2020 Hindsight

Policy Exchange

Does the renewable energy target help the UK decarbonise?

Simon Moore
Edited by Simon Less

2020 Hindsight

Does the renewable energy target help the UK decarbonise?

Simon Moore
Edited by Simon Less

Policy Exchange

About the Author

Simon Moore joined Policy Exchange in August 2010 as a Research Fellow for the Environment and Energy Unit.

Before joining Policy Exchange Simon worked for London-based think tank The Stockholm Network. He has a Master's degree in Public Policy from the University of Maryland and a Bachelor's degree in Politics from Lancaster University, where he was awarded the Oakeshott Prize for best overall performance in political theory and comparative politics.

Simon's research interests include energy security and EU-Russia relations.

Simon Less is Research Director, Environment and Energy, at Policy Exchange. He was previously a Director at Ofwat, leading market reform in the water sector, and has held a number of Senior Civil Service positions in the Treasury, including leading on energy policy, and in the Ministry of Justice. Simon is a Senior Research Associate at the Regulatory Policy Institute in Oxford; an independent regulatory policy consultant; and a trustee of ReStore Community Projects, a London furniture reuse charity. He has a first class degree and PhD from Cambridge University in chemistry, and an MBA from Imperial College Business School.

Published by
Policy Exchange, Clutha House, 10 Storey's Gate, London SW1P 3AY
www.policyexchange.org.uk

ISBN: 978-1-907689-00-0

Printed by F1 Colour
Designed by SoapBox, www.soapboxcommunications.co.uk

Contents

Policy Exchange's Environment and Energy Unit

The work of the Environment and Energy Unit at Policy Exchange

Policy Exchange's Environment and Energy Unit conducts innovative and independent policy research into a wide range of environmental challenges, including climate change. We produce a range of publications and bring together stakeholders through events, to disseminate our findings and promote our ideas. Our work seeks ways to tackle environmental challenges effectively, while minimising adverse impact on living standards. We promote well-designed regulation to exploit the power of markets to achieve positive environmental outcomes. To find out more about the work of the unit, contact: simon.less@policyexchange.org.uk

Acknowledgements

Policy Exchange would like to thank the Hadley Trust for its generous support for this project. We would also like to thank those who gave their opinions and advice at various points throughout.

Executive Summary

The UK has adopted a number of policies promoting decarbonisation of the electricity sector, as part of meeting the target for reducing overall UK greenhouse gas emissions by 80% by 2050. The dominant policies are those aimed at deploying renewable electricity generation by 2020. These policies are in large part driven by a European Union directive which mandates that the UK supply 15% of its total energy demand from renewable sources by 2020.

This report finds:

- The renewable energy target is hugely and unnecessarily expensive. Requiring the use of specific (renewable) technologies in the short-term raises the costs of decarbonisation. The target costs far too much to achieve far too little decarbonisation;
- The renewable energy target damages long term decarbonisation efforts in the UK and abroad;
- Government needs to take steps now either to renegotiate the target or to reduce the wasted costs of implementing it.

A cost-effective process of UK decarbonisation is important

This report stresses the importance of cost-effectiveness in the electricity decarbonisation process, because:

- The costs of decarbonisation reduce overall welfare in other areas, including through effects on business competitiveness;
- There are political limits to resources that can be devoted to electricity decarbonisation, so more cost-effective decarbonisation enables more decarbonisation to be achieved faster;
- The more expensive electricity becomes, the harder it will be to secure decarbonisation beyond the electricity sector, through electrification of the transport and heating sectors;
- What matters most in mitigating climate change is not reducing the UK's less than 2% of global electricity emissions, but global decarbonisation. The biggest potential impact from UK decarbonisation is as an example to other countries. An unnecessarily expensive process of UK decarbonisation does not set a compelling example to others.

Emphasising cost-effectiveness is not abdication in the climate change fight, but on the contrary is the only way ambitious carbon reductions can be achieved.

The renewable energy target fails to recognise future uncertainty about the cost-effective decarbonisation path

What cost-effective decarbonisation – of electricity and of the wider economy – over the next few decades will look like is highly uncertain and impossible to forecast accurately. We cannot know at present the future capacities needed, the costs and optimal mix of generation and demand-side technologies, and the most cost-effective order in which they should be deployed. New information to inform these judgements will be revealed over time.

In this report we conduct a 'meta analysis' of many different studies which look at how the UK is likely to reach the 2050 decarbonisation target. We find that the studies project a very wide range of different possible contributions from renewables to the 2050 target, ranging from 10% to 75% of electricity generation. Also, the timing of deployment of different technologies, particularly renewables and nuclear, varies substantially depending on assumptions about future rates of technological development and other factors.

Lack of information about the best future path of decarbonisation means that policy should be designed with recognition of that uncertainty. Policy should enable a wide range of options and technologies, stimulate innovation, help reveal new information, and encourage flexible adaptation as new information arises. Well-functioning, flexible markets are critical, subject to effective carbon pricing, and supported by public resources focused on effective research, development and demonstration.

The renewable energy target is hugely and unnecessarily expensive

Current UK energy policy is subject to a large number of different carbon and renewable energy targets. Of all the targets, the EU 2020 renewable energy target (RET) drives the largest and costliest policy interventions. The UK's contribution to the RET requires it to increase renewable energy's share of total primary energy use from 1.3% in 2005 to 15% in 2020, implying roughly 30-35% of electricity coming from renewables. This target is legally binding on the UK.

However, none of the models examined in our analysis found that meeting the renewable energy target was necessary or desirable for achieving the target for 80% decarbonisation of the UK economy by 2050. In fact, we conclude that the renewable energy target damages the prospects for achieving decarbonisation objectives in 2050 by allocating resources inefficiently, by failing to maximise innovation in low-carbon generation, and by setting an example of expensive decarbonisation other countries will find far from compelling.

The huge cost of the renewable energy is its biggest problem. It costs far too much to achieve far too little decarbonisation, diverting resources which could be better used elsewhere. The target also damages and distorts the ability of market processes to discover the best approaches to decarbonisation.

