# Technical Annex 2: Progress decarbonising the power sector

This Technical Annex supports the Power chapter of the report *Meeting Carbon Budgets - 2016 Progress Report to Parliament,* providing reference and detail alongside the main report, and covering the following sections:

1. Overview of emissions

2. Performance against the Committee's progress indicators

3. Forward look and policy gap

4. Indicator table

## 1. Power sector emissions

This section provides additional detail on drivers of the reduction in power sector emissions in recent years, specifically the growing contribution of low-carbon technologies to overall UK generation between 2014 and 2015 as well as the change in demand.

**Table A2.1.** Share of UK electricity generation by technology

| Technology | 2014 - TWh (% of generation) | 2015 - TWh (% of generation) |
|---|---|---|
| Coal | 95 (32%) | 72 (24%) |
| Gas | 87 (29%) | 87 (29%) |
| Oil | <1 (<1%) | <1 (<1%) |
| Nuclear | 58 (19%) | 64 (22%) |
| Onshore wind | 18 (6%) | 23 (8%) |
| Offshore wind | 13 (4%) | 17 (6%) |
| Biomass | 20 (7%) | 25 (9%) |
| Solar | 3 (1%) | 5 (2%) |
| Hydro | 6 (2%) | 6 (2%) |
| **Total UK generation** | **298** | **295** |
| *Imports* | 21 | 21 |

**Source:** DECC (2016) *Energy Trends Table 5.1***.** Available at: www.gov.uk
**Note:** Total UK generation is conventional generation from 'Major Power Producers' plus renewable generation from 'All generating companies' in DECC's Energy Trends Table 5.1. An adjustment is made to estimate solar power that is exported to the electricity grid (rather than being consumed on site). Imports are additional to total UK generation. Numbers may not sum due to rounding.

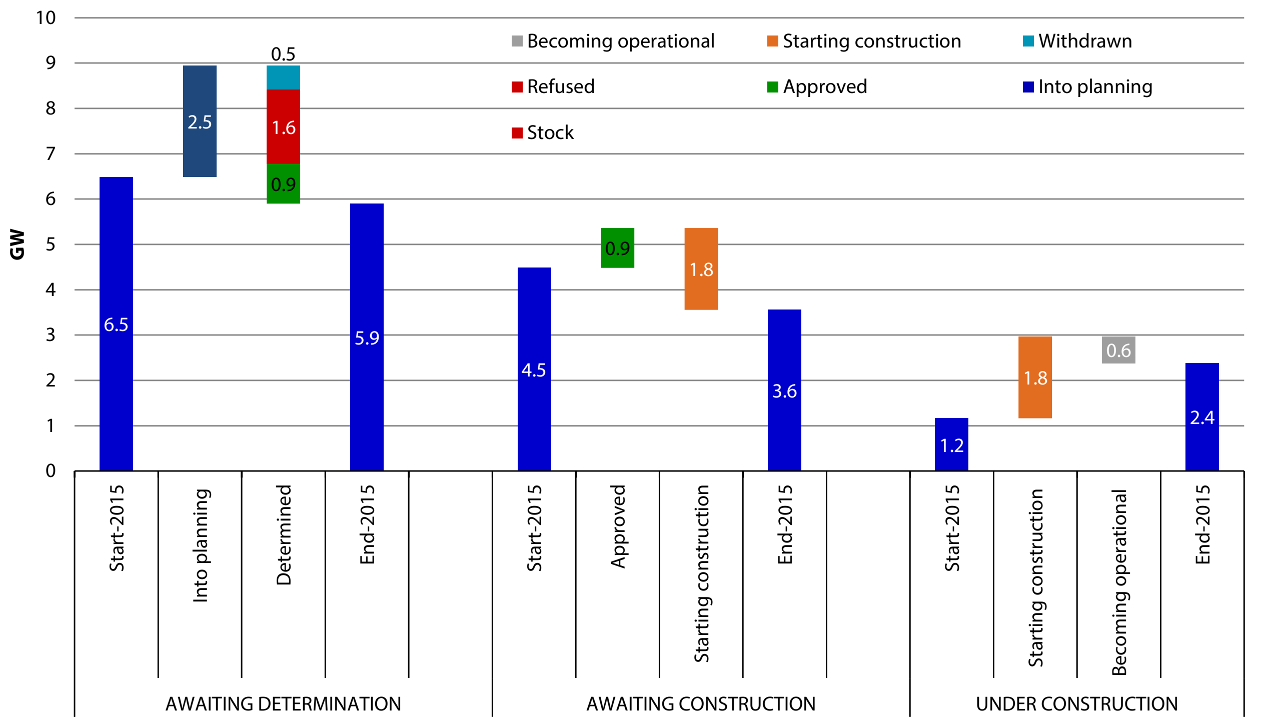
## 2. Performance against the Committee's progress indicators

This section provides additional detail on progress and delivery risks for deploying onshore and offshore wind, as well as detail on the costs and potential of marine technologies (wave and tidal).

