
Executive Summary

This is our sixth annual report to Parliament on progress reducing emissions.

Under the Climate Change Act (section 36), the Committee's progress reports are required to set out:

(a) the progress that has been made towards meeting the carbon budgets... and... the target for 2050

(b) the further progress that is needed to meet those budgets and that target, and

(c) whether those budgets and that target are likely to be met.

This report is published two years after the end of the first budget period (2008-12). It is therefore also required to address an additional provision in the Act to set out the Committee's general views on:

(a) the way in which the budget for the period was or was not met, and

(b) action taken during the period to reduce net UK emissions of targeted greenhouse gases.

Whether the first carbon budget was met/action taken during the period

The first carbon budget (2008-12) was met through a combination of the impact of the recession and low-carbon policies.

The net carbon account was 2,982 MtCO₂e compared to the legislated budget of 3,018 MtCO₂e. Emissions in 2013 were 12% lower than 2007 and 28% below their 1990 level.

There was good progress implementing some policies, in particular to support improved fuel efficiency of new cars and investment in wind generation. There was also good progress developing new policies, most notably Electricity Market Reform. However, there was limited progress in other areas including energy efficiency improvement in the commercial and industrial sectors, uptake of electric vehicles and heat pumps, and demonstration of carbon capture and storage.

More generally, the underlying pace of emissions reduction – allowing for the impacts of the recession – through the first carbon budget period and in 2013 was insufficient to meet future carbon budgets.

Further progress needed/whether future budgets are likely to be met

The legislated fourth carbon budget (2023-27) commits the UK to reduce emissions by 31% from 2013 to 2025 (50% from 1990).

Our recent *Fourth Carbon Budget Review* assessed the cost-effective path to meeting the UK's statutory 2050 emissions target (i.e. to reduce emissions by at least 80% on 1990 levels) and showed the clear economic benefit of cutting emissions as required to meet the budget. This offers significant cost savings relative to delaying action (over £100 billion under central assumptions for fossil fuel and carbon prices), and will build a resilient energy system that is less reliant on imported fossil fuels. Its potential impacts on energy affordability and competitiveness are important, but manageable with appropriate policies in place.

The fourth carbon budget is consistent with the target proposed recently by the European Commission (EC) to cut EU emissions by 40% in 2030 on 1990 levels. More generally, there is action internationally across all major emitters, and the UK is far from acting alone in cutting emissions.

Current policies have been designed to deliver emissions reductions to 2020, so it would not necessarily be expected that they would deliver the emissions cuts required in the 2020s. This is confirmed by the analysis in the report, which projects emissions in 2025 up to 60 MtCO₂e/year above the level of the fourth budget.

The cost of closing this gap is affordable, through a combination of changes on the demand and supply sides for electricity, transport and heat, based on low-carbon technologies that are currently available, supported by some behaviour change.

However, achieving this will require further strengthening of policies – including those for residential and commercial energy efficiency, electrification of heat and transport, and power sector decarbonisation. This policy strengthening will entail significant design improvements and increased ambition, extended further in time. There is also a need to extend funding in some cases, with opportunities for reduction in others.

- **Residential energy efficiency.** More low-cost insulation could and should be delivered by existing policies in the near term, supported by extended fiscal incentives. Beyond 2017, there is a fundamental choice about what the focus of policy should be and whether to continue with the current approach.
 - **Near-term ambition and incentives.** The focus of the redesigned Energy Company Obligation (ECO) on low-cost opportunities (i.e. loft and cavity wall insulation) is appropriate. However, the ambition for carbon reduction for this policy has been cut significantly and is low relative to underlying potential and funding; ambition should therefore be increased. Fiscal incentives should be maintained and developed in the light of take-up to 2017.
 - **Medium-term policy.** Beyond 2017, as low-cost potential is increasingly exhausted, there is an open question of whether ECO should focus on delivering more difficult options (e.g. solid wall insulation) across the housing stock or only for the fuel poor, or whether an alternative approach would better address fuel poverty. This should be considered in light of evidence on solid wall insulation costs, projected carbon prices, and whether an alternative and better delivery mechanism for addressing fuel poverty exists.

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- **Commercial sector energy efficiency.** Given limited progress to date, there is a need to strengthen incentives to improve commercial sector energy efficiency. At the same time there is scope to rationalise the number of policy instruments, leading to lower administrative costs as well as better delivery. A new approach should embody one instrument for each of information provision, financial incentives and regulation.
 - **Information.** It is essential that businesses and organisations have good information about their energy performance and scope to improve this; only one policy instrument is necessary here in place of the current complex landscape. For example, this could be based on a strengthening of current energy audits required under EU legislation.
 - **Financial incentives.** The carbon price signal should be consistent across firms and fuels. Therefore, the carbon price aspect of the Carbon Reduction Commitment should be abolished, and the Climate Change Levy increased, unless there is compelling evidence to suggest that this would undermine incentives.
 - **Regulation.** The Energy Act 2011 provides for the setting of minimum standards in the private rented sector from 2018, which can help to address the landlord-tenant split. This is particularly important in the commercial sector, where around 60% of space is rented and unexploited potential is likely to remain even if information is improved and financial incentives are strengthened. Given long refurbishment cycles, the Government should set the minimum standards for 2018 now, and a clear timetable for tightening these over time.
 - **Low-carbon heat.** Increasing uptake of low-carbon heat (i.e. renewable heat and district heating from low-carbon sources) is a priority. Despite the fact that the current instrument to incentivise this – the Renewable Heat Incentive (RHI) – is very generous, take-up to date has been low. The appropriate response is not to increase the subsidy. Rather it is to overcome financial and non-financial barriers to uptake. There may also be an opportunity to support action on fuel poverty by targeting RHI payments at the fuel poor, many of whom live in homes without access to the gas grid.
 - **Committing to the RHI.** While it is possible that alternative delivery mechanisms could be found in the future, the RHI is the only realistic support mechanism for investment in low-carbon heat for the foreseeable future. Given the need to increase low-carbon heat uptake, funding for the RHI should be committed to 2020, and a commitment should be made to its continued existence beyond 2020. This would resolve current uncertainty, where funding has been committed only until 2016, and the policy is due to end in 2020.

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- **Limiting RHI funding costs: addressing financial barriers.** The RHI is a subsidy paid quarterly to consumers and businesses, based on the additional upfront cost of low-carbon heat installations, along with their operational costs or savings, compared to the conventional heating technology. In the case of the domestic scheme, the net upfront cost is annuitised across a 7-year period. The tariff is calculated so as to give an overall return of 16% to consumers and 12% to businesses. These very high returns partly reflect the cost of finance. Therefore, if the cost of finance could be reduced, the cost of funding the RHI could also be reduced. The annual funding cost in the mid-2020s could be further reduced by spreading payments over a longer time period. Extending the Green Deal to pay for investment in low-carbon heat offers the opportunity to reduce financing costs and spread these over longer periods; it should be done as soon as possible in order to limit RHI funding costs.
 - **Limiting RHI funding costs: addressing non-financial barriers.** High returns paid under the RHI are also to offset non-financial barriers to uptake of low-carbon heat, including bias against new technologies and the hassle of changing heating technology. These could be reduced through improved information provision and confidence building. Further work on ways to reduce the costs of amenity loss (e.g. loss of space) would be useful.
 - **Targeting the RHI.** There is significant potential for cost-effective investment in low-carbon heat in homes of the fuel poor, many of which are not connected to the gas grid. Given dual policy objectives to reduce emissions and alleviate fuel poverty, consideration should be given to targeting part of the RHI funding to the fuel poor. Additional incentives over and above providing access to low-cost finance are likely to be required in order to drive uptake.
 - **Transport – Electric vehicles.** While there has been good progress improving fuel efficiency of conventional vehicles, progress on the uptake of electric vehicles (EVs, including both plug-in hybrids and pure battery electric vehicles) has been much more limited; they are therefore the focus of our recommendations. Early development of the EV market has begun (e.g. a range of models is available; funding has been committed for purchase subsidy, charging infrastructure and city schemes; some charging infrastructure has been deployed). To build on this, further action is required by the Government and industry to address financial and non-financial barriers to uptake. This action could be driven effectively by a strong EU target for new car emissions in 2030, which should be supported strongly by the Government. With progress addressing financial and non-financial barriers, purchase subsidy for electric vehicles could then be phased out.
 - **A strong EU 2030 target for new car emissions.** This should be designed to reflect significant penetration of EVs, so as to strengthen incentives for manufacturers to address financial and non-financial barriers, thereby minimising the costs of meeting the target.
 - **Addressing financial barriers: new financing approaches.** The Government should work with industry to explore new, low-cost approaches to financing electric vehicles, building on innovation to date (e.g. through battery leasing), including a possible role for the Green Investment Bank.

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- **Addressing non-financial barriers: investment in infrastructure.** Further investment in electric vehicle charging infrastructure within currently agreed funding to 2020 will help address non-financial barriers to uptake. Specifically, access to charging points is needed for people without off-street parking and, whilst slow home charging should meet the bulk of charging needs, a national rapid charging network is needed to alleviate range concerns for longer journeys.
 - **Addressing non-financial barriers: marketing EVs.** A key barrier is technology bias (i.e. a consumer preference for tried and tested conventional vehicles). This can be overcome – for example, this bias tends to disappear as people have experience of EVs. Car manufacturers are best placed to overcome this through their marketing, and would be incentivised to do so under a strong EU target. This could be usefully supplemented by time-limited use of softer measures for early adopters, which can often be made available by Local Authorities (e.g. access to bus lanes, preferential parking).
 - **Phasing out subsidy.** Together with ongoing battery cost reduction, these measures could allow the phasing out of existing capital subsidy. The Government should recognise this and consider how to phase out EV subsidy and whether there is any benefit in announcing this in advance (e.g. in stimulating manufacturers to develop financing packages).
 - **Power sector.** Good progress has been made on Electricity Market Reform (EMR). However, there is a high degree of uncertainty about investment in low-carbon capacity to come onto the system beyond 2020. This should be resolved as a matter of urgency through a package of measures including setting a power sector decarbonisation target for 2030, together with supporting funding, a commercialisation strategy for offshore wind and an approach to carbon capture and storage beyond the first demonstration projects.
 - **2030 decarbonisation target.** The Energy Act 2013 introduced long-term contracts for low-carbon power generation, which provide revenue stability for investors. However, there is currently no agreed objective beyond 2020 to guide the signing of contracts. Given the long lead-times for power investments, this should be resolved by setting a target range for carbon intensity in 2030, as legislated for in the Energy Act. Our previous analysis suggests a range of around 50-100 gCO₂/kWh would be consistent with the cost-effective path for a range of outcomes for fossil fuel prices, carbon prices and low-carbon technology costs.
 - **Offshore wind commercialisation.** Rates of deployment of offshore wind have been successfully increased, as required to meet the EU Renewable Energy Directive, and the Government has committed sufficient funding to continue deployment to 2020. To achieve the objective of commercialising this promising technology will require an ongoing programme beyond 2020. The Government should set out a strategy for that commercialisation that includes: a commitment to a critical mass of investment; a target cost-reduction schedule under which ambition will be maintained or increased; the point in time when the technology will be expected to compete with other low-carbon options without support; and any role for Government in driving cost reduction (e.g. investment in port infrastructure).

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- **Carbon capture and storage (CCS).** Progress with CCS is well behind the schedule we set out in our earlier reports. However, an effective approach is now in place for the first two demonstration plants, which should be progressed urgently. The Government should also set out the approach to projects to follow these demonstrations and to development of a CCS infrastructure. It should include an approach to industrial as well as power sector CCS and complement approaches in other countries.

Progress in reducing emissions in the devolved administrations has contributed to UK reductions, but it will need to increase to meet stretching targets at the devolved level. In this report, we pick out examples of innovative devolved policies that could be considered for the rest of the UK.