The government's 2008 Impact Assessment estimated the costs of the UK's overall Renewable Energy Strategy for meeting the 2020 target at approximately £66 billion NPV. A parliamentary written answer from January 2011 provided the following forecast of spending between 2011 and 2020 on the policies responding to the RET. "The spending is estimated at £32 billion from 2011 to

2020 under the Renewables Obligation; £3.6 billion under small-scale feed-in tariffs; £9.8 billion under the Renewable Heat Incentive; and £8.9 billion under the Renewable Transport Fuels Obligation." Pöyry Consulting found that the UK bears by far the highest cost burden of all EU countries of the target – around a quarter of the cost across the whole EU. The electricity sector takes the majority of the strain of meeting the RET, with £35.6 billion of the cost between 2011 and 2020 in that sector.

However, these enormous costs achieve little. Previous work by Policy Exchange highlighted the cost of the Renewables Obligation at £130 per tonne of CO2 saved, (and the Feed-In Tariffs for small-scale renewable generation at £460) compared with a marginal cost of carbon reduction of only around £14 per tonne of CO2 saved under the technology-neutral EU Emissions Trading Scheme.

Features of the 2020 renewable energy target which drive up costs include the following:

- The focus on selected renewable generation technologies unnecessarily narrows the range of decarbonisation options being pursued, regardless of whether these offer the most promising or cost-effective options;
- The short-term target requires large-scale deployment of some very costly technologies (in particular offshore wind) at an earlier date, and thus more expensively, than would occur under a technology-neutral approach;
- The very short time frame for large-scale offshore wind deployment substantially reduces the degree to which learning can feed through into lower costs of deployment;
- The target drives a co-ordinated spike in demand for renewable deployment across the EU, thus bidding-up prices as countries scramble to meet their contributions to the 2020 target;
- The excessive level of ambition for renewable deployment in the UK raises widespread concerns that the target will not be met, and the resulting regulatory uncertainty could lead to higher costs;
- The need to meet a target so closely defined in terms of technologies, capacity and timing, is pushing government policy towards more 'central planning', which damages the ability of the market to find the most cost-effective approaches.

The renewable energy target damages the prospects for UK decarbonisation to meet the 2050 target

The huge and unnecessary costs of the RET impose burdens on the economy, increasing businesses' costs and reducing household disposable income. Crucially, the RET also risks damaging the prospects for UK decarbonisation to meet the 2050 target and limits the UK's impact on encouraging a global decarbonisation process:

- The RET uses up the public's willingness to pay extra for energy for relatively little return, squandering the total resources available for decarbonisation, and damaging the prospects for meeting the ultimate 2050 carbon target.
- Available resources have to be focused on meeting the RET by 2020, rather than on supporting the innovation required to deliver decarbonisation over

the period to 2050. Spending huge sums on installing 11 GW or more of extra offshore wind capacity in only nine years is not the optimal way to maximise new knowledge.

- The RET depresses the EU Emissions Trading System (ETS) price by forcing companies to make carbon reductions through expensive renewable deployment, *without delivering any additional carbon reduction*. In other words, it disincentivises relatively cheaper carbon reduction measures;
- A key purpose of UK decarbonisation is to set an example to other countries, since the UK can have little impact on climate change on its own. But the huge costs of meeting the renewable energy target presents a far from compelling example to other countries for how to decarbonise;
- By unnecessarily raising the cost of electricity, the renewables target will tend to deter electrification of other sectors, such as space heating and transport, which will be needed as part of economy-wide decarbonisation to meet the 2050 target;
- By unnecessarily raising the cost of electricity, the RET could drive large energy users overseas, into jurisdictions where power is produced more carbon-intensively than in the UK.

Some argue that encouraging early investment in renewables will make British businesses into market leaders in renewable technologies. They will be able to export their expertise and products, yielding jobs for British workers and extra income for the British economy. But several questionable assumptions underlie this proposition. The first is the assumption that being a 'world leader in renewables' is more desirable than boosting alternative sectors through the employment of the same economic resources but allocated wherever the market would steer them. The second is the assertion that government policy is capable of creating such world leaders. The third is the assumption that the renewable energy target is the best available policy approach to accomplishing it. The history of government 'picking winners' in terms of future export industries is not good, and policies have often resulted in huge waste of resources.

Again, some argue that having a large renewable generating base helps protect consumers from future high fossil fuel prices, and price volatility. The first problem with this thesis is that insulating customers from price volatility by locking them in to a guaranteed *high* price for renewable energy is not particularly attractive. Secondly, the future path of global gas prices is far from clear, in particular given developments in relation to unconventional gas. But importantly, the government has no information about future prices that is not also available to the market. Market players have incentives to respond to future price expectations and to provide products to smooth and hedge price risks, if there is a demand from customers.

A third argument put forward in favour of the RET is that we have to rebuild a substantial proportion of generating capacity in the next 10-20 years, and if we allow gas to be built we will be stuck with it. Our analysis of 2050 models shows that that building substantial new gas generation, with half the emissions of coal, between now and 2020 would be compatible with 80% decarbonisation by 2050. In these scenarios, newly built gas would act as a bridging technology. In the latter years of its expected life span, gas generation might be switched to a reduced role, providing dispatchable peaking capacity, be retrofitted with CCS if the technology is successful, or 'stranded' (i.e. closed ahead of its 'natural' end of life), having paid back its capital costs over the intervening years. If the alternative is hugely expensive offshore wind in the 2010s (which would anyway need to be replanted after 20 years of operation), then even stranding gas generation is likely to be more cost-effective.

Policy needs to focus on carbon, including an effective carbon pricing framework and support for low carbon innovation

Policy needs to focus on carbon, not renewable generation deployment. The key focus for electricity decarbonisation policy needs to be building a more credible long-term carbon-pricing framework. The Treasury's proposal for a new Carbon Pricing Support Mechanism is a reasonable approach (given the current EU context), but it needs to be given greater long-term credibility, for example through contractual guarantees, and a longer timeframe.

The other critical element of decarbonisation policy is effective support for low carbon innovation. Innovation is what will eventually deliver our challenging long-term decarbonisation objectives. Low carbon research, development, demonstration and, often, early stage deployment, are not fully responsive to carbon price-driven market pressures. So support is needed to complement any effective carbon pricing framework (and more so in the absence of a fully effective carbon pricing framework). Support interventions could take many forms – tax breaks, R&D credits, prizes, subsidies or government procurement programmes. Critically, however, interventions should be distinct and separate from the business of mass deploying low carbon generation. Innovation interventions must be focused on maximising learning, not on meeting carbon reduction targets. It is for markets operating flexibly within an effective carbon-pricing framework (carbon cap or tax) to make least cost deployment decisions.