### Onshore wind

Figure A2.1 illustrates onshore wind capacity moving through the planning pipeline during 2015.

**Figure A2.1.** Onshore wind new capacity pipeline (2015)

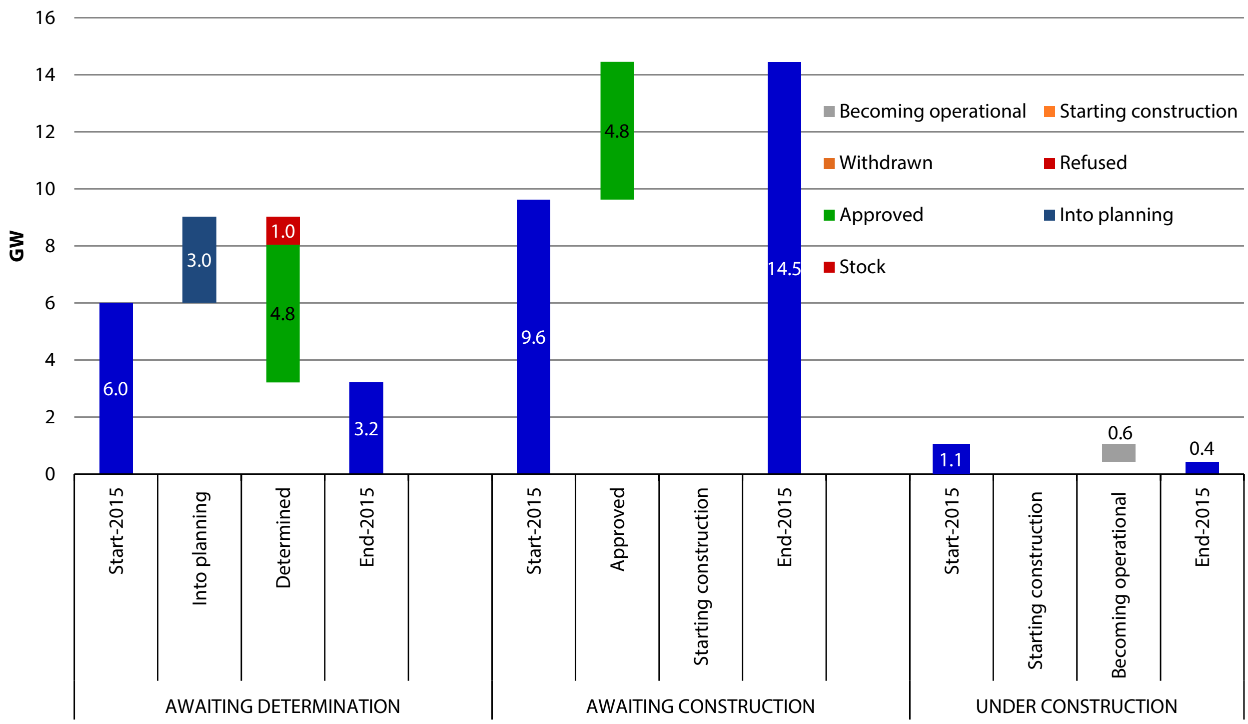



**Source:** DECC (March 2016) *Renewable Energy Planning Database*. Available at: www.gov.uk
**Notes:** Numbers may not sum due to rounding. As of 2015 the Renewable Energy Planning Database no longer contains projects below 1 MW in size; calculations of capacity moving through the planning pipeline may be slightly different to those published in previous years.

## Offshore wind

Figure A2.2 illustrates offshore wind capacity moving through the planning pipeline during 2015.

**Figure A2.2.** Offshore wind new capacity pipeline (2015)




**Source:** DECC (March 2016) *Renewable Energy Planning Database*. Available at: www.gov.uk
**Notes:** Numbers may not sum due to rounding. As of 2015 the Renewable Energy Planning Database no longer contains projects below 1 MW in size; calculations of capacity moving through the planning pipeline may be slightly different to those published in previous years.

**Table A2.2.** Planning approval rates for onshore and offshore wind

| Technology | 2007-2014 Average | 2015 |
|---|---|---|
| **Onshore wind** | 66% | 35% |
| England | 46% | 19% |
| Wales | 75% | 35% |
| Scotland | 75% | 34% |
| Northern Ireland | 79% | 73% |
| **Offshore wind** | 96% | 83% |

**Source:** CCC calculations based on DECC (2016) *Renewable Energy Planning Database*. Available at: www.gov.uk
**Note:** As of 2015 the Renewable Energy Planning Database no longer contains projects below 1 MW in size; calculations of average planning approval rates may be slightly different to those published in previous years.

