved by 2020. The UK interim targets are set at 4% for the period 2011-12, then 5.4% for 2013-14, 7.5% for 2015-16, and 10.2% for 2017-18. Progress against these targets will

be provided on an annual basis following publication of the Digest of United Kingdom Energy Statistics in July each year.

4.5 Government is already working to gather a broad range evidence on renewables through market intelligence, commissioned studies, and for national energy statistics. In areas where the market is changing or expanding, we are also seeking to expand our evidence base. DECC will gather data on renewable heat developments, as well as renewable electricity, to develop our understanding of the project pipeline in this growing market.

4.6 Alongside this we will continue to monitor the impacts of the barriers to deployment, and will review the progress of delivering the programme of actions set out above in Chapter 3. Continued engagement with the market will also enable Government to anticipate future deployment risks, innovation opportunities and changes to technology costs, and to reprioritise our delivery actions as appropriate.

4.7 Official reports to the European Commission, along with future iterations of the Roadmap, will be accessible online. This will enable stakeholders and the public to access the most up-to-date evidence and analysis on renewables. For example, it will include deployment information from the annual Digest of UK Energy Statistics, DECC's quarterly Energy Trends publications, and the Renewable Energy Planning Database.

Conclusion

4.8 Through implementation of the actions outlined in this Roadmap we intend to tackle the key barriers which are impeding the deployment of renewables in the UK. To ensure that we are focusing activity and resources effectively we will analyse the impact of these actions and monitor deployment progress across the sectors.

4.9 Technology costs, innovation breakthroughs and barriers to deployment will change over time. DECC will continue to work with market participants and others from across the renewables sector to better understand the potential of renewable energy through to 2020, and to identify and react to new constraints and opportunities as they emerge. With each edition of the Roadmap we will be one step further along the path to delivering our target for 2020.

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URN 11D/698