The renewable energy target should be renegotiated

Ideally, the UK should negotiate the abandonment, downgrading, or its exit from, the EU renewable energy target as the most direct way of escaping its costs and distortions. The RET damages the emissions reduction agenda by imposing hugely disproportionate costs, and by undermining the electricity and carbon markets. By putting emissions reductions, not renewables, at the centre of climate policy, the EU could focus its efforts on making the greatest impact, and setting the most compelling example to others, with its climate programme.

The UK government has been at the forefront of moves to tighten the emissions cap which, along with the RET, forms part of the EU's '20-20-20' package. Any tightening of the carbon cap should go hand in hand with loosening or removing the technological (renewables) requirements for its achievement. In this way, it could be demonstrated clearly that loosening the stranglehold of the renewables target was not about backing away from carbon emissions reductions. Additional carbon emissions reduction could be secured, and at lower cost.

With the removal of the RET, subsidies for renewable generation – in particular the Renewables Obligation – could be heavily reformed, switching focus to supporting low carbon learning and innovation.

- Savings could be used to support decarbonisation in a variety of other ways, for example by supporting increased energy efficiency measures, as the cheapest route to short-term carbon reductions, or by investing in innovation which could increase the chances of success of meeting the 2050 target. Given the wasteful spending driven by the RET, a significant proportion of savings could simply be taken as lower future energy bills, without damaging expected decarbonisation.
- No further targets for renewable generation deployment levels, or any other specific technologies, should be set for the period after 2020. European and UK policy should instead focus on carbon.

In the meantime, the renewable energy target can be met while saving up to £12.5 billion in wasted costs

If the RET cannot be renegotiated soon, this report sets out how, by focusing on achieving the target at minimum cost, £9-12.5 billion could be saved by 2020, by:

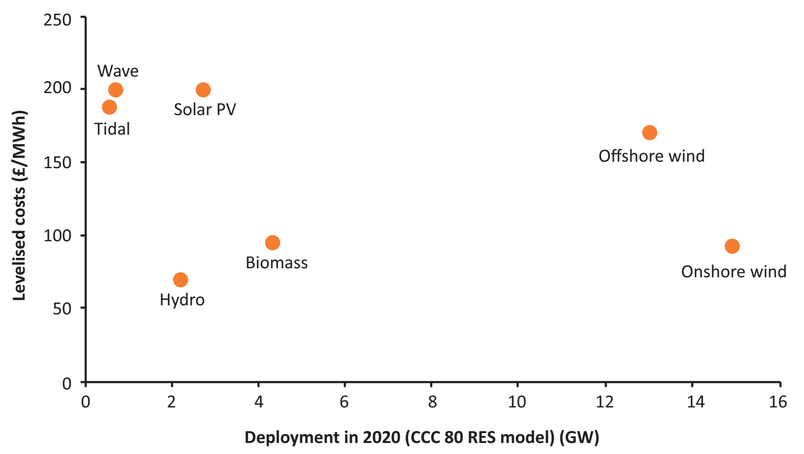
- scaling back the current Renewable Energy Strategy (RES), in particular to reflect lower 2020 GDP and energy usage forecasts than when it was drafted in 2008 (pre-recession);
- using cheaper renewable technologies instead of expensive ones such as offshore wind;
- increasing energy efficiency effort; and
- planning to make use of the Renewable Energy Directive's 'flexibility mechanisms' to trade renewable energy 'credit'.

When the Renewable Energy Strategy was written, electricity demand for 2020 was projected to be 386 TWh. Since the recession, recent estimates have revised that figure down to 375 TWh. The loss of 11 TWh of demand implies a decline of 3.85 TWh of renewable generation required or approximately 1.3 GW of installed offshore wind capacity in 2020, amounting to a capital cost saving of £3.9 billion.

Offshore wind is an outlier in the UK renewable generation policy (see Figure i), having a cost profile similar to 'experimental' technologies, such as wave power, but being subsidised to try to achieve an expected large scale of deployment by 2020 in line with much cheaper technologies such as onshore wind and biomass. The government's massive proposed levels of expensive offshore wind deployment over the next nine years cannot be justified.

- Policy could be revised to bring forward co-firing biomass, onshore wind, and other technologies, as cheaper replacements for the installation of expensive offshore wind.
- The government appears to be deliberately holding back co-fired biomass, including through a cap on its subsidised capacity. Relieving the cap could bring forward an additional 4 TWh of renewable generation in 2020 from co-firing, saving an estimated £0.5 billion.

Figure i: Technology costs and deployment rates for different renewable technologies



The UK planning system is the major barrier to wider expansion of onshore wind which is around half the cost of offshore wind. 6.8 GW of onshore wind applications are held up in planning processes. Historically, the planning approval rate for onshore wind projects is only about 40%. If planning reform could improve this to 60% it would allow about 1.4 GW of additional capacity to be brought onshore by 2020 – yielding a saving of around £1.6 billion compared to building the equivalent capacity offshore. Planning reform should not ignore or simply override the legitimate concerns of local people. Instead, a successful reform would recognise the costs to local people of new developments, and enable communities to agree appropriate benefits or compensation in return. The enormous additional cost of the 'next best alternative' (offshore wind), means large scope for compensation to local communities for onshore wind farms, while still making savings for society overall. If an additional 200 MW onshore development was built, saving £230 million compared to its offshore equivalent, then using only 10% of this saving to compensate local people would create a huge compensation pot of £23 million.

- Planning barriers to onshore wind and other generation should be urgently addressed. Mechanisms for rewarding or compensating local communities for accepting onshore wind or other generation developments should take into account the huge savings from securing such planning consents compared to the alternative of offshore wind. Increasing the success of onshore wind planning applications alone by 20 percentage points could save £1.6 billion by 2020.