### Marine energy

Table A2.3 presents an overview of load factors, capacity and costs for tidal stream, wave power and tidal lagoon technologies. Both wave and tidal stream technologies remain high cost early stage technologies, with limited potential to 2030. The wave industry is currently demonstrating several technology prototypes and is yet to focus on a single technology type to take forward, whereas tidal stream technologies being demonstrated typically represent similar technology types, indicating that tidal stream technologies may be closer to commercialisation. In Spring 2016 the Government announced that it was conducting a review of tidal lagoon technologies, considering their cost effective role in a future UK energy mix, as well as the potential scale of tidal lagoon opportunities, both in the UK and abroad. This will conclude in the Autumn. Tidal Lagoon Power, a company that proposes to develop tidal lagoons in the UK, is currently in negotiations for a Contract for Difference from the Government for its first project in Swansea Bay.  As no tidal lagoons have been built to date, the costs of this project are uncertain.

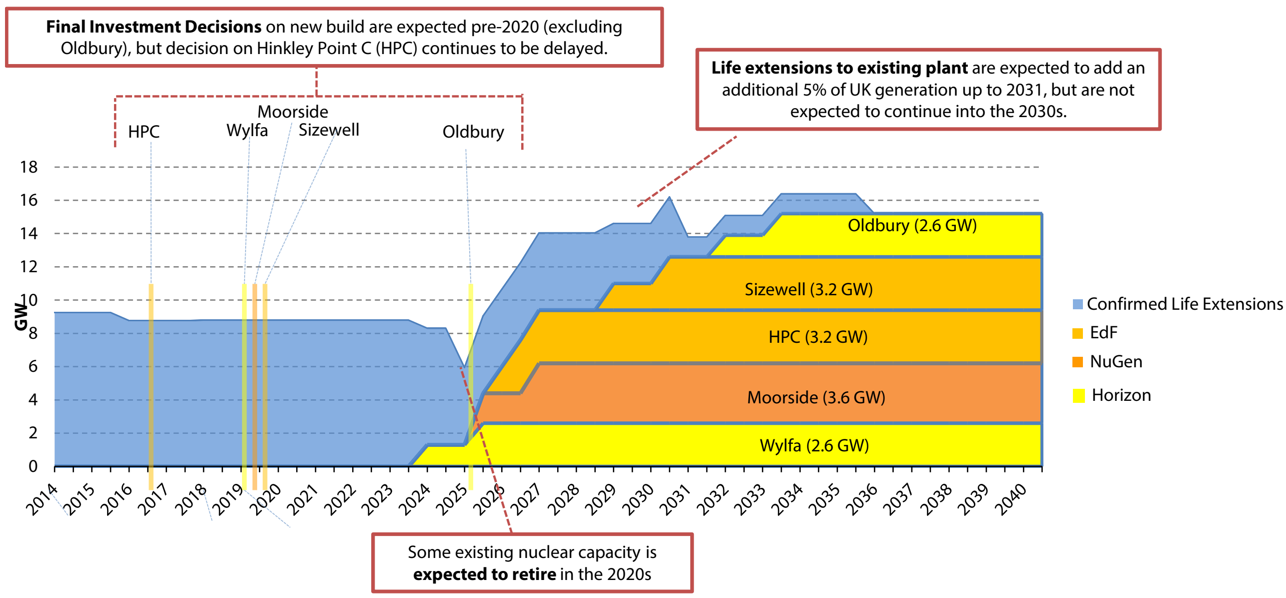
| **Table A2.3.** Overview of marine energy | | | | | |
|---|---|---|---|---|---|
| **Technology** | **Load Factor (%)** | **Installed Capacity (MW)** | **Capacity in pipeline (MW)** | **Current Cost Estimates (£/MWh)** | **Future Cost Estimates (£/MWh)*** |
| **Tidal lagoons** | 22% | 0 | 3620 | £130-170/MWh | £110/MWh (2020) |
| **Tidal Stream** | 31% | 5 | 730 | £200-300/MWh | £70-100/MWh (2030) |
| **Wave power** | 31% | 3 | 40 | £350-400/MWh | £120/MWh (2030) |

**Source:** Renewable UK (2016) *UK Marine Energy Database*. Available at: www.renewableukc.com. Pöyry (2014) *Levelised cost of power from tidal lagoons*. Available at: www.tidallagoonpower.com; ETI (2015) *Insights into wave and tidal energy*. Available at: www.eti.co.uk
**Note:** Load factor for tidal lagoon is an estimated volume weighted average load factor from Pöyry (2014). *Future cost estimates for wave and tidal stream from ETI (2015) are for 2030, and volume weighted average levelised cost for the first three tidal lagoons, based on Pöyry (2014). Capacity in pipeline defined as under construction or consented and awaiting construction in the UK Marine Energy Database.