The full set of recommendations in the report is summarised in Box 1 and the key analysis and findings from the report are set out in 12 sections:

1. Recap of the fourth budget review: economic benefits and impacts from early action to cut emissions
2. Economy-wide emissions
3. Meeting the first carbon budget
4. The non-traded sector
5. The traded sector
6. Progress reducing emissions in the devolved administrations
7. Progress reducing emissions in buildings
8. Progress reducing emissions in the power sector
9. Progress reducing surface transport emissions
10. Progress reducing industry emissions
11. Progress reducing emissions from agriculture
12. Progress reducing waste and F-gas emissions

Box 1: Summary of recommendations in 2014 progress report

Cross-sectoral

- Continue to **push for a combination of EU ETS reform and ambitious emissions targets for 2020 and 2030** that will put the EU on the cost-effective path to meeting its target for at least an 80% emissions reduction by 2050 relative to 1990 and will deliver an EU ETS price that is sufficient to incentivise emissions reduction activities in the power sector. The regulatory regime should also allow for negative emissions (e.g. from use of bioenergy with CCS) to count towards required emissions reduction.
- By 2016, **publish a strategy to develop carbon capture and storage (CCS) in both power and industry**, including CO₂ infrastructure development, minimum levels of deployment over the period to 2030, and an approach to funding for projects beyond current policy (including higher levels of deployment dependent on cost reduction).
- On **biomass sustainability for transport, power and heat**: continue to push for Indirect Land Use Change (ILUC) impacts to be fully taken into account in EU biofuel sustainability criteria; in the 2016/17 review of UK bioenergy strategy, add to the UK's criteria for biomass sustainability a requirement that all biomass is sourced from forests that can demonstrate constant or increasing carbon stocks, and push for this to be reflected in standards at the EU level.

Buildings

- **Strengthen the near-term framework for energy efficiency improvement in residential buildings**: increase ambition on insulating lofts and cavity walls while finalising the Energy Company Obligation (ECO); maintain fiscal incentives to 2017; by the end of 2014, publish proposals for minimum energy performance standards for the private-rented sector.
- **Build on the existing approach to incentivising low-carbon heat in residential buildings**: commit funding for the Renewable Heat Incentive to 2020 and commit to extending this approach beyond 2020 unless and until an alternative mechanism is in place; extend the Green Deal to cover the upfront cost of low-carbon heat technologies funded under the RHI and consider using Government guarantees to lower the financing cost; develop measures to improve consumer confidence in renewable heat.
- **Consider future options for the focus of the ECO** (i.e. whether this should be on delivering more difficult energy efficiency improvements for the fuel poor or across all households). This consideration should reflect evidence on costs of solid wall insulation, costs of alternative options for reducing emissions and whether an alternative delivery mechanism could better tackle fuel poverty.
- **Develop additional measures to tackle fuel poverty** in England to supplement the Affordable Warmth element of the ECO, possibly including targeting of the RHI.
- **Ensure that the Zero Carbon Homes standard requires investment in low-carbon heat** unless heating requirements are very low, and only grant exemptions where a clear economic rationale for these has been demonstrated.
- **In the commercial sector: simplify and rationalise existing policies for energy efficiency improvement**, with a view to strengthened incentives and decisions by the end of 2016, and publish proposals for minimum energy performance standards for the private-rented sector.
- By the end of 2014, **set carbon targets for central government** beyond 2015.

Power

- **Complete implementation of Electricity Market Reform (EMR)**: set appropriate strike prices and sign contracts for low-carbon capacity; ensure a suitable mix of low-carbon technologies is supported; ensure final market design recognises the value of demand-side measures, interconnection, storage and flexibility in generation; require that all biomass is sustainably sourced.
- In 2016, **set a carbon intensity target range for 2030** under the Energy Act 2013, consistent with cost-effective decarbonisation of the economy (e.g. 50-100 g/kWh).
- No later than 2016, **commit funding for low-carbon generation in the period beyond 2020**.
- By 2016, **publish a commercialisation strategy for offshore wind** that includes levels of ambition to 2030, cost reductions required to sustain that ambition and the Government's role in supporting those reductions.

Box 1: Summary of recommendations in 2014 progress report

Transport

- **Push for stretching EU targets for emissions of new cars and vans for 2030** in the context of negotiations around the overall 2030 EU emissions reduction package; these should take account of the scope for improving efficiency of conventional vehicles and the need to achieve greater take-up of electric vehicles (EVs) and other ultra-low emissions vehicles (ULEVs).
- Work with partner organisations (e.g. industry, local authorities, the Green Investment Bank) to **tackle financial and non-financial barriers to electric vehicle uptake** by providing: new, low-cost approaches to financing; on-street residential charge points and a national network of rapid charge points; softer time-limited measures such as access to bus lanes and parking spaces.
- With agreement of a strong EU target and/or financial and non-financial barriers being tackled there would be scope to phase out the existing capital subsidy for electric vehicles. The Government should **consider how to phase out EV subsidy and whether there is any benefit in announcing this in advance** (e.g. in stimulating manufacturers to develop financing packages).
- Over time, **adjust fiscal levers** (i.e. Vehicle Excise Duty, Company Car Tax and Enhanced Capital Allowances) to align to new vehicle CO₂ targets and provide additional incentives for ULEVs.
- Push for a swift conclusion to current EU work on **standards for HGVs** and press for new vehicle standards as soon as practical (e.g. soon after 2015).
- Ensure **demand-side opportunities** are realised: continue progress reducing car travel once the current Local Sustainable Travel Fund ends in 2015; encourage adoption of complementary technologies to support eco-driving, including pushing for fuel consumption meters to be reconsidered in future EU negotiations; monitor existing voluntary action in the freight sector aimed at improving fuel consumption and consider stronger levers as required, including ways to address barriers for smaller operators.
- **Fully evaluate the carbon implications of use of natural gas in vehicles** before any nationwide roll-out of gas infrastructure and support.
- When considering future **airport expansion**, plan on the basis of 2050 emissions at around 2005 levels, implying an increase in demand – provided aircraft efficiency continues to improve significantly – of around 60% on 2005 levels by 2050.

Industry

- Use the **“2050 decarbonisation roadmaps”**, planned for spring 2015, to identify and set out the opportunities for reducing emissions in industry, then by 2017 publish a strategy for delivering abatement in the 2020s, including milestones to monitor progress against.
- By the end of 2016, **set an approach to deploying initial industrial CCS projects** compatible with widespread deployment from the second half of the 2020s, and joined up with the approach to CCS commercialisation in the power sector
- **Review policies for compensating at-risk industries for costs of low-carbon policies**, by the end of 2016
- Work with industry and the EU to **improve knowledge sharing within industry and R&D** into opportunities to reduce emissions at low cost
- Investigate options to **overcome barriers to capital investment**.

Box 1: Summary of recommendations in 2014 progress report

Agriculture and land use

- Ensure that the agriculture sector **monitors the effectiveness of the GHG Action Plan**, including 'SMART' objectives, quantifiable targets and evidence of buy-in from farmers, to allow effective evaluation in the Government's review in 2016.
- Recognise the high delivery risk under the GHG Action Plan, and as part of the 2016 review **consider stronger policy options** to ensure savings are delivered.
- **The GHG inventory should include emissions from upland peat as soon as possible**, existing regulation should be enforced and the policy framework strengthened to enable further peatland restoration effort.

Waste & F-gases

- **Publish specific strategies for reductions in the amounts of the main biodegradable waste sources sent to landfill** (specifically food, paper/card, and wood), and introduce stronger levers to ensure these are met unless there is clear evidence that these are not required,
- **Set out an approach to increase methane capture rates**, towards best practice, with milestones and actions to ensure these are met.
- **Ensure UK businesses comply with new EU F-gas regulation and seek opportunities to go further** where cost-effective alternatives exist; if these are found, push for stronger implementation at the EU level.

Actions for specific departments and national authorities

The recommendations set out above imply various lead responsibilities across Government, set out here, and the need for joined-up action in implementation.

- **DECC** is the key department in ensuring that actions are taken in power, buildings and industry sectors.
- **DCLG** has an important role to play ensuring that building regulations for new homes are strong, minimum energy efficiency standards for non-residential buildings are set, and transport emissions fully accounted for as part of the planning process.
- **DfT** is responsible for actions to reduce surface transport emissions and decisions on airport infrastructure.
- **BIS** has an important role in relation to industry, including compensation for carbon policy costs, has the lead on the Green Investment Bank and an interest across these recommendations, many of which will require a business response and support the low-carbon economy.
- **Defra** is responsible for actions to reduce agriculture and other non-CO₂ emissions, including our specific recommendations on waste and F gases.
- **HM Treasury** is responsible for ensuring that there is sufficient funding, for example, in the Levy Control Framework, the Renewable Heat Incentive, and to support electric vehicle market development; and to ensure that fiscal levers such as Vehicle Excise Duty and the tax regime for ultra-low-emission vehicles are designed to ensure carbon efficient choice and investments.
- **Devolved Administrations.** Devolved policy needs to complement and reinforce UK instruments across the range of sectors. Devolved levers are particularly important for supporting energy efficiency improvement including addressing fuel poverty, making planning decisions for renewable power generation and renewable heat, delivering programmes to reduce car travel and support electric vehicle uptake, and developing approaches to reduce emissions from agriculture, land use and waste.

1. Recap of the fourth budget review: economic benefits and impacts from early action to cut emissions

The fourth carbon budget commits the UK to cut emissions by 31% from 2013 to 2025 (50% on 1990 levels). It can be met through a combination of energy efficiency improvement in buildings and industry, fuel efficiency improvement in vehicles, investment in low-carbon technologies in the power sector, extension of low-carbon power through electrification of heat and surface transport, use of sustainable bioenergy, and reductions of non-CO₂ greenhouse gases.

It is important to note that action is required in all areas to meet carbon budgets. Therefore while there are some trade-offs, these are not about whether for example to decarbonise power or heat, or to focus on supply rather than demand.

Our review of the fourth carbon budget, published in November/December 2013, updated our assessment of the cost-effective path to meet the 2050 target to reduce emissions by at least 80% on 1990 levels. It compared costs associated with this path against an alternative approach where investment to cut emissions in the 2020s was delayed until the 2030s. It showed that delayed action entailed additional costs of over £100 billion in present value terms under central case assumptions on fossil fuel and carbon prices, rising to £200 billion with high fossil fuel or carbon prices. Even if fossil fuel or carbon prices turn out to be low, early action is less costly than delay.

This reflects the more general observation that in order to stay on track to the stretching 2050 target, ongoing progress is needed. Costs are likely to increase if progress stalls for a significant period of time, as high-carbon investments are made that later need to be scrapped and deployment rates for low-carbon technologies have to increase subsequently at an implausibly fast rate.

Committing to continuing action through the 2020s would also improve conditions for low-carbon investment in the UK, allowing UK firms to position themselves to compete and prosper in growing markets for low-carbon goods and services. There are also various broader benefits to cutting emissions, such as improved air quality from reduced burning of fossil fuels.

Cost savings from early action accrue over time and require up-front investments in order to be unlocked. These will, in turn, result in higher energy prices over the near-to-medium term. Our assessment is that the impacts of these higher prices on affordability, fuel poverty and competitiveness are manageable

- **Energy affordability.** Higher energy prices are likely to add around £100 to the average annual energy bill for a typical household in 2020 compared to now; there is scope to more than offset this for many households through energy efficiency improvements, although stronger policies are required to incentivise this. Beyond 2020, a rising carbon price consistent with the UK's 2050 target would add up to a further £50 to the typical household bill by 2030, with a further £20 required to support low-carbon investment.
- **Fuel poverty.** Investment in low-carbon power generation will increase energy prices and therefore fuel poverty. Offsetting this, energy efficiency improvements in homes will decrease energy use. The net impact on fuel poverty is likely to be broadly neutral, provided energy efficiency improvement is targeted effectively at fuel-poor homes. This will still leave a large number of households in fuel poverty, leaving a significant challenge for Government to address through: increasing funding under the fuel poverty part of the ECO or replacing this with another instrument; targeting funding under the Renewable Heat Incentive; income transfers/social tariffs.
- **Competitiveness impacts.** Higher costs associated with policies to reduce direct emissions from energy-intensive industries are being addressed to 2020 through the design of the EU ETS. Post-2020 risks need to be addressed as part of the broader EU 2030 package currently being discussed. Electricity-intensive industries subject to international competition are at risk of higher electricity prices. Schemes to address higher prices from the EU ETS, Carbon Price Floor (CPF) and renewables investments to 2020 are in place or being planned.

The remainder of this summary considers progress and challenges in meeting carbon budgets and unlocking the associated economic benefits.