Many energy efficiency measures, considered expensive as demand reduction measures, would still be more cost-effective than offshore wind. For example, solid wall home insulation, which is generally considered too expensive to be part of the Green Deal, has broadly comparable costs to offshore wind *in terms of contribution towards the renewable target alone* (by reducing energy demand it reduces the need to build 15% renewable generation). In addition, an energy efficiency approach to the renewable energy target delivers around seven times the carbon emissions reduction as an offshore wind based approach.

There is a provision for trading between EU Member States of their contributions to the RET, which a number of countries are planning to use, but not the UK. The UK could buy 'statistical transfers' of renewable energy from countries projecting a surplus such as Germany or Spain. This would almost certainly be substantially cheaper than building our own offshore wind. But even if this were not the case, it would be worth paying, say, Poland a contribution to build more onshore wind and biomass than they were planning, rather than build our own much more expensive offshore wind. We estimate that between £3.4 billion and £6.7 billion could be saved by 2020 through the UK planning to trade only one percentage point of the renewable energy target.

Table i summarises the estimated savings potentially available from the measures set out above for planning to meet the RET at minimum cost, totalling £9-12.5 billion by 2020.

Measures could be pursued individually or as a package. Should some individual measures prove unachievable, there is scope for others, in particular trading, to be pursued with greater ambition than assumed in Table i, in order to maintain the ambition of the package as a whole.

Table i: Summary of some of the potential savings of meeting the renewable energy target at least cost

Policy measure	Estimated capacity of offshore wind saving by 2020	Estimated cost saved or reallocated
Removal of cap on co-firing biomass	1.4 GW	£0.5 billion
Planning reform (20 percentage point increase in granting permission for onshore wind)	1.4 GW	£1.6 billion
Use of flexibility (trading) mechanisms	5.7GW	£3.4-6.7 billion
Cutting support no longer needed due to reduced energy demand from recession	1.3 GW	£3.9 billion
Total	**9.8 GW**	**£9-12.5 billion**

Recommendations

To effectively contribute to carbon emissions reduction, both to meet the UK's 2050 target for 80% emissions reduction and globally, there needs to be an exemplary and cost-effective process of UK electricity decarbonisation. This report has argued that the current UK strategy, dominated by the EU renewable energy target, is a hugely costly obstacle to such a process. We make the following recommendations for change to current policy.

Under any circumstances:

1. **The key focus for electricity decarbonisation policy needs to be building a more credible long-term carbon pricing framework. The Treasury's proposal for a new Carbon Pricing Support Mechanism is a reasonable approach (given the current EU context), but it needs to be given greater long-term credibility, for example through contractual guarantees of the carbon price and a longer timeframe.**
2. **No further targets for renewable generation deployment levels, or any other specific technologies, should be set for the period after 2020. European and UK policy must instead focus on carbon.**

The costs of the renewable energy target need to be tackled, ideally through adopting Policy Option 1, renegotiation of the target:

3. **As a first priority, the UK should explore the scope for renegotiating the 2020 renewable energy target, which currently results in huge and unnecessary spending in the UK and which damages the prospects for overall electricity decarbonisation.**
4. **UK support for any moves to extend the ambition of the EU 2020 carbon reduction target should be contingent on removing the technology constraints on its achievement, by scrapping renewable energy targets.**
5. **Having removed the constraint of the renewable energy target, the government should reform its renewable support policies to instead focus on low carbon innovation and learning, by focusing on developing, demonstrating and, where appropriate, limited early stage deployment of new technologies which hold out the promise of a substantial global impact. Such support programmes should not be mixed up with mass deployment of generation, which should be governed by market choices subject to a credible, long-term carbon pricing framework.**

We do not recommend Policy Option 2, simply disregarding the EU target, given the serious implications of a deliberate policy to abandon a UK legal commitment.

6. **If renegotiation of the EU renewables target proves unachievable quickly, then a package of measures should be brought forward to minimize the cost of the response to the renewable energy target, with the potential to save £9-12.5 billion by 2020. Measures include following:**
   a) **As a result of the recession electricity demand in 2020 is forecast to be 11 TWh less than forecast when the Renewable Energy Strategy was developed in 2008. There is no case for doing more than the minimum necessary to meet the renewable energy target. Therefore the generosity of renewable generation subsidy levels should be scaled back to produce proportionately less renewable capacity in 2020, potentially saving £3.9 billion by 2020.**
   b) **The cap on the amount of co-fired biomass which qualifies for renewable subsidies should be lifted, bringing forward a relatively**

cheap source of short-term renewable generation as a bridge to the 2020 renewable target, saving a potential £0.5 billion.

c) **Planning barriers to onshore wind and other generation should be urgently addressed. Mechanisms for rewarding or compensating local communities for accepting onshore wind or other generation developments should take into account the huge savings from securing such planning consents compared to the alternative of offshore wind. Increasing the success of onshore wind planning applications alone by 20 percentage points could save £1.6 billion by 2020.**

d) **The huge costs of meeting the renewable energy target should be fully taken into account in setting the level of ambition for energy efficiency policies, including the Energy Supplier Obligation for supporting energy efficiency improvements in 'hard to heat' homes.**

e) **The government should plan to use the flexibility provisions of the Renewable Energy Directive to buy cheaper renewable generation credit towards the UK's target from other countries, saving £3.4 to £6.7 billion if merely a single percentage point of the UK's target were to be traded.**

1
Introduction

The UK has adopted a number of policies promoting decarbonisation of the electricity sector, as part of meeting the target for reducing overall UK greenhouse gas emissions by 80% by 2050. The dominant policies are those aimed at deploying renewable electricity generation by 2020. These policies are in large part driven by a European Union directive, which Tony Blair signed up to, which mandates that the UK supply 15% of its total energy demand from renewable sources by 2020.[1] There is broad consensus that meeting this target will require the UK to produce 30-35% of its electricity from renewables by 2020, because of the constraints on using renewable sources in other areas of energy consumption, such as transport and heating.

The renewable energy target has focused public spending on climate change policy towards renewable generation deployment, but has been the subject of widespread criticism, particularly in relation to its massive cost.

The purpose of the research in this report is to examine whether this strategy, focused on delivering renewable generation by 2020, is the best approach towards achieving electricity decarbonisation as part of meeting the 2050 target.