## Nuclear power

Figure A2.3 presents an overview of existing and new build nuclear power in the UK between 2014 and 2040 based on publicly available information from both the Office of Nuclear Regulation (ONR) and developer websites.

**Figure A2.3.** Potential timing of new nuclear projects currently under development in the UK (2014-2040)




**Source:** ONR (2016) *Generic Design Assessment Timeline*. Available at: www.onr.org.uk; Developer websites.

## Carbon Capture and Storage (CCS)

New analysis by Pöyry, and a report from our CCS Advisory Group, underpin our recommendation that a strategy to develop CCS in the UK should be progressed immediately. The Executive Summaries of the Pöyry and CCS Advisory Group reports are set out in Boxes A2.1 and A2.2, respectively.

**Box A2.1.** Executive Summary of Pöyry analysis

Withdrawal of funding from the Commercialisation Programme in 2015 left the UK without any explicit funding mechanism for developing CCS in the UK. With CCS now facing a highly uncertain future the Committee on Climate Change (CCC) has commissioned Pöyry to provide a short report exploring the options for commercialising Carbon Capture and Storage (CCS) in the UK.

While CCS is one option for decarbonising the power sector, it is the only available option for decarbonising many industrial processes. In the longer term, CCS combined with biomass could be a source of negative carbon emissions, allowing cost savings by reducing the need to decarbonise elsewhere. Analysis by the CCC indicates that developing a CCS industry is essential to decarbonising the UK industrial sector, and work from the ETI suggests that CCS infrastructure needs to be in place by the late 2020s or early 2030s.

The Commercialisation Programme has left the UK with well characterised storage ready for development, a detailed appraisal of capture technologies and costs and a significant body of knowledge around the creation of successful commercial arrangements for CCS.

These assets create the opportunity for rapid development of CCS within the UK if appropriate support is put into place. Recent falls in expected UK gas prices also make CCS more cost-effective when compared to technologies that are not dependent on fuel prices.

In this report, we explore the key steps required to establish a CCS industry in the UK, and the costs of doing so. Critically, we consider that one of the most important lessons to learn from the commercialisation is the difficulty of funding CCS on a "full-chain" approach, where a single payment rewards the construction and operation of capture, transport and storage. We suggest that any cost-effective CCS strategy will require the Government to absorb cross-chain risks via "part-chain" funding mechanisms, where transport and storage are supported either via a second funding scheme, or a risk sharing arrangement.

Our broad view of how to achieve cost reductions is unchanged from our 2015 report to the CCC. Development should be focused around capture and storage hubs, reducing costs by sharing transport and storage infrastructure. As far as possible, and subject to cost targets, continuous rollout of CCS power generation will drive savings via lower financing costs and development of supply chains. Finally, optimal technology choice, location choice and knowledge transfer will be crucial to access learning by doing and risk reduction cost savings.

We consider that industrial CCS should be considered a critical part of the overall CCS strategy, but we do not believe that CCS should be developed around industry alone. The requirement for CCS for industry provides a framework for considering necessary investment that could drive the development of at least one CCS hub. Once a hub is in place, cost estimates suggest that power CCS is a valuable source of low-carbon generation, and immediate development of power CCS helps drive cost reductions and captures significant volumes of carbon that can be used to securely drive the development of a transport and storage network.

Exploring timelines for the roll-out of CCS, we conclude developing low cost CCS by the early-2030s requires immediate progress on a new strategy for UK based CCS. Even with immediate development, we consider it very challenging to get CCS operating in the early 2020s, and expect that second

**Box A2.1.** Executive Summary of Pöyry analysis

generation power CCS would begin operation around 2030, around 5 years later than in our 2015 report. To drive this schedule, some key steps need to be taken:

- Making an early decision on a preferred region(s) from which capture facility bids will be accepted, ideally accompanied by a decision on which storage facility to develop.
- Committing to making funding available for carbon capture units, provided that cost targets can be met.
- Choosing an initial business model to support transport and storage, with the Government absorbing a significant part of four key risks:
  - Cross chain funding risks
  - Carbon volume flow risks
  - Long term storage liabilities
  - Fuel price risk
- Allocating responsibilities within the business model to existing bodies where possible, and creating new bodies if required.
- Establishing a mechanism that will support the development of carbon capture from industrial processes.

In addition to exploring the objectives of a CCS strategy, and the steps required to meet them, we have updated the cost estimates from 2015 to take into account recent developments, and separation of funding for capture units from transport and storage. Using fuel prices from the 2015 DECC Reference Scenario, and engineering estimates from the 2013 Cost Reduction Task Force we calculate that post-combustion gas CCS, commissioning in the mid-2020s, could be developed with a 15 year Contract for Difference (CfD) at around £115/MWh, and that once learning, development and economies of scale are taken into account, costs would reduce to £85-90/MWh in the 2030s.