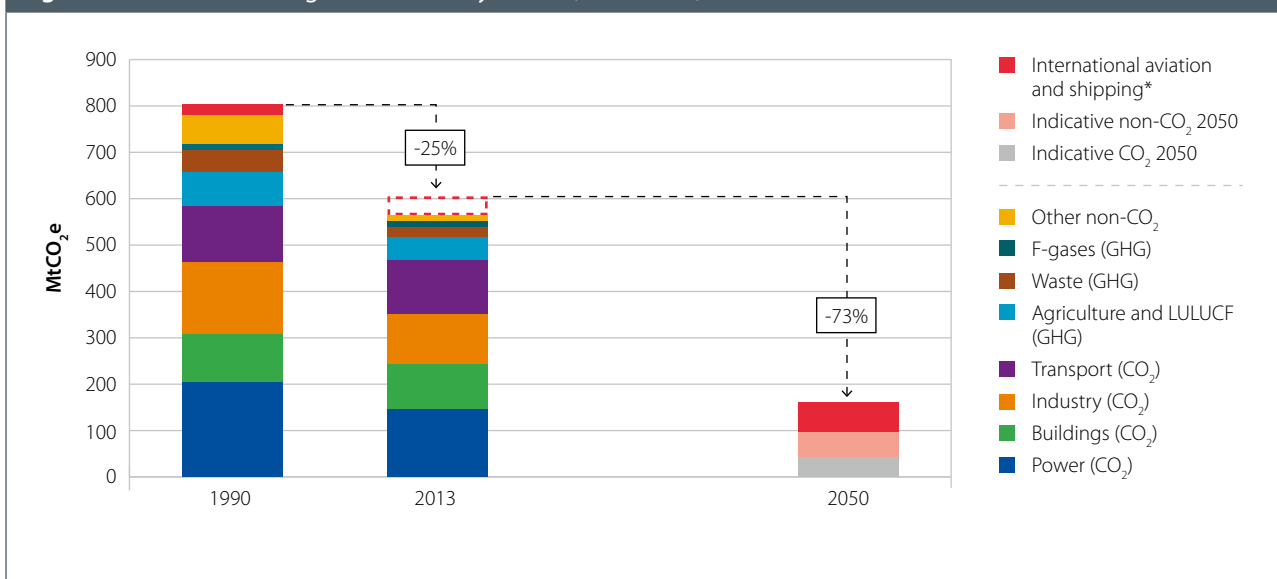
2. Economy-wide emissions

UK greenhouse gas emissions including international aviation and shipping were 605 MtCO₂e in 2013. Emissions in 2013 are now 25% below their 1990 level, and will need to fall a further 73% to meet the 2050 target (Figure 1).¹

Emissions are dominated by the energy sectors (i.e. electricity generation, heat in buildings, industry and transport) with some contributions from industrial processes and non-CO₂, including emissions from agriculture, waste and F-gases. There have been falls across these sectors since 1990 and 2007 and mixed results since 2012 (Table 1).

¹ Carbon budgets do not currently include emissions from international aviation and shipping, but these are included in the 2050 target (see section 9).

Figure 1: UK Greenhouse gas emissions by sector (1990-2050)



Source: NAEI (2014) *Final emissions estimates*; CCC analysis.

Notes: *Emissions from international aviation and shipping are not currently included in carbon budgets. This will be reviewed by Government in 2016.

Table 1: UK greenhouse gas emissions

Sectors	2013 emissions (MtCO ₂ e)	% change		
		2012-2013	2007-2013	1990-2013
Power (CO ₂)	145	-8%	-18%	-29%
Buildings (CO ₂)	98	+3%	0%	-6%
Industry (CO ₂)	108	+1%	-22%	-31%
Transport (CO ₂)	117	0%	-12%	-2%
Agriculture and LULUCF** (GHG)	49	-2%	-6%	-33%
Waste** (GHG)	21	-1%	-24%	-55%
F-gases**	15	-1%	+10%	+5%
Other non-CO ₂ (GHG)	12	-1%	-26%	-81%
Total CO₂	464	-2%	-15%	-21%
Total non-CO₂	100	-1%	-11%	-47%
Total GHGs	564	-2%	-14%	-28%
IAS* (2012 data)	41	-	-10%	+67%

Source: DECC (2014) UK Greenhouse gas emissions, provisional estimates; NAEI (2014) Final emissions estimates.

Notes: *Emissions from international aviation and shipping are not currently included in carbon budgets, the government will review this in 2016. **Detailed emissions data for non-CO₂ is not yet available for 2013; these figures assume the same % of total non-CO₂ emissions for agriculture and waste as in 2012. GHG stands for greenhouse gas emissions.

Emissions in 2013

Emissions decreased 2% in 2013, driven by falling emissions from the power sector as several coal plants closed permanently.

- CO₂ emissions decreased 2% due to falling power sector emissions, which were somewhat offset by increases in buildings and industry, whilst transport emissions remained broadly flat.
- Non-CO₂ emissions estimates for 2013 will not be available until next year; provisional emissions statistics assume that non-CO₂ emissions continued long-term trends and decreased 1% in 2013.

Overall, conditions dampened energy demand in 2013. There was a moderate increase in GDP, increases in residential and industrial energy prices but a reduction in road fuel prices, and slightly lower winter temperatures than 2012.

Because temperatures in the winter months of 2013 were only slightly lower than 2012, the weather had a much smaller impact on emissions than in recent years when there have been large temperature swings. Adjusting for this suggests the decrease in greenhouse gas emissions would have been around 2.5%, compared to the outturn of 2%.

Moreover, most of the reduction was due to a switch away from coal in the power sector. Although there is scope to reduce coal use further in future, meeting carbon budgets will also require deep reductions across the rest of the economy, for which emissions rose 0.5% in 2013.

Therefore the underlying reduction in 2013 was relatively small compared to the average annual reduction of 3% required to meet the fourth carbon budget, especially for a year with low GDP growth and increasing energy prices.

Emissions trends from 2007

Over the period 2007-2012 emissions decreased 12%.

- CO₂ emissions decreased 13%, with emissions falling across all sectors. This was mainly due to the very large effect of the economic crisis reducing energy demand, as well as improved CO₂ intensity of the car fleet and a structural shift to less carbon-intensive industry.
- Non-CO₂ emissions decreased 10%. This reflects falling waste emissions as less biodegradable waste has been sent to landfill and an assumed reduction in agriculture emissions as livestock numbers fell.

Without the impact of the economic crisis, and allowing for fluctuations in temperature – there was a particularly cold winter in 2010 – the underlying rate of emissions reduction was around 1% per year, less than the 3% rate required to meet the fourth carbon budget.

The UK imports a large amount of products and services, which have embedded carbon. From 1997 to 2004 these embedded emissions from imports increased by 23%, but they have since fallen 29% to 252 MtCO₂ in 2011. The UK's overall carbon footprint has decreased by almost 20% between 2007 and 2011. We acknowledged the need to reduce the UK's imported emissions in our 2013 carbon footprint report, setting out approaches to achieve this.

3. Meeting the first carbon budget

The Climate Change Act requires that this report includes an assessment of whether the first carbon budget was met. Emissions data from the UK Greenhouse Gas Inventory show that this was the case, and that the UK net carbon account was around 1% below the level of the budget. The net carbon account was 2,982 MtCO₂e, compared to the legislated budget of 3,018 MtCO₂e.

The budget was met due to some progress implementing policies to reduce emissions, together with the impact of the recession; these effects were partially offset by an upward revision to the UK's Greenhouse Gas Inventory:

- The first budget was designed to reflect a limited rate of progress implementing actions to reduce emissions, to allow for the lead-time developing and implementing new policies. Progress implementing policies was made, most notably on energy efficiency improvement in the residential sector (although this dropped off in 2013), for wind generation and for new cars. However, with these exceptions, progress was generally at or below the level assumed when designing the budget.
- The impact of the recession on energy demand and emissions was not fully anticipated in the design of the budget, since this was undertaken in 2008 before the scale and length of the recession was known. In particular, the 5% reduction in GDP in 2009, together with low growth rates through the remainder of the first budget period, significantly reduced emissions compared to expectations.
- The greenhouse gas inventory was revised in 2014, largely to reflect improved information for estimating emissions in the waste sector. The effect of the revision was to increase emissions through the budget period by around 1%.

The Climate Change Act allows for the possibility to carry forward the difference between emissions and the legislated budget to the second carbon budget. We advised the Government that there was no basis to do this and that to carry forward the surplus would undermine incentives for further development and implementation of required policies, ultimately increasing long-term costs and risks.

The Government accepted this advice and decided in May 2014 not to carry the small difference forward.

The remainder of this summary focuses on further progress that is required if future carbon budgets are to be met. In particular, it identifies a significant gap between emissions projections based on progress to date, including developing new policies, and the fourth carbon budget; and it identifies options to close this gap.

4. The Non-Traded Sector

Progress to date

The non-traded sector of the economy comprises emissions not covered by the EU Emissions Trading System (EU ETS). They arise from burning of fossil fuels (mostly natural gas and some oil) for heat in buildings, non-energy-intensive industry, use of fossil fuels in surface transport, and non-CO₂ emissions, and do not include emissions from electricity used in these sectors. Non-traded sector emissions accounted for 60% of total greenhouse gas emissions in 2013.

Non-traded sector emissions decreased 1% (5 MtCO₂e) in 2013, to 339 MtCO₂e. This follows a 9% (36 MtCO₂e) decrease over the period 2007-2012, from 380 MtCO₂e in 2007 to 344 MtCO₂e in 2012.

Across the period of the first carbon budget (2008-12), there was good progress in improving fuel efficiency of new cars and installing insulation in homes. However, there is limited evidence of progress at required rates in relation to: energy efficiency improvement in the commercial and industrial sectors; development of markets for low-carbon heating (i.e. heat pumps or district heating from low-carbon sources); improvement of fuel efficiency for HGVs; behaviour change in surface transport; and in improving the carbon efficiency of agriculture. Uptake of heat pumps and electric vehicles was low.

Evidence from 2013 shows continued progress improving fuel efficiency of new vehicles, but the good progress in the residential sector did not continue, as the new Energy Company Obligation was introduced (see section 7 below). Progress was limited in other areas.

Consistency of current policies with future carbon budgets

The Climate Change Act requires that we assess whether future carbon budgets and targets are likely to be met based on progress made.

We make this assessment against a set of indicators, first laid out in our 2009 report to Parliament, for uptake of low-carbon technologies and behaviours, and development of policies to drive future uptake. In this report we assign a 'traffic light' rating to these indicators based on progress since the start of the first carbon budget (Table 2).

We conclude that if there were no further progress, then we would expect a significant shortfall in emissions reduction compared to the fourth carbon budget (Figures 2 and 3).

- We have assessed what emission reductions would follow from existing policies without significant risks to delivery. We estimate that these would result in roughly a continuation of the current rate of underlying emissions reduction and a level of emissions up to 60 MtCO₂e/year above the fourth carbon budget (i.e. 42% rather than 50% below 1990 emissions in 2025).
- Even if the Government’s ambition for these existing policies could be fully delivered, this would still result in emissions around 45 MtCO₂e/year above the fourth carbon budget (i.e. 44% rather than 50% below 1990 emissions in 2025).

This highlights that much more is needed if future carbon budgets are to be met. Sections 7-12 of this summary set out the policy ambition and policy strengthening required.