As part of the research, we have drawn together the work of a number of research groups who have modelled decarbonisation of the UK energy system to 2050, to understand the range of possible trajectories and the potential role of renewables.

1 Sir David King, the former chief scientific advisor to the government, has said that "there was some degree of confusion at the heads of states meeting dealing with this ... If they had said 20% renewables on the electricity grids across the European Union by 2020, we would have had a realistic target but by saying 20% of all energy, I actually wonder whether that wasn't a mistake." BBC News (2008), 'Poverty fears over wind power', London, http://news.bbc.co.uk/1/hi/7596214.stm. Author interviews with Treasury officials from the time the decision was taken suggest the switch from 20% of electricity to 20% of total energy coming from renewables was an unexpected reversal of the UK negotiating position.

2
Approach to Climate Change

While uncertain, the preponderance of scientific evidence points to major risks from climate warming. Among those who accept the scientific consensus, there is nevertheless a vigorous debate about how best to address the risks from climate change. Issues such as what the costs and benefits of different climate actions and the most effective ways to intervene all remain hotly disputed. Many of these debates revolve around economic questions, such as the appropriate rates at which to discount future costs of climate change, as well as how governments are most effective in intervening to achieve low carbon futures. It is beyond this report to assess this debate in detail. The focus of this report is on the policy approach to UK electricity decarbonisation. We therefore take as read the UK government's target of reducing the UK's total carbon emissions by 80% (compared to 1990 levels) by 2050 for the purposes of this report. That does not imply that this target should be pursued at any cost to society, however large. At present, we cannot know the costs of meeting the target, and the focus of this report is to promote cost-effectiveness as a key component of a successful decarbonisation policy to 2050.

3
Importance of Cost-Effective Electricity Decarbonisation

Cost-effective decarbonisation is important for four main reasons:

- The costs of decarbonisation reduce overall welfare in other areas, including through effects on business competitiveness;
- There are political limitations on the resources that can be devoted to electricity decarbonisation, so more cost-effective decarbonisation will enable more decarbonisation to be achieved faster;
- The more expensive electricity becomes, the harder it will be to secure decarbonisation beyond the electricity sector, through electrification of the transport and heating sectors;
- What matters critically in mitigating climate change is not reducing the UK's less than 2% of global electricity emissions, but global electricity decarbonisation. The biggest potential impact from UK decarbonisation is as an example to other countries. An unnecessarily expensive process of UK decarbonisation does not set a compelling example to others.

Cost-effectiveness should be the critical criterion for assessing the carbon reduction policy options. Emphasising cost-effectiveness is not abdication in the climate change fight, but on the contrary is the best way ambitious carbon reductions can be achieved.

Political and economic limitations on climate spending

Government, individuals and businesses each have multiple priorities for spending. Money spent on mitigating climate change has an opportunity cost – those resources cannot be spent on something else. For business, this represents money not spent on productive assets, be they capital or labour, nor returned to shareholders. (It can also reduce firms' competitiveness compared to rivals in countries less affected by climate policy, as discussed in Chapter 7.) Households may forgo some other desired or needed good in order to pay for a more expensive low-carbon product (including low-carbon electricity).

The government has argued that spending on climate mitigation will create future UK 'green jobs' and green growth. Key to the argument is that government industrial policy can pick future UK green industry 'winners', and intervene to put them in a better position than their competitors in other countries, to capture projected future growth opportunities. Some jobs will undoubtedly arise from measures put in place to tackle carbon emissions. But making green jobs *per se* an explicit objective of energy policy is unlikely to lead to higher levels of employment in the long run, and could lead to extensive wastage on inefficient decarbonisation programmes. There is a very poor track record of government's picking future industry winners in this way. Of course, there is considerable scope for financially cost-beneficial carbon reduction measures, in particular to improve energy efficiency which should straightforwardly benefit the economy.

> "Most of the British public believes climate change is a serious problem and an important area for government action. But the public is unlikely to be willing to stomach excessively large costs in order to decarbonise"

Most of the British public believes climate change is a serious problem and an important area for government action. But the public is unlikely to be willing to stomach excessively large costs in order to decarbonise. There will be inevitable political limits to the public's willingness to pay for this policy area. In the USA in 2009, a survey attempted to find the limits of US public willingness to pay for carbon mitigation. More than half the population there was unwilling to pay as little as $175 extra per year on energy bills for the now-abandoned American Clean Energy and Security Act (Waxman-Markey) Bill.[2] While the British public has historically given climate change a more sympathetic hearing, the costs of current UK policy are likely to be much higher than the figure at which most Americans balked. As Policy Exchange's 2010 report *Green Bills* explained, by 2020 the costs of current energy policies alone will reach around £6 billion per year for households and around £10 billion per year for non-domestic customers, levied on gas and electricity bills. By that time, the accumulated energy and climate change policies levied on bills will constitute around 2% of entire UK taxation, the equivalent of 4p on the basic rate of income tax today.[3] UK surveys suggest that the public sees climate change as less important than other areas of public policy including the economy, crime and the NHS.[4] Money to spend in all these areas is finite. While the government and others seek to lead, rather than simply follow, public opinion on climate action, perceptions of wasteful and inefficient spending of public funds on decarbonisation could jeopardise public acceptance of climate action generally, reducing the resources available.

Noël and Pollitt point out that "we should keep in mind that political parties fight elections about transfers of less than half of one percent of GDP... In the recent past, leaders and governments have fallen on the back of unpopular (i.e. expensive) climate policies in Australia, Sweden, Norway and New Zealand; President Sarkozy of France had to remove his flagship proposal of a national carbon tax in the face of public outrage."[5] Over recent years, the UK has had a strong degree of cross-party support for climate change policy. However, over those years, the costs have been relatively restrained, certainly in comparison to what lies ahead if the renewable energy target alone is to be achieved, let alone further progress towards the 2050 target.

2 *The Economist*/YouGov Poll, June 28-30 2009, http://media.economist.com/media/pdf/Toplines20090701.pdf

3 Including the Renewables Obligation, Feed-in Tariffs for microgeneration, the Climate Change Levy, the roll-out of smart meters, the EU Emissions Trading Scheme, the Supplier Obligation, and the Carbon Capture and Storage levy. Less S (2010), *Green Bills*, Policy Exchange.