Driving this investment, in addition to CfDs for capture units, will require the creation of a transport and storage network. A minimum transport and storage investment of around £600m is likely to be required, dependent on the geographical choice of the initial hub, and the storage facility used. At the high end of our rollout estimates, with significant support for CCS power generation and industrial capture, we estimate that around £2.5bn of investment by 2035 could support 7.5 GW of power generation and 5 Mtpa of industrial capture.

**Source:** Pöyry (2016) *A Strategic Approach for Developing CCS in the UK*. Available at: www.theccc.org.uk.

**Box A2.2.** Executive Summary of CCS Advisory Group report

The Committee on Climate Change (CCC) has commissioned expert input on policy, strategy and costs for carbon capture and storage (CCS). This analysis will inform the CCC in their advice to government on a strategy for CCS in the UK. The CCC commissioned Consultants Pöyry to produce analysis of potential CCS costs and strategy. The CCC convened an expert Advisory Group to help scope, steer, oversee and comment on the consultants' analysis. This report provides a Chair's summary based upon the reflections of the Advisory Group. It comments on the report the consultants have produced and the wider issues associated with this crucially important topic.

The Group notes the importance of CCS as a flexible enabler of low carbon energy – whether through continued use of fossil fuels for electricity, or by enabling industrial decarbonisation and the production of hydrogen which can be used flexibly in a wide range of end uses. CCS has the potential to play an important role in the power sector, in enabling industrial decarbonisation, low carbon hydrogen (and syngas) production and, potentially, a pathway to negative emissions in combination with bioenergy (e.g. biomass gasification with CCS).

The Group finds that the analysis from Pöyry is well-conceived and provides valuable new insights into policy and strategy to promote CCS during the 2020s. Detailed cost and strike price analysis from Pöyry suggests that the levelised costs of gas-fired capture plants connecting to a well-utilised transport and storage infrastructure could be below £100/MWh. The Group believe that this is feasible under sensible assumptions, noting that estimates of future CCS costs are subject to considerable uncertainty and there is a wide range of estimates in the literature.

The cancellation of the planned CCS Commercialisation Programme is a significant set-back to the development of CCS in the UK. However, work undertaken in preparation for the cancelled Programme has provided important information on technology costs and in the characterisation of stores. These are now considered ready for development and have generated developer interest in follow-on projects that could in principle be retained.

The Group believes that there is a valuable opportunity to rethink strategy and policy to facilitate the creation of CCS infrastructure at lowest overall cost. The Group note the importance of separating the handling of contracting and risks for capture plants from the transport and storage of CCS (T&S). There is substantial scope to improve the allocation of risks, ensuring they are allocated to the party best-placed to absorb or manage them, thus allowing industry participants to access lower costs of capital. Moreover, if T&S infrastructure is able to serve multiple sectors it is possible to improve utilisation and increase economies of scale, which can also lower costs per unit of $CO_2$ stored.

There is a need for government to take steps during this Parliament to provide clarity over aspirations and objectives for CCS, both in terms of long term goals and development of early projects. The Group recommends that policy to allow development of a strategically planned CCS T&S infrastructure is given detailed attention by DECC and the National Infrastructure Commission.

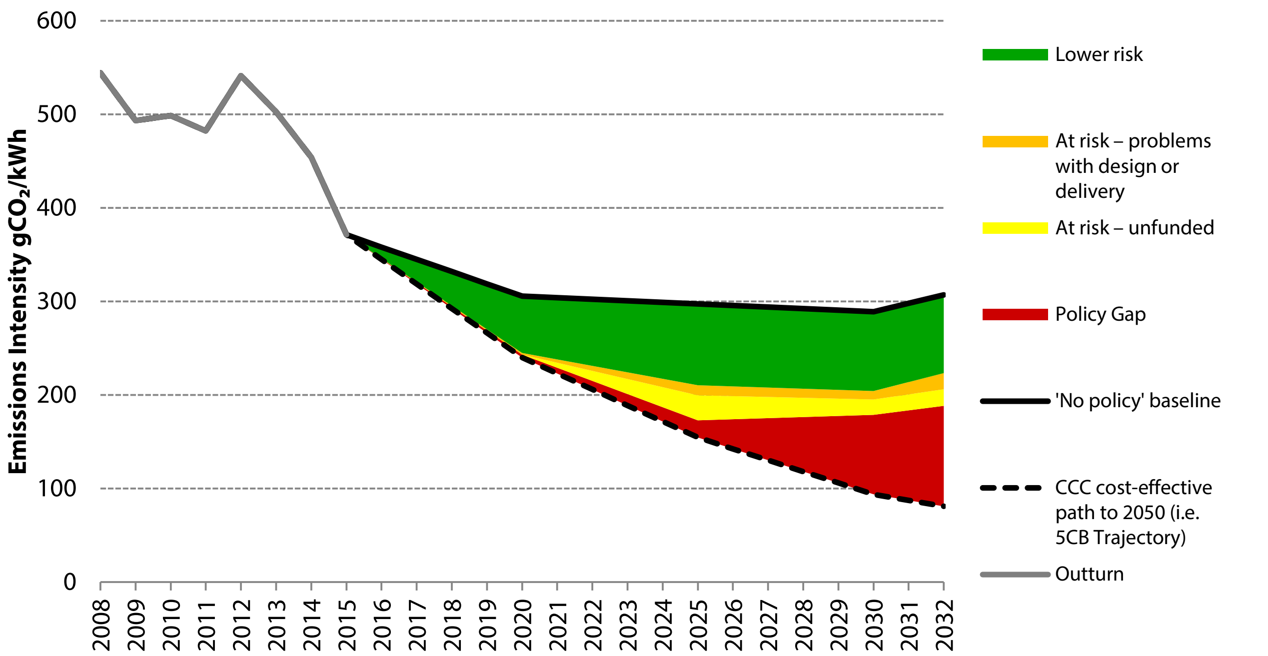
Whilst international CCS developments and ongoing research and development (RD&D) are important to cost reduction they cannot substitute for developments in infrastructure and learning that are UK specific. Therefore there is a need for action on three main fronts: Funding for near-term CCS projects, an approach to risk allocation for $CO_2$ storage sites, and strategy and regulation to allow industry to invest in a future CCS T&S infrastructure.