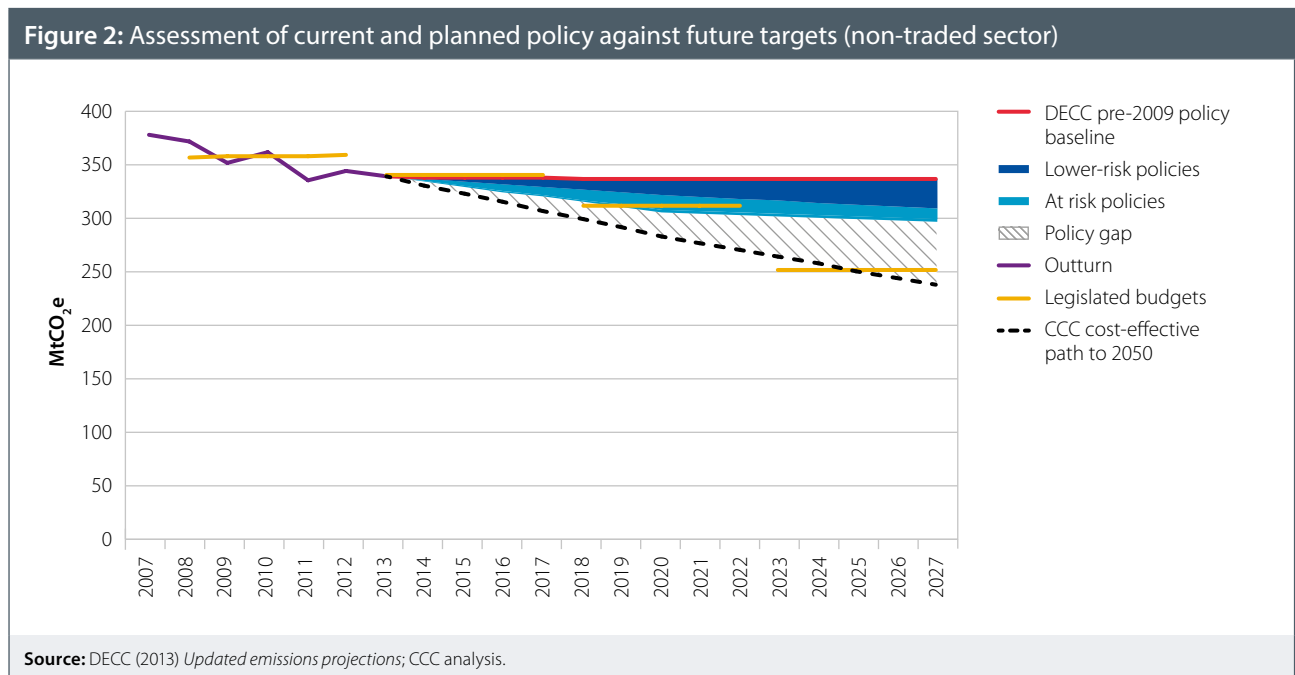










Table 2: Non-traded sector traffic light assessment		
Indicator for progress to date	Traffic light evaluation of progress	Comments
Buildings		
Implementation		
Uptake of loft insulation		Progress good until 2012 but very low in 2013 following change in policy framework. Cumulative loft insulation levels in 2013 were 650,000 below our indicator (6.3 million).
Uptake of cavity wall insulation		Progress good until 2012 but very low in 2013 following change in policy framework. Cavity wall insulation levels at 2.9 million are 45% below our cumulative indicator for 2013 (5 million).
Uptake of solid wall insulation		Very low uptake numbers (170,000 cumulatively by the end of 2013, compared to 500,000 in our indicator). Some success during 2012 (final year of Community Energy Saving Programme) but uptake numbers have fallen under Energy Company Obligation (ECO). Latest evidence suggests available cost-effective potential may be lower than expected.
Uptake of boilers		High uptake of new efficient boilers, with cumulative uptake by 2013 1.8 million higher than our indicator (5.9 million).
Buildings, penetration of low-carbon heat (%)		Progress in buildings is off-track, with 0.3% of heat coming from low-carbon sources in 2012 compared to 0.6% in our indicator trajectory.
Uptake of energy efficient appliances		Stock penetration for the most efficient appliances is low (e.g. wet appliances A+ or better are 9% of the stock versus 16% in the indicator). However, overall efficiency of the appliances on the market has improved significantly.
Policy		
New energy efficiency financing mechanism		Green Deal introduced in 2013 but very low uptake. Scope for currently unattractive interest rates to fall in future as Green Deal lending is scaled up.
Domestic and Non-domestic Renewable Heat Incentive (RHI) schemes in operation		Delays to Domestic RHI launch, but some progress made in setting standards and improving evidence base. Non-domestic scheme up and running since 2011, but low uptake apart from biomass.

Table 2: Non-traded sector traffic light assessment











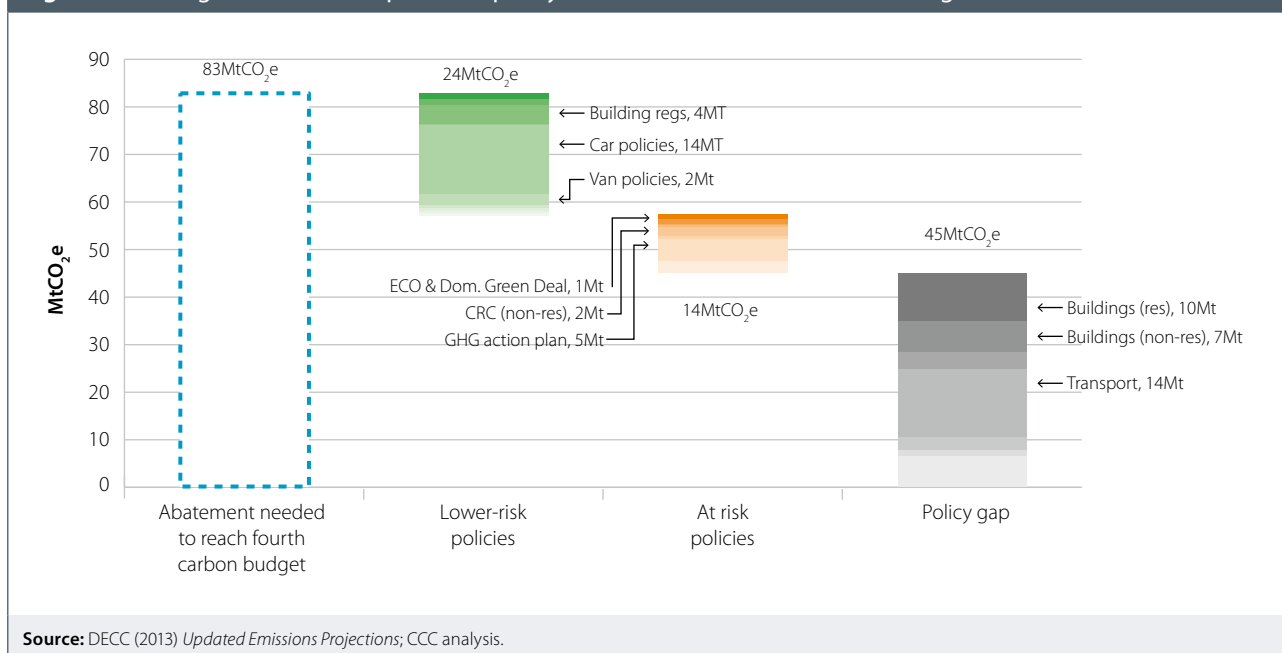
Indicator for progress to date	Traffic light evaluation of progress	Comments
Industry (non-traded)		
Implementation		
Industry penetration of low-carbon heat	 Green	1.25% uptake compared to 1% in indicator.
Policy		
Publish industry strategy including milestones, incentives and mechanisms for meeting carbon budgets	 Red	No strategy to meet carbon budgets has been published, but 2050 Roadmaps underway.
Transport		
Implementation		
New car CO ₂	 Green	Outperforming trajectory. Evidence of a growing gap between real-world and test-cycle emissions suggest real-world improvements were smaller; however likely still to have met trajectory.
Electric vehicle sales	 Red	Uptake well below trajectory, although market developments (e.g. availability of a range of models) have been positive and in hindsight uptake in the proposed trajectory was too high.
Policy		
Biofuel policy	 Amber	Biofuel penetration in line with our trajectory for first few years, falling short in past two years but improvements in sustainability.
Smarter Choices policy	 Amber	Local Sustainable Transport Fund is funding a number of projects across England but evaluation framework is not comprehensive.
Waste and F-gases		
Implementation		
Biodegradable waste sent to landfill	 Green	47% fall compared to 30% in trajectory.
Percentage of methane captured at landfill sites	 Amber	Indicator suggested maintain at 75%, but a re-estimation suggests that the rate was 59% in 2012, although rising from 54% in 2007.
Policy		
Develop comprehensive waste policy	 Amber	National Waste Prevention Programme published December 2013 but slow progress developing effective policy across waste streams.
Update to the EC's F-gas regulation to make it fit for purpose by end 2013	 Amber	New EU F-gas regulation published in April 2014 and to come into force in 2015; Government still to transpose within UK legislation.

Figure 3: Getting from the DECC pre-2009 policy baseline to the fourth carbon budget in 2025



5. The Traded Sector

The traded sector of the economy comprises those industries covered by the EU ETS, i.e. power generation and energy-intensive industries; it accounts for around 40% of economy-wide emissions.






Under the current accounting rules of the Climate Change Act, the traded sector part of the carbon budget is defined in terms of net rather than gross emissions. In other words, gross emissions are adjusted for any purchase or sale of carbon allowances by UK firms and for banking of allowances for future periods.

However, while the purchase of allowances may result in the budget being met, it is important also to focus on actual (gross) emissions, given the need to reduce these in the context of meeting longer-term carbon targets.

Gross emissions from sources currently included in the traded sector fell 3% from 2012 to 2013, leaving emissions 19% below 2007 levels. This reflects similar contributions from the power sector, where emissions fell 18% from 2007 to 2013, and from energy-intensive industry, for which emissions fell 19%.

The reduction in emissions since 2007 largely reflects the impact of the recession, during which there were significant reductions in output from energy-intensive industries and in electricity demand.

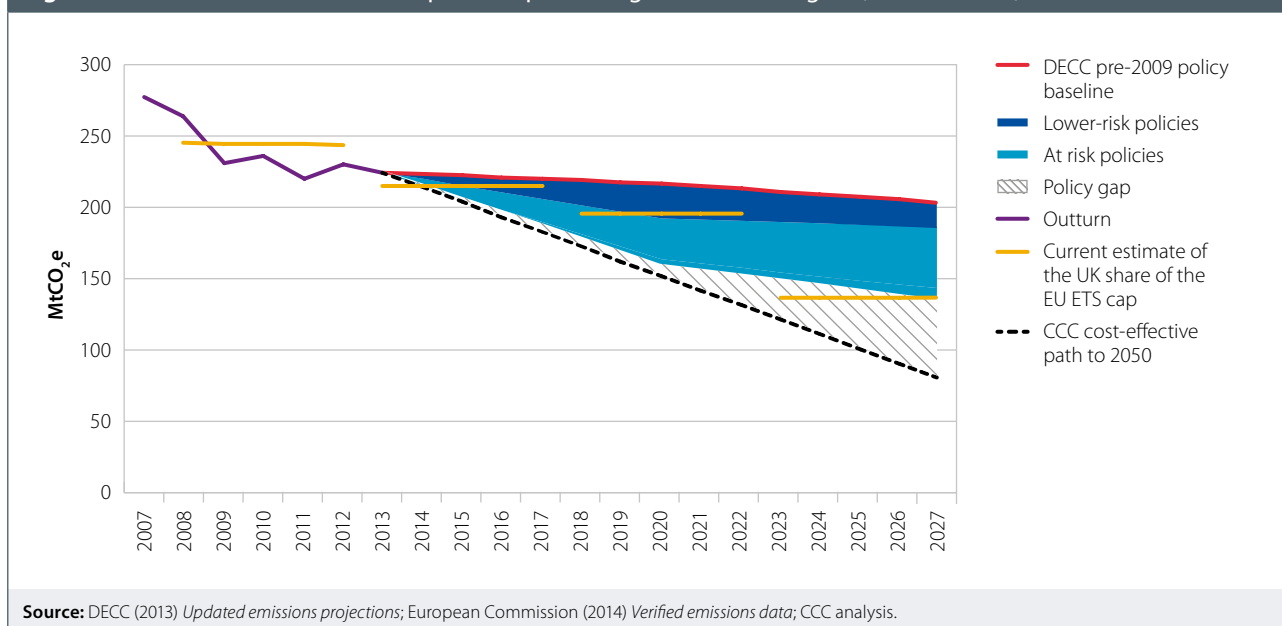
There has also been some progress in decarbonising electricity supply, both in deploying new low-carbon generating capacity and developing the policy framework, albeit with some areas showing very poor progress (Table 3).

Table 3: Traded sector traffic light assessment		
Indicator	Traffic Light	Comments
Power sector		
Implementation		
Onshore and offshore wind		Capacity in line with indicator and a strong pipeline of projects to 2020. However, longer-term uncertainty could undermine the flow of projects from the pipeline to delivery.
Nuclear new build		Delayed new-build programme by at least 5 years, with expected completion date of first new plant pushed back from 2018 to 2023. However, strike price and terms of contract now agreed and potential programme of future projects.
Policy		
Review of electricity market to begin in first budget period		Energy Act legislated in 2013 including key elements of reform (long-term contracts and funding to 2020), but lack of clarity beyond 2020 and no decarbonisation objective could undermine delivery.
Carbon Capture and Storage (CCS) Front End Engineering and Design (FEED) studies complete by 2010, with first CCS project online 2014		FEED studies now due to complete in 2015 (i.e. 5 years behind indicator). However, some lessons learned and programme due to deliver 2 plants by 2020.
Industry covered by the EU ETS		
Policy		
Publish industry strategy including milestones, incentives and mechanisms for meeting carbon budgets		No strategy to meet carbon budgets has been published, but 2050 Roadmaps underway.

Looking forward, our assessment is that there will be insufficient emissions reduction under current policies, both in power generation and energy-intensive industries (Figure 4).

This shortfall must be addressed if carbon budgets are to be met in a cost-effective manner; we set out options to drive the deep emissions cuts required in sections 8 and 10 below.

Figure 4: Assessment of current and planned policies against future targets (traded sector)



Source: DECC (2013) *Updated emissions projections*; European Commission (2014) *Verified emissions data*; CCC analysis.