4 McIlveen R (2010), 'The Cost of Cutting Carbon' in Less S (Ed) *Greener, Cheaper, Policy Exchange*, p. 17

5 Noël, P and Pollitt, M (2010), "UK Energy Policy: Radical Reforms Needed" in *Parliamentary Brief* (July 2010)

Impact on overall climate change mitigation

Climate change is a global problem which will require a global solution. The amount the UK can contribute to this through direct decarbonisation is tiny. The UK accounts for 1.7% of global greenhouse gas (GHG) emissions and less than 2% of global emissions from electricity production.[6] Thus, the value of the UK's effort to decarbonise electricity in the UK cannot be measured principally in terms of the carbon it cuts. Rather, a large proportion of its potential impact on global climate change will come in demonstrating to the rest of the world that cutting carbon can be achieved at acceptable costs, demonstrating effective processes for keeping decarbonisation costs down. Conversely, unnecessarily expensive electricity decarbonisation policies would not offer a credible or compelling example to other countries. At the same time, the UK should also be helping to develop and lower the costs of new and early stage low carbon generation technologies with the potential to be a significant part of global decarbonisation.

Thus, *how* the UK electricity sector is decarbonised is critically important in securing global impact. Electricity decarbonisation in the UK is a stepping-stone towards global electricity decarbonisation, and policymakers should see it in that context. If the UK's choices are not encouraging other countries to imitate them, then its efforts are wasted. The methods of UK policy matter as much as the results.

Compounding these problems, increasing the price of electricity through unnecessarily high-cost decarbonisation methods also risks jeopardising decarbonisation of other (non-electricity) parts of the UK economy. For uses such as transport and space heating, a critical option for decarbonisation comes through increased electrification. Increasing the cost of electricity relative to the oil and gas currently used will delay or deter electrification of these parts of the economy, and make it harder to reach the ultimate 2050 target.

6 The Committee on Climate Change (2008)

4

The Role of Uncertainty in Electricity Decarbonisation

What the path of cost-effective decarbonisation – of electricity and of the wider economy – over the next few decades will look like is highly uncertain.

The complexity of the systems involved in decarbonisation, and the timeframe over which measures will develop, means that the scope for accurate forecasting and planning is highly constrained. We cannot know at present the optimal future mix and capacities of generation and demand-side technologies and the most cost-effective order in which they should be deployed. A wide range of unknowns contributes to this uncertainty, including unknowns in relation to:

- the feasibility of key new technologies, such as carbon capture and storage (CCS);
- the future relative costs of existing and new generation technologies;
- possible new disruptive technologies;
- future electricity demand, which depends on unknowns about future energy efficiency, economic growth and developments in technologies which use electricity including transport and heating;
- international carbon reduction commitments and agreements;
- climate science itself.

This uncertainty means that policy should be aimed (a) to find out more information over time to reduce uncertainty; and (b) to recognise and be responsive to uncertainty. Therefore, to promote cost-effective carbon reduction, policy needs to enable and incentivise a wide range of options and technologies, to stimulate innovation, to help reveal new information, and to encourage flexible adaptation of approaches to decarbonisation as new information arises. Well-functioning market processes are critical, supported where appropriate by public resources focused on effective research, development and demonstration.

Generation technology unknowns

There are a number of different kinds of unknowns in relation to generating technology.

There are unknowns in relation to technical feasibility, for example, can CCS work effectively at an industrial scale? In some cases, there are political unknowns in relation to technologies, for example can onshore wind (or nuclear) overcome protests of 'not in my back yard'? Perhaps most important are the economic unknowns – how far and how fast can a new technology that works be brought down in cost? Also relevant are the evolving costs of fuels including gas, coal and biomass. Finally, there is a chance that technological breakthroughs could arise which fundamentally reshape the climate or energy debates.

As we move through the next 40 years, generation technologies will evolve in different and often unexpected ways. The revelation of new information – whether about CCS feasibility, offshore wind capital costs or gas prices – affects what the optimally cost-effective decarbonisation trajectory is. That includes what the best mix of generation technologies is, as well the order in which technologies should be deployed. The order of technology deployment is critical in driving overall costs: deploying cheapest technologies first, and more expensive ones later, or waiting for technology costs to fall, may radically decrease the costs of decarbonisation. For example, if the costs of offshore wind remained higher than expected and gas prices lower, then an optimal trajectory may involve more gas generation in the earlier phase, with offshore wind coming in later.

In addition, low carbon generation technology costs should not be looked at in isolation. The evolution of costs of low carbon generation ought to affect the relative resources and urgency devoted to decarbonisation in electricity vs. heat, transport and other sectors.

Table 1 provides Mott MacDonald's benchmark cost estimates (as used by the Department of Energy and Climate Change) for a selection of available generating technologies, and shows their assessment of the scope for learning-based cost reductions and potential exploitation levels. Low or no emission technologies are those with the most scope for future learning to take place, and thus the most uncertainty around their future cost, and potential to contribute.

The unknowns in relation to different generating technologies vary in importance depending on the characteristics of the technology.

For *gas* generation, the main unknown is the future cost of fuel. Gas prices fluctuate in the traded domestic market in response to supply and demand pressures. Expansion of the UK's piped gas and Liquefied Natural Gas (LNG) import facilities, combined with increasing proportions of global gas being traded on the international LNG market have enabled the UK to become more resilient to domestic price spikes, but have increased exposure to global price movement. Meanwhile, shale gas has the potential to increase global reserves significantly. Experience from the United States, where shale production has been pioneered, has been encouraging (proven gas reserves increased by 35% between 2006 and 2010, and prices dropped by around 40% over the same period). After years with sellers ascendant, the International Energy Agency estimates global reserves of unconventional gas to be more than five times proven conventional resources, bringing down prices and reducing security of supply concerns. Longer-term trends are, of course, harder to determine. Expanding demand for gas from developing economies could cause prices to rise as importers compete for available resources – even if the 'shale revolution' occurs, new demand could outweigh additional supply. But if gas prices were lower in the medium-term than expected it could be cost-effective for gas to play a larger role in the earlier phase of electricity decarbonisation. Low gas prices

7 Mott MacDonald (2010), *UK Electricity Generation Costs Update,* p. 87 Using Case 1 figures http://www.decc.gov.uk/assets/decc/statistics/projections/71-uk-electricity-generation-costs-update-.pdf

8 Jamasb, T, Nuttall, W et al (2008), "Technologies for a low carbon electricity system: an assessment of the UK's issues and options" in Grubb M, Jamasb T and Pollitt M, *Delivering a Low Carbon Electricity System*, Cambridge University Press, Cambridge, p. 75. MacKay D (2009), *Sustainable Energy – Without the Hot Air,* UIT, Cambridge. MacKay freely admits his estimates for capacity are exceptionally optimistic, as they look at technical capability rather than considering other real-world constraints, and also based on delivery times to 2050; for his comparisons with other projections see p. 107.