**Source:** Gross (2016) *CCS in the UK: A New Strategy*. Available at: www.theccc.org.uk.

## 3. Forward look and policy gap

In our annual Progress Reports to Parliament we assess the likelihood that current and planned policies might fail to deliver the necessary reductions in emissions in our scenarios. We assess policies that are adequately funded and are based on proven delivery mechanisms as "low risk"; we assess policies that are unfunded (or inadequately funded) or are based on unproven delivery mechanisms as "at risk". We then assess the "policy gap", where the set of current and planned policies are not sufficient to meet the cost-effective path through the recommended fifth carbon budget (to 2032).

**Figure A2.4.** Assessment of current and planned policies: power sector




**Source:** CCC analysis. Based on DECC (2015) *Updated Emissions Projections*.
**Notes:** Policies to reduce electricity demand (e.g. Products Policy, Building Regulations), are covered in the relevant sectoral chapters (Chapter 3 - Buildings and Chapter 4 - Industry). We have updated our analysis since last year to reflect actual 2015 grid intensity, and the capacity mix changes in the latest DECC 'no policy' baseline. Emissions in the baseline increase beyond 2030 due to nuclear plant retiring from the electricity system.

| **Table A2.4.** Assessment of current and planned policies | |
|---|---|
| **Policy** | **Comment** |
| **Lower Risk Policies** | |
| **Renewables Obligation, FiTs, FIDER and CfDs to 2020.** | Renewable deployment up to 2021 is considered lower risk, as contracts for difference have been signed for 28 TWh of generation to come online by 2021, and 11 TWh of projects under construction are expected to commission under the Renewables Obligation grace periods. |
| **Coal-to-gas switch** | In November 2015 the Government announced that the UK would phase out coal-fired capacity by 2025, conditional on new build gas capacity being deployed to replace it. While no policy has yet been enacted to ensure no coal plant operate beyond this date, we consider phasing out of coal to be lower risk, particularly given the impacts of existing policy, such as the Carbon Price Floor, and the Large Combustion Plant Directive (LCPD) and Industrial Emissions Directive (requiring fitting of costly nitrous and sulphur oxide filtering equipment). |
| **Policies with design/delivery problems** | |
| **Support for offshore wind until cost-competitive in the mid-2020s** | The newly announced Pot 2 CfD auctions for deployment post-2020 could deliver 3-6 GW of offshore wind by 2026, in line with the lower end of our indicators (5-10 GW); however, auction dates and precise rules have not yet been set and there is a risk that offshore wind could be crowded out by other eligible technologies or fail to deliver the stretching cost reductions that have been set. We have therefore assessed this deployment as "at risk". |
| **Unfunded policies** | |
| **Nuclear – first 2 reactors at Hinkley** | Further delays to the Final Investment Decision for Hinkley Point C sustain uncertainty over success of the new build nuclear programme. State aid approval has been granted, the agreed strike price appears appropriate, contract terms have been agreed, however contract is not signed and funding has not yet been allocated. |
| **Missing policies** | |
| **Power sector deployment beyond 2020** | Moving the power sector from 200-250 $gCO_2/kWh$ in 2020 to 100 $gCO_2/kWh$ by 2030. No new CfD auctions have been announced or funding allocated for Pot 1 (onshore wind, large-scale solar PV) technologies, while funding for Pot 2 is not enough to compensate for a lack of deployment from other technologies. There is therefore a 'policy gap' for these opportunities. |
| **CCS** | Following cancellation of the CCS Commercialisation Programme, there is now no policy to develop CCS in the UK. |

## 4. Indicator Table

We track progress in the power sector against our detailed indicator framework, which we set out in our first Progress Report in 2009 and revised in our 2014 Progress Report. Our power sector indicators cover the overall policy framework, deployment of low-carbon capacity (renewables, nuclear and carbon capture and storage) and the infrastructure required to support a low-carbon power sector (e.g. interconnection). We will be updating these indicators in our 2017 Progress Report, including a new focus on electricity system flexibility.