EU ETS emissions and carbon prices

The effectiveness of the EU ETS is undermined by the current oversupply of allowances and consequent weak carbon price. In order to restore the long-term value of the EU ETS as a policy instrument and for the credibility of EU climate policy more broadly, it is vital that the cap to 2030 is sufficiently stretching. This in turn requires that the EU adopts a stretching level of overall ambition for 2030.

The European Commission put forward its proposal for the 2030 framework in January 2014. Its key provisions included a target of a 40% emissions reduction below the 1990 level, met through domestic action (i.e. without purchase of international carbon credits), together with plans for structural reform of the EU ETS. Enacting both the structural reform and the proposed 2030 framework would be a significant step forward towards a fully functioning ETS; given the importance of UK action within both EU and international action, this is something that the Government should continue to strongly support.

However, given the relatively low level of current emissions, it is not clear that the proposed EU ETS cap will require significant effort to reduce emissions for some time. This suggests that the EU could increase its ambition without a large escalation in costs. The UK should push for a combination of ETS reform and emissions targets for 2020 and 2030 that will put the EU on the cost-effective path to meeting its target for 2050 and deliver a strong ETS price.

This supports the UK Government's position that the EU should aim for a reduction of 50% in 2030 relative to 1990 as part of an international effort to combat climate change.

6. Progress reducing emissions in the devolved administrations

From 2007 to 2012 emissions fell by 15% in Scotland, 6% in Wales and 7% in Northern Ireland, compared to a 12% reduction across the UK. The different rates of reduction in part reflect the relative dominance of different sectors (e.g. agriculture has a very high share in Northern Ireland and has fallen less quickly than other sectors across the UK). It also reflects the importance of individual power and industry installations at the devolved level (e.g. one reactor closing at Wylfa nuclear power station and being replaced by fossil fuel generation had a very large impact on emissions in Wales).

In some policy areas the devolved administrations lead the UK, in particular in residential energy efficiency, waste and agriculture where there are devolved competencies:

- **Energy efficiency and fuel poverty.** Unlike England, the devolved administrations operate tax-payer funded schemes to tackle fuel poverty in addition to the supplier obligations. These often focus on area-based delivery and work with local authorities.
- **Waste.** Ambitious household waste recycling targets have been set in Scotland and Wales. Wales met its target of 52% for 2012/13, but Scotland missed its first target for 2010/11 and – without a substantial improvement – is likely to have missed the 50% target for 2013. Northern Ireland is progressing towards its 2015 target of 45%.
- **Agriculture.** Like England, the devolved administrations place considerable emphasis on a collaborative approach with the farming industry. However, Scotland has made it clear that it will introduce regulation if sufficient progress is not made through the current voluntary approach – as we have recommended at the UK level.
- **Forestry.** Scotland has yet to reach its target of 10,000 ha afforestation per year, and Wales and Northern Ireland have been falling well short of their targets.

For the future the devolved administrations have adopted stretching targets. If these are to be achieved, stronger action will be required in key areas including energy efficiency programmes, increasing low-carbon heat penetration, encouraging greater uptake of electric vehicles, and increasing the rate of tree planting.

7. Progress reducing emissions in buildings

(i) Emissions trends

Emissions from buildings accounted for 37% (206 MtCO₂e) of all UK GHG emissions in 2013, split broadly equally between direct (i.e. from burning fossil fuels for heating) and indirect emissions (i.e. from generation of electricity used by lights and appliances). The residential sector accounts for 65% of these emissions, the commercial sector 26%, and the public sector 10%.

From 2007 to 2012, buildings CO₂ emissions declined by 5%. Emissions would have fallen further if the winter months of 2012 had not been particularly cold; adjusting for this effect, emissions would have fallen by around 10% over the period. This is more than the 7% reduction we had assumed in our carbon budget indicators, however given the context of

rising energy prices and the economic crisis this does not imply that low-carbon policy was more effective than we expected.

In 2013, buildings emissions fell by another 3%. This was mainly due to the 8% decrease in the emissions intensity of electricity consumed from the grid, whilst direct emissions rose.

(ii) Progress improving energy efficiency in the residential sector

Progress implementing energy efficiency improvements

Whereas up to 2012 there had been good progress insulating lofts and cavity walls, there was a significant reduction in the implementation of these measures in 2013 due to policy changes. Progress insulating solid walls remained very limited, as was uptake of the most efficient appliances. There was good progress on boiler replacement.

- **Loft and cavity wall insulation.** Progress insulating lofts and cavity walls was good until the end of 2012. From 2013, the Government expected that loft and easy-to-treat cavity wall insulation would be delivered mainly under a new market-based approach (the Green Deal). However, incentives under the Green Deal were insufficient and the scheme was perceived as complex by consumers, resulting in a significant reduction in the number of lofts and cavity walls insulated.
- **Solid wall insulation.** Under the Energy Company Obligation (ECO), introduced in 2013, energy companies were required to switch their focus from providing loft and cavity wall insulation (which was restricted to low-income homes) to solid wall insulation and hard-to-treat cavity walls. However, these measures are expensive and difficult to deliver, and actual numbers insulated fell compared to 2012 (e.g. 29,000 solid walls were insulated in 2013, compared to 82,000 in 2012, and the 43,000 projected in 2013 in the ECO Impact Assessment).
- **Boilers.** Progress replacing old inefficient boilers with new, efficient models was good throughout the first carbon budget period and in 2013.
- **Appliances.** Penetration of the most efficient appliances in the stock has been slow (e.g. the best – A++ or better – fridges and freezers only represent 1% of the stock).

Strengthening incentives for near-term delivery of energy efficiency improvement

In late 2012, following claims by energy suppliers that ECO costs were escalating, the Government proposed changes – yet to be finalised – to its design. In line with the Committee's advice that there should be a greater focus on low-cost measures, this shifted the focus of the largest element of the ECO from solid wall and hard-to-treat cavity wall insulation to measures such as loft and easy-to-treat cavity wall insulation.

However, the level of ambition in the redesigned policy has been reduced significantly and is low relative to the potential for insulation of lofts and cavity walls and the amount of money available to pay for this.

- The ambition in the new policy has been reduced by around 50% in carbon terms and to around £900 million notional delivery costs; the Government now expects the ECO to lead to the insulation of 440,000 lofts, 720,000 cavity walls (250,000 of which are easy-to-treat) and 85,000 solid walls between April 2014 and March 2017.
- This compares to several million lofts that could benefit from top-up insulation, 0.7-1.6 million cavity walls which are easy to treat and would be cost-effective to insulate, and around 10 million solid walls and hard-to-treat cavity walls where the economics of insulation is uncertain (see below).
- Even with the reduced amount of money notionally available under ECO, as set out in the Government's Impact Assessment, more lofts and cavity walls could be insulated (e.g. the Association for the Conservation of Energy identify potential to increase ambition by around 10% within this funding limit).
- Furthermore, given that it is not transparent by how much bills have been reduced following the revised policy, it is not obvious why less funding should be available. Under the previous level of funding (a notional £1.3 billion), considerably more could be achieved, for example almost all of the easy-to-treat cavity walls (constituting the majority of the low-cost abatement) could be insulated.

Given potential to go further on loft and cavity wall insulation, and the benefits that this would bring in terms of cost-effective emissions reduction and energy affordability, the Government should increase the ambition in the Energy Company Obligation to 2017.

The costs and risks associated with delivering increased ambition could be reduced through extending current financial incentives further out in time, and introducing minimum standards for the private rented sector.

- **Financial incentives.** As part of the redesigned ECO, new financial incentives were introduced in June 2014 through the Green Deal Home Improvement Fund. These have already stimulated consumer demand, and should be maintained and developed in the light of take-up to 2017. As we have previously recommended, there may also be a case for additional incentives such as stamp duty relief to ensure people maximise energy efficiency improvements when carrying out general refurbishments (e.g. on moving home).
- **Minimum standards.** In recognition of landlord-tenant split incentives (i.e. tenants receive the benefits of energy efficiency improvements but these are paid for by landlords), the Energy Act 2011 provides for the introduction of minimum standards for energy performance in the private rented sector, to be introduced from 2018. To provide certainty for landlords, the Government should set the minimum standards for 2018 now and a clear timetable for tightening these over time. Standards should require the implementation of cost-effective efficiency improvements such as loft and cavity wall insulation.

The above relates primarily to the part of ECO available to fund efficiency improvements in any households, accounting for around 60% of the total funding. There is also an element ('Affordable Warmth') specifically reserved to reduce heating costs for low-income

households, including the fuel poor. Most of the initial target (which runs to March 2015) has already been met.

As a result, many eligible vulnerable households in England (the devolved administrations have additional fuel poverty programmes) have been left unable to access ECO funding at a time when the number of fuel-poor households has been rising (to an estimated 2.9 million in England in 2013). There is therefore a need to explore other instruments to ensure more widespread action on fuel poverty in the near term.

Options for the Energy Company Obligation beyond 2017

Beyond 2017, as low-cost potential is increasingly exhausted, there is an open question of where the ECO should focus. We identify three options:

- **Option 1: Focus on solid wall insulation and other hard-to-treat measures.** As the majority of low-cost opportunities are taken up, it might then be justified to move the focus to more expensive measures such as solid wall insulation. However, considerable uncertainty remains over the potential costs of such a large-scale programme. If this option were pursued, safeguards may be appropriate to ensure that solid wall insulation is not installed in very expensive cases (e.g. a possible buy-out mechanism could be included in the Energy Company Obligation).
- **Option 2: Focus on fuel poverty.** Currently, around half of the ECO is targeted at low-income households. The proportion targeted at the fuel poor could be increased to help achieve the Government's forthcoming fuel poverty target (which is likely to be based on achieving a minimum energy performance rating in fuel-poor homes).
- **Option 3: Reduce the scope of the ECO.** If a wider solid wall insulation programme is shown to be prohibitively costly and if other ways are found to address fuel poverty (e.g. through taxpayer funding, using local authorities as the delivery vehicle as currently done in Scotland) it might be appropriate to reduce the scope of the ECO. This would allow energy bill savings against the £55 currently paid by the typical household. But it would also raise questions about how future carbon budgets would be met, requiring additional actions in other sectors of the economy, and about how to roll out low-carbon heat for homes with solid walls (e.g. this would be more challenging for heat pumps, for which the economics are more favourable in well-insulated homes with lower peak heating requirements).

Further evidence on the cost of solid wall insulation and other options for hard-to-treat properties is required before a choice between these options can be made; and any choice should be made in conjunction with the development of a broader strategy for addressing fuel poverty.

Zero carbon homes

The Government committed in 2006 to ensuring that new homes should be zero carbon from 2016. Building regulations have been tightened twice (in 2010 and 2013) in preparation for the new standard, although the 2013 changes have been less stringent than initially proposed.

Typically 'zero carbon' implies that new homes are highly energy efficient, have their heating supplied by a low-carbon source (e.g. a heat pump or low-carbon district heating) and include on-site electricity generation from a low-carbon source (e.g. solar photovoltaic panels).

There is merit in the principle of zero carbon homes given that these measures are considerably cheaper to install in new homes than to retrofit to existing homes, and that new homes will still be standing in 2050 by when buildings emissions may need to be reduced to very low levels. Furthermore, new homes are a key cost-effective segment of the low-carbon heat market and a potential driver for developing this market.

However, there may be specific cases where individual measures are prohibitively expensive – for example, site conditions may not be supportive to on-site generation, or capital-intense heating technologies (e.g. heat pumps) may be inappropriate in extremely efficient houses with very low heating needs. There could therefore be a case for specific off-site solutions, provided these do not undermine the principle that new houses should be responsible for no more than a minimal amount of emissions.

In June 2014, the Government announced more details of the design of the Zero Carbon Homes policy, including an "allowable solutions" mechanism and a small developments exemption.

- The 'allowable solutions' mechanism allows developers to construct homes that do not fully meet the zero carbon standard (i.e. they do not have low-carbon heating or do not include on-site generation) if they instead make payments into an energy efficiency fund.
- Small developments are to be exempt from the zero carbon requirement, with a consultation to determine the specific coverage of the exemption.

Applied to on-site electricity generation the 'allowable solutions' mechanism is sensible, given that large-scale off-site generation is often a cheaper way to provide low-carbon electricity. However, when applied to heat and efficiency measures it is problematic. For all new houses policy should require that either low-carbon heating is installed or efficiency is so high that heating requirements are minimal.

No rationale has been provided for the exemption for small developments. It is not clear why the economics of efficiency measures or low-carbon heating should significantly differ from larger developments. Therefore, this proposal should be dropped unless the Government can show clear evidence of its value.

More generally, the scope of the Zero Carbon Homes policy has been changed a number of times in recent years. While policy changes can be justified in some circumstances, too frequent change creates uncertainty and can result in badly designed policies, and should therefore be avoided in future.