Table 1: Cost, output potential and capacity potential estimates for generating technologies

Generating technology	Subtype	Total current levelised costs (£/MWh)[7]	Maturity and scope for cost reductions and learning	Current installed capacity	Annual potential (Jamasb)/Capacity potential (MacKay)[8]
Gas	Non-CCS	80.3	Mature	35 GW	N/A
	CCS	112.5	Pre-demonstration	0 GW	N/A
Coal	Non-CCS	104.5	Mature	29 GW	N/A
	CCS	142.1	Pre-demonstration	0 GW	N/A
Wind	Onshore	93.9	Post-deployment, cost reductions expected with experience	<4 GW	50 TWh/ 50 GW
	Offshore	160.9 (190.5 for Round 3)	Post-deployment, cost reductions expected with experience	<2GW	100 TWh/ 120 GW
Nuclear		99.0	'Third generation' at demonstration phase, cost reductions expected with experience	11 GW	N/A
Solar	PV	N/A	Deployed, cost reductions expected with experience	<1 GW	<1 TWh/ 137 GW
Bio energy	Biomass	95-120	Deployed, some further cost reductions expected with experience	<2 GW	41 TWh/ 24 GW (includes biogas and non-generating biofuels)
	Biogas	50-60	Deployed, some further cost reductions expected with experience		
Marine	Wave	N/A	Pre-demonstration	<1 GW	33 TWh/ 10 GW
	Tidal barrage	N/A	Pre-demonstration (little scope for learning with big projects (e.g. Severn Barrage) as few opportunities to repeat)	0 GW	50 TWh/ 27.5 GW (includes tidal stream)
	Tidal stream	N/A	Pre-demonstration	<1 GW	18 TWh/ N/A
Geothermal	Ground source heat pumps	N/A	Deployed, some further cost reductions expected with experience	<1 GW	8 TWh/ 2.5 GW
Hydro	Large scale	70-80 (with reservoir)	Mature	4 GW (of which 2.8 GW is pumped storage)	5 TWh/ 3.75 GW (includes small scale)
	Small scale	N/A	Mature	<1 GW	10 TWh/ N/A
Oil		N/A	Mature	4 GW	N/A / N/A

would effectively make low carbon generation technologies relatively more expensive, and so it could be more cost-effective to switch resources at the margin to accelerate decarbonisation approaches in other areas, such as more energy efficiency or transport decarbonisation. We will discuss the question of lock-in in Chapter 6.

For *coal*, the critical uncertainty is whether carbon capture and storage can be made to work, at commercial scale at an economically competitive cost. Without it, it is hard to envisage a role for new coal generation in a significantly carbon-constrained future. CCS is largely unproven at commercial scale, and serious questions remain about its cost. Four CCS plants in different parts of the world are currently operational, trialling various methods for separation and capture processes. More demonstrations will be needed to provide a full understanding of the range of methods and to provide the 'learning by doing' experience to drive CCS costs down. The volume of storage potential is unlikely to pose a constraint on CCS in the UK for a long time – energy consultants Pöyry estimate there is enough capacity in depleted oil and gas fields alone to cope with the CO_2 produced by 18GW of CCS plant by 2030.[9] Coal seams that are too deep to mine and saline aquifers can also be used for CO_2 sequestration, though their capacities are less well understood. A CO_2 transport infrastructure would also need to be constructed to move trapped gases from generating locations to the storage fields. Were CCS not demonstrated to be cost-competitive at commercial scale, this could have a profound impact on the future optimal generation technology mix, as well as the overall costs of decarbonising electricity (see Chapter 7).

Onshore wind's main obstacle in the UK has come from the difficulty in obtaining planning permission. Continuing uncertainty over the ability of investors to get permission to build, and over the future of the planning system more broadly, makes projecting a future for onshore wind difficult. If the government eased planning system problems, onshore has the potential to make a much more substantial contribution to the generation mix in the UK, because of its relatively modest costs compared to some other technologies and demonstrated levels of deployment in other countries.

The critical unknowns in relation to offshore wind include difficulty of deployment, maintenance and longevity, and cost. There is relatively little experience at present with deep-water deployment and the operation and maintenance challenges over turbines' lifetime in hostile marine environments. The present high subsidy levels (two Renewables Obligation Certificates (ROCs), worth £74/MWh at current prices) required to sustain offshore wind reflect its current very high cost of deployment. The big questions are whether those costs can come down sufficiently, and if so how fast. The answer should determine offshore wind's future role – its proportion of generation mix and whether it is deployed early or late – in an optimal electricity decarbonisation trajectory. As with many generating technologies, a larger role for storage technologies could be beneficial for wind generation. When output peaks coincide with low demand periods (in the middle of the night, for instance) wind turbines may have to be switched off to prevent the grid being thrown off balance, More storage would allow this power to be retained and released to the grid when demand reached a sufficiently high level.