**Table A2.5.** Power Sector Indicator Table

| **Power** | | **Budget 2** | **Budget 3** | | **Budget 4** | | **2015 Outturn** |
|---|---|---|---|---|---|---|---|
| **Headline Indicators** | | | | | | | |
| | | | *50g trajectory* | *100g trajectory* | *50g trajectory* | *100g trajectory* | |
| Emissions Intensity ($gCO_2/kWh$) | | 328 | 151 | 174 | 53 | 100 | 370 |
| Total emissions (% change from 2007 in final year of budget period) | | -57% | -78% | -75% | -91% | -80% | -43% |
| Achievable Emissions Intensity ($gCO_2/kWh$) | | 205 | 103 | 122 | 53 | 100 | 244 |
| Generation (TWh) | Wind | 43 | 83 | 82 | 116 | 116 | 40 |
| | Nuclear | 58 | 57 | 57 | 140 | 118 | 64 |
| | CCS | 0 | 13 | 5 | 33 | 5 | 0 |

| Supporting Indicators | | | | |
|---|---|---|---|---|
| **Transmission** | | | | |
| Grid reinforcement planning approval | Estimated connection dates for several 'Stage 1' transmission assets have been delayed until the 2020s, pending a review of the needs case for these assets. | | | Central Wales still a concern. Other assets (except Scotland Stage 1) delayed due to reassessment of needs case. |
| Grid reinforcement construction begins | | 2018: Scotland Stage 2<br>2019: Wales Stage 1 (North)<br>2019: South West | 2020s: English East Coast Stage 1; South East | Scotland Stage 1 in construction, delayed by 1 year. Wales stage 1 on track for 2019 |
| Grid reinforcements operational | 2017: Scotland Stage 1 | 2019: Wales Stage 1 (Central).<br>2021-27: Wales Stage 1 (North).<br>2022: South West | 2022-31: South East<br>2023: Scotland Stage 2.<br>2025+: English East Coast Stage 1 | N/a for 2015 |
| Agreement on long-term charging regime | Project TransmiT confirmed and adopted in 2016. | | | Project TransmiT implemented in 2016. |
| Tendering for first offshore connections under enduring OFTO regime | 2014 | | | Continuing to tender under a combination of both the transitional and enduring regimes. Tender Round 3, under the enduring regime, began in February 2014. |
| Construction of first offshore connections under enduring OFTO regime begins | 2015 | | | Westermost Rough, one of two assets in Tender Round 3, is now operational. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| First offshore connections under enduring OFTO regime operational | | 2016 | | | | | Connections have been built successfully under transitional regime, and Westermost Rough, one of two assets in Tender Round 3 (the first for the enduring regime), is now operational. |
| **Market** | | | | | | | |
| Next steps on EMR & long-term vision for energy sector | | 2014: First CfDs and Capacity Market auctions<br>2015: Ensure power sector can invest on a ten year lead time. Confirm LCF funding post-2020. Launch cost reduction strategies for CCS and offshore wind. | | | | | Auctions announced for 'Pot 2' technologies (incl. offshore wind) beyond 2020. Subsidy-free route to market needed for less mature renewables. |
| **Wind** | | | | | | | |
| | | | *50g trajectory* | *100g trajectory* | *50g trajectory* | *100g trajectory* | |
| Generation (TWh) | Onshore | 24 | 35 | 30 | 49 | 30 | 23.0 |
| | Offshore | 21 | 54 | 45 | 104 | 67 | 17.4 |
| | | | *50g trajectory* | *100g trajectory* | *50g trajectory* | *100g trajectory* | |
| Total capacity (GW) | Onshore | 10.1 | 15.4 | 13.0 | 21.4 | 13.0 | 9.1 |
| | Offshore | 6.3 | 16.7 | 13.8 | 32.2 | 20.8 | 5.1 |
| Capacity entering | Onshore | 0.9 | 1.2 | 0.0 | 1.2 | 0.0 | 1.8 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| construction | Offshore | 0.8 | 3.4 | 1.4 | 2.9 | 1.4 | 0 |
| Capacity entering planning (GW) | Onshore | New planning applications will be required from the end of the second budget period at the latest to maintain flow into construction | | | | | 2.5 |
| | Offshore | New planning applications will be expected in line with site leasing | | | | | 3.0 |
| Average planning period (months) | | <12 | <12 | | <12 | | >20 |
| Cost reduction and commercialisation strategy for offshore wind. | | In place | Monitor cost reductions in line with objectives identified in commercialisation strategy | | | | Auctions and funding for Pot 2 technologies in the 2020s, alongside a cost reduction objective announced for offshore wind. |
| **Nuclear** | | | | | | | |
| Generic Design Assessment | | Westinghouse's AP1000 (NuGen) resumes GDA. | Horizon's UK-ABWR approved in 2018. | | | | GDAs underway for both NuGen's and Horizon's reactors. |
| Agreement on long-term plan for waste disposal facility | | National geological screening | Talking to communities, providing information and investment; designing and planning for a facility | | Site investigation and investment, aiming for construction in 2030s | | Government White Paper in 2014 restarted voluntary approach to communities hosting a waste disposal facility. |
| Entering planning | | Subsequent applications at approximately 2 year intervals | | | | | N/A for 2015 |