(iii) Progress improving energy efficiency in the non-residential sector

While there are specific examples where organisations have cut energy consumption significantly, there is no clear evidence of energy efficiency improvement in the commercial

and public buildings sector overall, with both energy use and emissions remaining broadly flat over the first carbon budget period. This is despite rising energy prices and reduced economic activity during the economic crisis.

The current policy landscape is complex, with multiple carbon price instruments and information requirements. Policies have been developed separately over time and, as a result, they are not mutually reinforcing, entail excessive administrative burden and have incomplete coverage (e.g. for SMEs).

Given this complex landscape, we have previously highlighted scope for rationalisation, and the need to fill gaps. The lack of progress reducing emissions to date also suggests the need for strengthening of incentives.

Any redesigned policy framework should provide a combination of information on energy performance and scope to improve this, financial incentives, and regulation. Policies should provide a clear and consistent signal, should be stable over time, and should be designed as part of an integrated and mutually reinforcing package.

Assessing the current policy framework against these principles suggests the following options:

- **Financial incentives: Rationalising carbon price instruments.** The carbon price signal should be uniform and consistent across firms and fuels. Therefore, the carbon price aspect of the Carbon Reduction Commitment should be abolished, and the Climate Change Levy increased, unless there is compelling evidence to suggest that this would undermine incentives.
- **Regulation.** Around 60% of space is rented in the commercial sector. As a result of the landlord-tenant split, therefore, even with strengthening of financial incentives and improvement in information, much unexploited potential for energy efficiency improvement is likely to remain. Regulation is required to address this. In particular, the Government should now introduce minimum standards consistent with take up of cost-effective abatement, as provided for under the Energy Act 2011. Given long refurbishment cycles, setting out a clear timetable for tightening standards over time would improve investor confidence and unlock additional abatement from retrofit.
- **Information.** It is essential that organisations understand their energy consumption – and scope to improve this. This requires only one good source of information, rather than the multiple but often weak information sources currently in place. This one source could be the energy audits, although these would have to be significantly enhanced relative to the current design. Alternatively Display Energy Certificates (DECs) could be rolled out across the non-residential sector. If one of these were to be implemented, it may also be justified to drop the information requirements associated with the Carbon Reduction Commitment (CRC).

Improving policies in the ways described above would strengthen incentives for organisations to make changes which will both save them money and put the economy on the cost-

effective path to meeting longer-term objectives, whilst reducing the administrative burden associated with current policies. It should therefore be a priority for the Government.

(iv) Progress investing in low-carbon heat

Trends in low-carbon heat penetration

Progress on low-carbon heat over the first carbon budget period has been slow. Whilst the economy-wide production of low-carbon heat was on track with our indicator in 2012, much of this was due to the use of biomass boilers, with investment in heat pumps remaining particularly low (only £400,000 has been spent out of a budget of £39 million).

At current rates of investment, low-carbon heat is unlikely to reach the Government's economy-wide ambition of 12% penetration by 2020; and is likely to be very far from the indicative 25% in 2030 suggested in our fourth carbon budget review, to be delivered in buildings mainly through heat pumps.

Progress in policy development

The fact that the non-residential Renewable Heat Incentive (RHI) has been almost entirely focused on biomass is a source of concern, as bioenergy resources are limited and for heat should be targeted at industrial process heat where few low-carbon alternatives exist, rather than in buildings where alternatives are available in the form of heat pumps or district heating.

The Government has responded with a new set of tariffs in the non-residential scheme which should help address limited uptake of non-bioenergy options, although more work is required to address non-financial barriers.

The residential RHI was launched several years late in April 2014, so support to date has been limited to a small-scale grant scheme. This has nonetheless generated useful evidence on technology performance and consumer feedback, which are critical for securing savings and boosting consumer confidence.

Future low-carbon heat policy compatible with carbon budgets

A very significant scaling up of investment in low-carbon heat is required to meet future carbon budgets, particularly as regards heat pumps.

It is possible that alternative ways could be found to support investment in low-carbon heat (e.g. subjecting heat consumption to a carbon price or requiring low-carbon heat investment under buildings regulations). While these alternatives should be considered, they are unlikely to be technically or politically feasible in the near-to-medium term, implying that the RHI is the only realistic delivery mechanism for the foreseeable future.

Given that it is the only feasible mechanism, there is a need to reduce current uncertainty about the RHI by committing funding to 2020, and committing to its continued existence beyond 2020.

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- **Committing funding to 2020.** Funding for the RHI has only been committed for the period to 2016. This undermines incentives for supply chain development and should be addressed as a matter of urgency through committing funding to 2020.
 - **Committing to continued existence of the RHI in the 2020s.** A very significant ramp up of investment in low-carbon heat is needed to meet carbon budgets in the 2020s. The Government should commit to the continued existence of the RHI in the 2020s until and unless an adequate replacement is in place.

To support this commitment, measures should be put in place to address financial and non-financial barriers to investment, which would otherwise result in funding costs for the RHI being prohibitive.

- **Reduce funding costs through addressing non-financial barriers.** The RHI is a subsidy paid quarterly to consumers and businesses, based on the additional upfront cost of low-carbon heat installations, along with operating costs or savings. In the case of the domestic scheme, the net upfront cost is annuitised across a seven-year period. The tariff is calculated so as to give an overall return of 16% to consumers and 12% to businesses. These very high returns are in part to overcome non-financial barriers to uptake. These barriers should be addressed through improved information and confidence building.
 - Sustained large-scale marketing campaigns through multiple channels are required to raise the profile of low-carbon heat technologies and awareness of the finance available.
 - Consumer confidence can be improved through basic installer training for all heating engineers, along with support for consumers at initial set up, plus follow-up for those installing heat pumps.
 - Further work on ways to reduce the costs of amenity loss (e.g. loss of space) would be useful.
- **Reduce funding costs by introducing new financing instruments.** The high return offered under the RHI also partly reflects the cost of finance to consumers. Therefore if the cost of finance could be reduced, the cost of funding the RHI could also be reduced. The annual funding cost in the mid-2020s could be further reduced by spreading payments over a longer time period. Extending the Green Deal to pay for investment in renewable heat offers the opportunity to reduce financing costs and spread these over longer periods. It should be done as soon as possible in order to limit RHI funding costs.
 - If the cost of finance for households could be reduced from 7.5% to 3.5% this would reduce the annual funding cost in 2025 by £300 million.

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- Spreading costs over the life of the heat pump, rather than seven years as under the RHI currently, could further reduce the required annual funding (e.g. by around £300 million in 2025).
 - There is scope to achieve this by extending the Green Deal to cover the full upfront cost of heat pumps. This assumes that the Green Deal interest rate falls from its currently high level, which should be possible as the instrument becomes established and could be facilitated by Government guarantee.

As part of strengthening the approach to supporting investment in low-carbon heat, there may be scope to join this up with policy to reduce fuel poverty. In particular, there is a significant opportunity for cost-effective investment in low-carbon heat to replace inefficient heating systems in fuel-poor households. The Government should work to understand and address barriers to uptake of low-carbon heat in fuel-poor households. It should consider targeting part of the RHI to the fuel poor, which together with provision of low-cost finance may be sufficient to encourage uptake. There may also be a case for additional subsidy, for example, through the Energy Company Obligation.

8. Progress reducing emissions in the power sector

(i) Power sector emissions trends

The Committee's indicator framework sets out a path towards a largely decarbonised power sector by 2030.

Annual emissions fell by 11% from 2007 to 158 MtCO₂ in 2012, as a result of falling demand for electricity and reduced carbon intensity of electricity supply.

Emissions would have been lower given the large impact of the recession, but for increased coal burn, especially in 2012. This reflected falls in the price of coal and the collapse of the EU carbon price, resulting from the economic crisis.

In 2013 emissions fell 8 % as a result of increasing renewables and coal plant closures (having reached the end of their allocated hours under EU legislation).

We also monitor underlying progress, based on the achievable emissions intensity (AEI). This is emissions per unit of electricity if plant were dispatched in order of emissions intensity, beginning with renewables and nuclear, followed by gas and finally coal. The AEI has fallen by 38% since the start of the first carbon budget period to 285 gCO₂/kWh in 2013. This reflects falling demand, increased capacity for renewable generation and increased gas capacity (able to displace coal).

Over time we would expect actual emissions intensity (currently around 500 gCO₂/kWh) to converge on achievable, as coal comes off the system. In theory, the system could be dispatched at an emissions intensity close to the achievable level now (i.e. around 285 gCO₂/kWh) at limited additional cost to consumers, given that electricity prices are currently set by gas plants for most of the year.

Looking ahead, our assessment of the cost-effective path for the power sector under carbon budgets implies achievable and actual emissions intensity falling towards approximately 50 gCO₂/kWh in a central case. Intensity could be as high as 100 gCO₂/kWh if some low-carbon options prove harder than expected to deploy, or if, for example, coal provides a significant amount of back-up generation.

(ii) Progress investing in renewable power generation

There has been good progress to date investing in new renewable generating capacity, particularly wind, which has increased from 3 GW in 2008 to 11 GW in 2013. There is also a strong pipeline of potential future projects in development, in planning and in or ready to enter construction.

However, the pipeline is at risk given current uncertainties about whether there will be ongoing support for investment and, if so, which technologies will be supported.

The Government should resolve this uncertainty through deciding which portfolio of technologies it will support and then provide assurance about this.

In making this decision, the Government should recognise that onshore wind is a cost-effective technology; that offshore wind is currently expensive but promising, and an important part of a portfolio; and that the economic case to support investment in solar generation in the near term is limited.

- **Onshore wind.** If the objective is to bring forward investments on the cost-effective path to power sector decarbonisation, then onshore wind should continue to be supported. Debate and discussion over the future of onshore wind should be framed in this context: that a failure to invest in it is a departure from the cost-effective path, which will ultimately result in higher energy bills at a time when energy affordability is a significant concern.
- **Offshore wind.** This remains a relatively expensive technology. However, it is promising, in the sense that there is a large potential and strong evidence to suggest that costs can be reduced significantly to the point where offshore wind will be competitive in the future (e.g. larger, 6 MW, turbines are now available in the market, and 8 MW turbines are expected by 2017). There is significant value having offshore wind as part of a portfolio, given the need to decarbonise the power sector, limits on scope for investment in onshore wind and nuclear, together with uncertainties over CCS, and the importance of UK deployment in driving cost reduction.

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- **Solar.** Internationally the costs of solar have come down considerably in recent years, and even in the UK its generation costs are approaching other mature low-carbon options (e.g. onshore wind). However, the economics of solar generation in the UK are undermined because its generation profile is poorly matched to UK demand (i.e. solar output is high in summer and demand is high in winter). Until cost-effective seasonal storage or low-carbon back-up options are developed further, it is appropriate to limit investment in solar power, while not ruling out that much higher penetration may become appropriate in future. The Government should consider imposing limits on funding for solar generation under the Levy Control Framework, in the absence of which investment in other technologies may be displaced, or affordability issues exacerbated.

The context for decisions related to specific renewable technologies should be the broader approach to Electricity Market Reform, where there are key decisions to be made about the setting of a decarbonisation target, funding to achieve this, and technology commercialisation.

(iii) Progress investing in CCS

Carbon capture and storage (CCS) has a potentially crucial role to play in long-term decarbonisation of the economy, in power, heavy industry and in conjunction with bioenergy. Whilst the UK emissions targets could in principle be achieved without CCS, our previous analysis suggests that the associated costs would be considerably higher. As a key technology option for decarbonisation pathways across several sectors, it is therefore urgent to move CCS quickly towards commercialisation.

The first CCS projects will be important not only to help prove the set of technologies, but also to establish a CO₂ transportation and storage infrastructure to which subsequent projects could connect.

There has been slow progress in CCS against an ambition of four demonstration plants by 2020 set out in the Coalition Agreement and in our indicators. This is in part due to the failure of the first competition, but there has also been little sign of urgency for the subsequent process.

The near-term priority is to move ahead quickly with the two initial projects, so that they are operational this decade and, crucially, so that the infrastructure is then available for further projects to follow on.

It is also important to provide visibility to project developers outside of the preferred bidders, so that interest can be maintained and projects are available for deployment in subsequent phases. As we have previously set out, the Government should set out a strategy to reduce costs and commercialise CCS through the 2020s on the path to a level of ambition by 2030 of up to 10 GW, or potentially more if feasible and the technology proves to be cost competitive.

The UK's CCS programme is part of a wider international effort to develop the technology. Projects in other countries are also behind original plans, although there have been some encouraging developments recently: 2 power projects are expected to enter into operation in North America this year, and a steel plant in Abu Dhabi has awarded contracts for construction.