| | | | | |
|---|---|---|---|---|
| Planning approval; site development and preliminary works begin | State Aid approval from the European Commission for Hinkley Point C in 2014. Subsequent planning application approvals, site development and preliminary works at ~12 month intervals | | | State aid approved 2014. However, project subject to severe delays. |
| Construction begins | | First plant in 2017, subsequent plants at approximately 12 month intervals | | N/A for 2015 |
| Plant begins operation | | | First plant in 2023, with subsequent plants at approximately 12 month intervals. Site potential for 16GW by 2030 | N/A for 2015 |
| **CCS** | | | | |
| Launch Commercialisation Program | | | | No progress, given cancellation of Commercialisation Programme |
| Front-End Engineering and Design (FEED) studies for competition contenders initiated | FEED studies start in 2014 | | | FEED studies begun in 2014 |
| FEED studies for competition contenders completed | FEED studies complete in 2015 | | | FEED studies expected to be complete, but as yet unpublished |

| | | | | |
|---|---|---|---|---|
| Final Investment Decision for Demonstration projects | For both preferred bidders by the end of 2015 | | | No progress, given cancellation of Commercialisation Programme |
| Quantification of saline aquifer $CO_2$ storage potential | No later than 2015 | | | Storage potential estimated in 2013, under the UK Storage Appraisal Project, managed by the British Geological Survey, Energy Technologies Institute and Crown Estate |
| Review of technology (including cost reduction and commercialisation strategy), strategic plan for infrastructure development and decision on framework for future support. | No later than 2016* | | | No progress, given cancellation of Commercialisation Programme |
| Planning and authorisation approval, land acquisition, and storage site testing completed, construction commences | 2015-2016 for first demonstrations | | | As above |
| Demonstrations operational | | First plant in 2018, subsequent plant in 2019 | | As above |
| First new full CCS plants supported via the post-demonstration mechanism | | First plant operational | | As above |

| | | | | |
|---|---|---|---|---|
| **Grid Requirements for Decarbonisation** | | | | |
| Interconnection | Interconnection Regime in place by 2016. Phase 1 assets (pre-2020) entering construction. Phase 2 assets (pre-2030) entering development and planning | Potential for more than 7 GW by 2020 | Additional 10 GW by 2030. | Ofgem approved projects for more than 7 GW of additional interconnection to come online by early 2020s. Government set ambition for an additional 1.7 GW. |
| Smart Meter Deployment (Electricity) | On track to Government's trajectory of 17m installed by 2017 | Full rollout (28m) complete by 2020 | | Full rollout to begin in Autumn 2016. |
| **Other Drivers** | | | | |
| Total demand (TWh), coal and gas prices, nuclear outages | | | | |
| Average wind load factors, availability of offshore installation vessels, access to turbines | | | | |
| Technology costs | | | | |
| Nuclear supply chain, availability of skilled staff | | | | |
| International progress on CCS demonstration and deployment | | | | |
| Uptake of solar power, and developments in seasonal storage. | | | | |
| Planning approval rates and frequency of public inquiries to decisions of Infrastructure Planning Commission | | | | |
| Participation of demand response and demand reduction in Capacity Market auctions and in the wider electricity market. | | | | |

**Source:** CCC estimates.
**Notes:** * The Energy Act 2010 requires a rolling review of CCS progress, to report on the appropriate regulatory and financial framework by 2018.
The 50g and 100g trajectories reflect uncertainty around which low-carbon technologies will be cost-effective in a future generation mix: the lower end of the range indicates no, or limited, further deployment beyond 2020 (e.g. due to cost, political and public acceptability considerations), the upper end of the range indicates continued deployment due to favourable costs compared with other technologies.