(iv) Progress investing in nuclear power

Nuclear power can play an important role in the decarbonisation of the power sector through cost-effective baseload low-carbon generation.

Nuclear accounted for 20% of all generation in the UK in 2013 and life extensions were granted to several plant; only 1.1 GW out of 8.8 GW is now scheduled to retire by the end of the decade.

In 2013 the terms of contract and level of support were agreed for the first new nuclear reactor at Hinkley Point C. The agreed strike price (£92.50) falls within the range suggested by our analysis (£85-100/MWh) and implies significant potential cost savings from a new nuclear programme in the UK compared to unabated gas generation facing a carbon price consistent with tackling climate change. State Aid clearance is now required for this project to proceed and be operational by 2023, on which a decision is expected by the European Commission later in 2014.

Other projects also remain in the pipeline, with potential for deployment up to around 17 GW by 2030 across the three consortia with existing plans to build new nuclear reactors in the UK.

In order for a successful program of new nuclear generation to be deployed, projects need to deliver to time and budget. We will closely monitor this and any announcements of cost overruns. If costs rise further and the benefits of a programme do not translate to lower costs than for the first plant, then the value of a nuclear programme would be called into question, particularly if other low-carbon options (i.e. renewables and CCS) are making good progress.

(v) Challenges and next steps in Electricity Market Reform

Good progress has been made on Electricity Market Reform in recent years, notably: the passage of enabling legislation; the introduction of long-term contracts to provide revenue stability for investors, thereby reducing the cost of capital and bringing forward investment at least cost to the consumer; agreement on funding to support investment coming on the system to 2020; publication of prices to be paid for generation from different technologies; and agreement on contracts for particular projects.

In order to gain the economic benefits from what has been achieved to date, and the commitments that have been made to 2020, continuing investment will be required through the 2020s. A failure to invest beyond 2020 would imply that earlier investments are largely wasted, in that they were aimed at technology commercialisation which did not ensue.

In order to secure investment beyond 2020, current uncertainty about the direction of travel for Electricity Market Reform will have to be addressed; this is undermining incentives for project development and supply chain investment, both of which are necessary for technology commercialisation.

To address the uncertainty will require that the Government provides investors with confidence that there will be a market for low-carbon technologies in the 2020s. Success

here requires a package that balances certainty of a future market with incentives for cost reductions, while retaining some flexibility to safeguard consumer interests.

The package should include a target range for decarbonisation, approaches to developing emerging technologies, funding commitments to support these and an assessment of how these fit together in an efficiently run electricity system:

- **A carbon intensity target range.** As legislated for in the Energy Act 2013 the Government should set a range for the carbon intensity of power generation in 2030. The range should balance the need for flexibility with the need to provide a valuable signal to industry on the direction of EMR – that the focus in the 2020s will be on low-carbon investment. Our previous analysis suggests a range of around 50-100 gCO₂/kWh would be consistent with the cost-effective path for a range of outcomes for fossil fuel prices, carbon prices and low-carbon technology costs.
- **Approach to less-mature technologies.** Alongside this objective the Government should set out its approach to driving cost reductions for the important less-mature technologies, including offshore wind and CCS.
 - For offshore wind this should include: a commitment to a critical mass of investment to drive costs down, recognising the likely market in other countries; target cost reduction schedules under which ambition will be maintained or increased; the point in time when the technology will be expected to compete with other low-carbon options without support and any role for Government in driving cost reduction (e.g. investment in port infrastructure). It is important to note that this goes well beyond the Government's current *Offshore Wind Industrial Strategy*.
 - For CCS the strategy should set out the approach to projects beyond the two being funded in the current competition and to development of a CCS infrastructure. It should include an approach to industrial as well as power sector CCS and complement approaches in other countries.
- **Funding, and funding limit.** To make these strategies credible requires that funding is committed consistent with their delivery and based on realistic assumptions of cost reduction. If costs turn out significantly higher for some options, which would question the economics of investment in these, this would suggest a change in ambition for these rather than an automatic increase in funding.
- **Optimising the system.** Increased flexibility and back-up capacity will be required as the power sector is decarbonised. There is a risk that the new market arrangements could undermine signals for this flexibility. Market signals should reflect the different value of alternative generating technologies and of flexibility mechanisms. All options (including demand changes, interconnection, existing plant and new gas plant) should be allowed to compete in the capacity market in a way that brings forward the lowest-cost options.

We will develop and recommend approaches to commercialisation and cost-reduction as part of our advice on the fifth carbon budget (2028-32), which will include an updated recommendation for the appropriate target range for power sector decarbonisation in 2030.

9. Progress reducing transport emissions

(i) Emissions trends

UK domestic transport CO₂ emissions accounted for 25% (117 MtCO₂) of all UK CO₂ emissions in 2013. The majority of these are from surface transport (94%). Domestic aviation and shipping account for 3% with the remainder from other sources. Cars are the biggest contributor to surface transport emissions (58%), followed by heavy goods vehicles (22%) and vans (14%).

Domestic transport CO₂ emissions were flat from 2012 to 2013, having fallen by 12% between 2007 and 2012.

Key drivers of this reduction were improvements in efficiency for cars and vans and a small decrease in demand, reflecting the impact of rising fuel costs and the economic recession.

There are also 41 MtCO₂ of emissions from international aviation (32 MtCO₂) and shipping (9 MtCO₂) – based on latest available data from 2012. These are not currently included in carbon budgets but are covered by the 2050 emissions target for at least an 80% reduction on 1990.

(ii) Supply-side progress reducing emissions

Progress reducing new car and van emissions

There has been good progress reducing emissions from new cars and vans, driven by efficiency improvements as manufacturers strive to meet EU legislation, with little contribution from consumer purchase decisions.

- Average test cycle emissions for new cars fell by 19% from 2007 to 2012 and by a further 3.6% in 2013 to reach 128 gCO₂/km, meeting the EU 2015 target of 130 gCO₂/km two years early. There have been improvements in emissions intensity across all classes of new cars but particularly in top models within classes.
- Over the first carbon budget period there was a polarisation of consumer purchases towards both larger and smaller cars away from mid-class models. There was also increasing purchase of more-efficient diesel vehicles; both trends continued in 2013. The net effect on emissions has been broadly neutral.
- New van CO₂ intensity fell by 8% between 2009 (the earliest date for which data are available) and 2012, and by a further 1.4% in 2013 to 186 gCO₂/km, ahead our indicator (192 gCO₂/km).

In order to maintain momentum, it is important that stretching new EU targets are set for 2030, which reflect the move to the new Worldwide Harmonized Light Vehicles Test Procedure (WLTP), and take full account of the role of electric cars and vans and other ultra-low emission vehicles (ULEVs) in delivering emissions reductions. Government should strongly push for this in the context of negotiations around the overall 2030 EU emissions reduction package.

Progress reducing heavy goods vehicle (HGV) emissions.

Emissions from HGVs declined by 7.7% over the first carbon budget period, slightly more than our indicator trajectory reduction of 7%. Sharp falls in HGV travel during the economic downturn have been partly offset in recent years as the economic outlook has improved; and implied emissions intensity has increased. Although data on actual changes are limited, it is likely that emissions rose in 2013.

- HGV km fell by 14% from 2007 to 2012, but rose 1% in 2013. This reflected the steep decline in manufacturing output over this period, where recessionary impacts were greater than for the rest of the economy.
- Average emissions intensity per vehicle-km rose for HGVs over this period, despite increased biofuel penetration. However there was a move to heavier vehicles and higher loading factors suggesting some improvement in vehicle utilisation.
- Data on HGV emissions in 2013 are not available, but information on distance travelled and biofuel penetration suggest that there was a small rise in emissions last year.

There is no comprehensive EU policy aimed at reducing emissions from this sector, partly due to the diverse nature of trucks and activities. Work is being carried out to measure and report whole-vehicle emissions from heavy-duty vehicles (HDVs, i.e. HGVs, buses, coaches and so on). This will open the way for the setting of mandatory limits for new HDV emissions. The Government should push for this to be resolved swiftly, soon after 2015.

Increasing penetration of biofuels

Despite being on track with our indicator for most of the first carbon budget period, biofuel penetration fell below our indicator in 2012 and 2013, largely as a result of changes in the accounting rules for more sustainable biofuels.

- In 2013 biofuel penetration reached 3.5% by volume, 1.5 percentage points short of our indicator.
- Following an EU move to encourage feedstocks with a lower risk of indirect land-use impacts, double-counting of waste-derived biofuels, residues and advanced biofuels was introduced in the Renewable Transport Fuels Obligation (RTFO) in 2012.

The primary concern for biofuels is for them to be sourced from sustainable feedstocks. The recent EC proposal for suppliers to report on indirect land-use change (ILUC) impacts should be seen as a first step towards their full inclusion in EU sustainability criteria.

Progress, challenges and responses developing electric vehicle markets

Growth in the electric vehicle (EV) market in the UK has been slow to date, with cumulative sales of 9,800. However, there are a number of positive developments, both here and in other countries, which provide some confidence about the market in future.

- Following recent launches, a wider range of models is now available in the UK market, with a range of price and quality characteristics providing some choice for consumers.
- There has been good progress investing in charging infrastructure, which should help to address the issue of range anxiety. This has been focused on slow charge points (i.e. 3-7 kW), with only a few (<5%) fast or rapid (20-50 kW) chargers. The Plugged-in Places (PiP) programme provided over 4,000 charge points by March 2013, of which around 65% were publically accessible, while non-PiP organisations may have also installed about 5,000 charge points nationwide.
- The Government has committed funding of £500 million between 2015 and 2020, aimed at improving take-up. This covers continuation of Plug-in Car Grants; support for vans and taxis; continued development of rapid-charge infrastructure; R&D and a competition for a new city scheme to promote EVs.
- Market development and commitments in other countries have led to rapid deployment. For example, in Norway EVs comprise 6% of new car sales, resulting from a mix of financial incentives and attractive softer measures such as access to bus lanes and road and ferry toll exemptions, as well as strong public procurement. Similar measures have been implemented in the Netherlands, which has also had a highly innovative and successful awareness raising campaign with opportunities to test drive EVs easily accessible to the public.

Nevertheless, significant barriers to mass uptake of electric vehicles remain, both as regards financial and non-financial barriers.

- **Financial barriers.** Evidence suggests that people heavily discount operating cost savings from electric vehicles, making them less financially attractive. If this is not addressed, prohibitively large subsidy could be required to encourage mass uptake.
- **Non-financial barriers.** Awareness and acceptance of EVs is currently low and negative perceptions amongst some consumers need to be addressed. Additionally, buyers value range and the option to complete longer trips if desired, which is currently limited for pure battery electric vehicles (but not for plug-in hybrids).

These barriers can be addressed through a combination of innovative financing; investment in charging infrastructure; facilitation of on-street residential charging; and car manufacturers engaging consumers through innovative marketing strategies.

- **New financing instruments.** The key to making electric vehicles more attractive from a financial perspective is to spread upfront battery costs over time, and to do this at as low a rate of interest as possible. Our analysis suggests that by the early 2020s this could remove the need for continued purchase subsidy

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- **Investment in charging infrastructure.** A rapid charging network is needed to address range constraints for longer journeys by pure battery electric vehicles. These should be strategically located, easy to use, easy to find and offer convenient access and payment options. An initial rapid charging network can be achieved within current committed spending.
 - **On-street residential charging.** Around 30% of households do not have access to off-street parking. In order for these households to purchase electric vehicles, they would have to be able to charge at home overnight. This could be achieved through investment in a network of slow-charging points in areas without off-street parking, with parking by these charging points reserved for those who own electric vehicles.
 - **Innovative marketing approaches.** A key barrier is technology bias (i.e. a consumer preference for tried and tested conventional vehicles). This can be overcome – for example, this bias tends to disappear as people have experience of EVs. Car manufacturers are best placed to overcome this through their marketing, if incentivised to do so. This could be usefully supplemented by time-limited use of softer measures for early adopters, which can often be made available by Local Authorities (e.g. access to bus lanes, preferential parking), and increased exposure (e.g. through public procurement, taxis and car clubs).

To make this happen, the Government should:

- Strongly support the setting of an EU target for new car emissions in 2030 that reflects significant penetration of electric vehicles. This would strengthen incentives for manufacturers to promote EV uptake.
- Work with industry to explore scope for new ways to finance battery investment costs, building on innovations to date (e.g. battery leasing), including a possible role for the Green Investment Bank
- Ensure appropriate development of charging infrastructure, including strategically located rapid charge points to facilitate longer journeys, and access to overnight charging for people without off-street parking.
- Encourage Local Authorities to use powers available to them to promote EV uptake through softer, sometimes time-limited, measures (e.g. bus lane access, parking policy, car clubs, public procurement policies), ensuring winners of OLEV's city scheme competition act as exemplars.
- Consider how to phase out current purchase subsidy, given progress in these areas, and consider whether there would be value in announcing this in advance (e.g. this could spur industry action in addressing the barriers).

This set of actions to address financial and non-financial barriers would support the very significant growth in the electric vehicle market required to meet future carbon budgets; and to be on the cost-effective path to economy decarbonisation.

(iii) Demand-side progress reducing emissions

Complementing the move to more efficient and electric vehicles, our fourth carbon budget trajectory involves actions to reduce travel demand. Smarter Choices are being funded and, if sustained, could deliver savings in line with our trajectory. Savings from measures to encourage efficient driving and limit speeding are more at risk. There is more financial incentive for efficient running of freight operations but the current voluntary industry approach to streamline logistics may need strengthening.

- Funding through the Local Sustainable Travel Fund (LSTF) is available to local authorities to promote sustainable travel. Types of action being supported include workplace travel plans, walking and cycling, and car sharing, which have proved to be effective in reducing car travel, but need to be sustained to ensure benefits last.
- The industry-led Low Carbon Reduction Scheme has driven improvements in efficiency in the freight sector through changes such as better routing, improving vehicle fill and in-cab telematics. The scope and ambition of this scheme may need to be extended to encourage take-up among a wider range of operators.
- Uptake of eco-driving training is far short of our trajectory and likely to remain so, but future savings could be delivered through technology-based solutions (e.g. gear shift indicators and fuel use displays, which also encourage more fuel efficient driving).

(iv) Aviation and shipping

In 2012 emissions from domestic aviation and shipping (included in carbon budgets) were 4.0 MtCO₂, representing 3% of domestic transport emissions.

Emissions in aviation and shipping fell in the first carbon budget period, with reductions in both domestic and international emissions (currently excluded from carbon budgets but in the 2050 target).

- Domestic aviation emissions fell 28%; international emissions fell 10%. This largely reflected falling demand in the UK due to the economic crisis and improvements in fuel efficiency.
- Reductions in emissions from domestic and international shipping were both around 10% over the first carbon budget.

In December 2013, the Airports Commission released its interim report which recommended the need for an additional runway in the south east by 2030. It also suggested there could be a case for a second additional runway by 2050.

We have previously suggested that returning aviation emissions to around 2005 levels in 2050 is an appropriate level of ambition. Both Airports Commission and CCC analysis suggest an additional runway by 2030 can be compatible with this approach, provided that aviation demand growth is limited to around 60% above 2005 levels and that there are significant improvements in carbon intensity of aviation (e.g. of around one-third by 2050).

This approach should continue to be the basis for government policy unless and until technology improvements allow higher passenger demand growth – and associated infrastructure investment – to be demonstrated compatible with the 2050 target.

10. Progress reducing industry emissions

(i) Industry emissions trends

Emissions from industry accounted for around a third of UK greenhouse gas emissions in 2013 (around 170 MtCO₂e), of which around 90% are CO₂. Industry CO₂ emissions comprise around 74% direct emissions (of which 92% are from the combustion of fossil fuels and 8% are from chemical processes) and 26% indirect emissions (i.e. electricity-related).

Between 2007 and 2012 industrial GHG emissions fell 19% and direct CO₂ emissions fell by 26%. The fall in direct CO₂ emissions was more than the 15% reduction we had assumed for our indicator. However, emissions reduction did not reflect the unlocking of energy efficiency potential. Rather, large emissions cuts were a result of the economic recession reducing output and disproportionately impacting the more carbon-intensive sectors (e.g. iron and steel).

In 2013 direct CO₂ emissions from industry increased by 1%. This reflected a shift towards more carbon-intensive production, specifically the reopening of Teesside steelworks. An overall 2% reduction in industry emissions in 2013 was mainly due to the 8% reduction in the carbon-intensity of electricity consumed from the grid.

(ii) Implementation of measures to cut industry emissions

Progress improving industrial energy efficiency

Significant improvements in industrial energy efficiency are possible, and needed to meet the fourth carbon budget. However, there is no clear evidence to date of energy efficiency improvement sufficient to reduce the carbon intensity of production across industry.

The lack of progress might be expected given weak policy incentives currently in place:

- The EU ETS carbon price remains very low, undermining cash flows of projects to improve energy efficiency.
- Ambition in Climate Change Agreements is low relative to the potential for cost-effective energy efficiency improvement.

Close monitoring is required to understand better what is being done in industry to improve energy efficiency. Depending on the results of this monitoring, strengthened incentives may be needed so that measures are implemented and carbon budgets met in the most cost-effective manner.

Progress demonstrating CCS in industry

We have repeatedly recommended that the Government should publish an approach to demonstration and commercialisation of industrial carbon capture and storage (CCS) compatible with deployment in the 2020s.

This is now urgent, given the timeline to deployment, and the opportunity for substantial CCS abatement if deployed alongside expected industrial plant refurbishments from the late 2020s, by when CCS should be approaching commercialisation. Failure to address industrial CCS now will result in missing opportunities in plants' refurbishment cycles, raising the costs and risks of industrial decarbonisation.

Industry roadmaps

CCS is a major option for industry decarbonisation that should be included in the Government's industry roadmaps. Other key options include increased electric-arc steel production, clinker substitution in cement and optimisation of refineries.

In developing roadmaps, the risk is that these remain high level, and do not result in required investment. To mitigate this risk, it is important that they include key milestones for each technology, together with policies to ensure that milestones are met in practice, noting that policies are likely to go beyond reliance on the carbon price in EU ETS, even if this is strengthened significantly.

(iii) Progress managing competitiveness risks

It is important to ensure that increased energy costs resulting from low-carbon policies do not result in offshoring of UK industry. Output moving abroad would not have any benefits for the UK's overall carbon footprint (i.e. including consumption emissions) and therefore global emission reductions, and would not be desirable from a wider economic perspective. The Committee's assessment in 2013 concluded that there has been no significant industry relocation to date as a result of low-carbon policies and there is no reason to expect this in future, given current and planned policies to limit competitiveness risks.

Competitiveness risks arise from higher costs associated with policies to reduce direct emissions for energy-intensive industry. These are being addressed to 2020 through the design of the EU ETS, with a need to address post-2020 risks as part of the broader EU 2030 package currently being discussed.

There are also potential competitiveness risks for electro-intensive industries that are subject to international competition and face higher electricity costs relative to competitor countries. We have previously recommended that at-risk sectors are compensated for these additional costs and that the Government should aim to provide greater long-term certainty. These proposals are in place or being planned.

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- A scheme to compensate industry from the indirect impacts of the EU ETS is in place and proposals to exempt industry from the effect of the Carbon Price Floor (CPF) recently received State Aid approval. Budget 2014 extended these schemes to 2019-20, in line with our previous advice.
 - Government plans to introduce a new compensation scheme to help energy-intensive sectors with higher electricity costs resulting from renewable energy schemes from 2016-17. These are due to be consulted on shortly. Revisions to EU Energy and Environment Aid guidelines (EEAG) published in April 2014 extended the list of sectors that could potentially be eligible for help from this scheme.

The combined funding available from these compensation measures is in line with our previous estimates of support needed to address competitiveness risks of energy-intensive sectors in 2020.

Our previous analysis demonstrated the largest impacts occur due to electricity price increases to 2020; incremental impacts from higher electricity prices in the 2020s are relatively small. It is important that competitiveness impacts this period are closely monitored as regards appropriate approaches to support specific sectors at further risk of competitiveness impacts.

11. Progress reducing emissions from agriculture

Agriculture emissions are highly uncertain, with an estimated range of 42-91 MtCO₂e in 2012.

When reporting emissions trends, we use the best estimate within this range, while recognising the need to improve the methodology for estimating emissions and to get better information about farming practices. The current methodology is largely based on applying IPCC Tier 1 global emissions factors that do not reflect soil and climatic conditions in the UK, and is in part based on livestock numbers. It suggests that agriculture emissions were around 57 MtCO₂e (10% of UK greenhouse gas emissions) in 2012.

Estimated agriculture emissions fell 3% from 2007 to 2012. While this is broadly consistent with our high-level indicators, it does not imply that the underlying potential for emissions reduction that we identified has been addressed, given the lack of evidence that changes in farming practice have driven emissions reductions.

Our indicators also include carbon intensity of arable and pasture land and livestock productivity. In each case, there is no clear evidence that farming practice has become more carbon efficient in recent years.

- Nitrous oxide intensity of arable land – largely related to use of fertiliser for growth of crops – increased slightly over the first carbon budget period.
- While nitrous oxide intensity of grasslands fell, this reflects lower livestock numbers feeding on this land rather than more efficient use of fertiliser.
- Although livestock productivity has improved, it is unclear whether this has been achieved through more carbon-intense diets.

Better data are needed to be able to assess fully what has is happening in terms of farming practice. The new Smart Inventory will help in this respect, as will data collected to assess progress against Defra's indicators.

However, further monitoring and evaluation of the industry GHG Action Plan is needed to fully assess its effectiveness in driving changes in this sector. This will make it possible to take an informed view on whether the current light-touch policy approach to reduce agriculture emissions is working, or whether new policies with stronger incentives are required.

12. Progress reducing waste and F-gas emissions

(i) Waste and F-gas emissions trends

Waste emissions (predominantly methane emissions arising from biodegradable waste degrading anaerobically in landfill sites) and F-gases (mainly from their use as coolants in refrigeration and air conditioning) accounted for around 4% and 3% respectively of total UK emissions in 2012, the latest year of available data.

Estimates of waste emissions have been revised upwards by around 30% since our last progress report, due to a review of the methane capture rates at landfill sites. The Committee previously recommended that capture rates should be measured rather than assumed, and the new estimates reflect the latest attempts to measure performance.

Between 2007 and 2012 waste emissions fell by 24%, continuing a longer-term trend where emissions have fallen by 54% since 1990, largely due to reduced waste landfilled and increased capture of landfill methane. F-gas emissions rose by 12% in this period, continuing a longer-term trend where emissions have risen by 33% since 2000, and largely driven by growth in demand for products such as air conditioning and refrigeration units.

(ii) Drivers of progress reducing waste emissions

Progress to date has been driven by the landfill tax, which has increased from £7/tonne on its introduction in 1996 to £80/tonne in 2014, supplemented by voluntary responsibility deals, information awareness campaigns and strategies to support anaerobic digestion. These have led to a reduction in the amount of waste arising and in the share that is sent to landfill.

However, large volumes of paper/card, food, wood and textile waste continue to be sent to landfill and barriers may prevent the landfill tax from driving effective action throughout the waste chain (collection and disposal, as well as prevention).

We therefore repeat our recommendation for the Government to publish specific strategies on how to reduce each of the main biodegradable waste sources, to consider mandating UK-wide provision of separate food waste collection services by local authorities, and to consider bans on major sources of biodegradable waste from landfill on a case-by-case basis.

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- We made these recommendations in our 2013 progress report to Parliament. The Government responded that priority should be placed on waste prevention to reduce biodegradable waste sent to landfill; that it is for local authorities to decide on provision of separate collection of food waste; and that they did not believe landfill bans were the best way to achieve this goal.
 - Nevertheless, action needs to be taken at every step along the waste chain including collection and disposal. Wales and Scotland already have or are planning both separate food waste collection and biodegradable waste landfill bans. Such actions to divert biodegradable waste from landfill could further unlock potential for producing energy through anaerobic digestion.

There may also be potential to reduce emissions by improving the average rate of methane capture at landfill sites, given that the new estimates suggest this is lower than previously thought and below levels being achieved in other countries and under best practice. Therefore, we recommend that the Government publish an approach to increase methane capture rates based on their improving evidence base, towards best practice, with milestones and actions to ensure these are met.

(iii) Achieving reductions in F-gas emissions

The EU F-gas Regulation introduced in 2006 reduced the growth in F-gas emissions, which have been flat since 2010 at an EU level, although UK F-gas emissions increased by 2% between 2010 and 2012.

An update to this regulation, which applies from January 2015, aims to cut the EU's F-gas emissions by two-thirds from 2014 to 2030. The new regulation limits the total amount of the most important F-gases that can be sold in the EU from 2015 onwards, phasing them down in steps to one-fifth of 2014 sales in 2030. This now needs to be transposed to UK legislation.

We recommend that Defra ensures UK businesses comply with the new regulation and seek opportunities to go further where cost-effective alternatives exist; if these are found, the Government should push for stronger implementation at the EU level.