As with *onshore wind*, planning difficulties pose a challenge to expansion of nuclear power. Local areas which already have nuclear facilities tend to be reasonably welcoming to further development, but adding reactors in new areas is difficult, and ideological hostility to nuclear power in general is unique among generating technologies. Add to these struggles, the length of time required to construct the plant once permission is given and the arduous planning process

9 Pöyry Energy Consulting (2009), *Carbon Capture and Storage: Milestones to deliver large-scale deployment by 2030 in the UK*, http://downloads.theccc.org.uk/Poyry_-_CCS_Timelines_and_Milestones_for_CCC_2009_final.pdf, p. 34

means the lead-time on new build can be a decade or more, adding to uncertainty. The cost of building new nuclear plants is a key unknown. A prototype reactor that French manufacturer Areva is building at Olkiluoto, Finland, has suffered from chronic delays and cost overruns. With limited recent build experience, there is scepticism about the quoted prices for the new reactor fleet. The pace and costs at which the first new build nuclear plants develop should inform the ongoing role of nuclear generation in an optimal decarbonisation trajectory. With the safety of nuclear power having returned to prominence in the wake of the disaster in Japan, the political difficulties of future nuclear development have increased. At minimum, the costs of compliance with state-of-the-art safety codes will add to the economic obstacles faced by nuclear developers.

A key uncertainty about solar photovoltaic (PV) generation is whether it will be able to become cheap enough not to require continued large subsidies to compete in the UK marketplace. Given the limited output of solar installations in the UK (a function of latitude and climate) this seems in doubt. As the price of silicon has returned to its pre-recession heights and driven up the materials costs of manufacturing PV panels, optimistic projections of solar PV reaching grid parity within the next three years look unattainable, at least in the UK. In countries with sunnier climates, though, (especially those with desert expanses in which to install large facilities) solar may be a more competitive option. Its competitive position could also improve with developments in storing electricity.

Uncertainties related to the use of *biomass* in electricity generation include scope for expansion in the range of biomass fuels, fuel costs, demand for biomass in energy projects around Europe and policy limits on its use in some circumstances (see Chapter 8). Over the long term, the viability of a large expansion of biomass facilities depends on the amount of fuel material available – wood and fuel crops have already become a traded energy commodity. Given a currently relatively small domestic supply, importing from more established producers including Russia, Sweden and Canada may be necessary to fulfil demand at least over the short-term. As demand for biomass products grows, more land may be utilised for energy crops. Generators in the UK already use a variety of fuel sources including mainly forestry and agricultural residual products, as well as some wood and purpose-grown fuel crops. There is potential to expand further the usage of biomass fuel types, including fuels such as straw and olive cakes, creating revenue from agricultural wastes. Supply chain infrastructure, from growing fuel to processing and distribution, is less well developed in the UK than in other countries where forest industries have had a greater historic role, and would need to develop. Likewise, storage facilities at generating sites need to be adapted to suit the chosen fuel type, making frequent changes in supply source uneconomic. Improvements to processing and harvesting could improve the overall energy yield from biomass. If the potential for substantial new cost-effective, sustainable sources of biomass are borne out, domestically and/or internationally, then biomass could play a substantial part in an optimal electricity decarbonisation trajectory in the medium-term.

There is considerable space for learning to take place on marine generation, the processes of harnessing the energy of waves and tides. There are substantial unknowns in relation to the amount of energy devices could extract from these sources, or much in the way of practical experience from installing and operating many of the relevant technologies. As well as wanting to boost energy yields and lower manufacturing and installation costs, engineers working on marine energy sources have yet to discover the durability of installations in harsh maritime conditions.

One project proposed as a potentially significant contributor to UK generation is harnessing the tides of the River Severn, among the strongest estuarial tides in the world. Estimates of the potential output of a Severn barrage range up to 5% of total UK demand (at least for the eight hours per day it would be generating power) using well-established technology. However, the estimated economic and environmental costs of such a scheme have hitherto proven prohibitively high, while providing little scope for learning for future projects, causing the government to abandon in 2010 further study into the viability of the project. In the event of an urgent need to increase low-carbon generation, the Severn barrage idea could be revisited.

In summary, there are a number of critical unknowns associated with the range of generation technologies. Over time, new information will be revealed about these unknowns, which should have an important role in informing electricity generation investment and the optimal trajectory to decarbonisation.

Demand side unknowns

The future level and shape of electricity demand is a key unknown, with important consequences for the trajectory to decarbonisation. Future demand will depend on factors including:

- economic growth and the economy's mix of industrial sectors;
- the rate of change in overall levels of energy efficiency, including behavioural changes in households and businesses;
- developments in the technologies which use electricity, including developments in the electrification of transport and heating;
- the development of demand-side response technologies, including smart meters and associated 'smart grid' technologies.

Long-range predictions in the energy sector (and elsewhere) have often proven, historically, to be of limited value.[10] Looking ahead, among the forecasting models we looked at in this study (see Chapter 7), the highest estimates for electricity demand in 2050 were about 80% higher than the lowest estimates (see Figure 2 on page 50). Much depends on assumptions made by the modellers on, for example, levels of economic growth, energy intensity of production, improvements in non-industrial energy efficiency, and rates of electrification of transport, space heating and industrial processes.

The energy intensity (i.e. the amount of energy input per unit of GDP output) of the UK economy has improved at an average rate of around 2% per year since the 1970s, in part due to "improvements in energy efficiency; fuel switching; a decline in the relative importance of energy intensive industries; and the fact that some industrial uses, such as space heating, do not increase in proportion to output."[11] We would not therefore expect energy, including electricity, demand to rise in step with GDP, but GDP growth will remain an important influence on electricity demand.

10 Policy Exchange's *Re-Monopolising Power* provides a listing of failures of prediction and planning in the energy market, including the Central Electricity Generating Board predicting in 1970 that demand in 1995 would be twice the turnout figure, the failure to anticipate gas turbine generation, overoptimistic expectations for nuclear power, and the abrupt reversal between 2003 and 2006 of the government's position on nuclear, with it going from being seen as unnecessary to essential. Less, S. (2011), p. 11

11 Department of Trade and Industry (2002), *Energy Consumption in the United Kingdom,* London. Data from Office of National Statistics, available http://www.decc.gov.uk/en/content/cms/statistics/publications/ecuk/ecuk.aspx p. 13

It is worth noting that one of the ways the UK has achieved lower energy intensity is by importing more of its manufactured goods from abroad, in particular China in recent years, shifting the corresponding energy use, and carbon emissions, abroad in the process.[12] This illustrates how global economic development and UK trade with the rest of the world are also significant, and hard to predict, factors influencing future UK electricity demand.

Widespread behaviour change could have an important impact on reducing electricity demand. This could include many behaviours, for example, meat consumption, cycling or walking to work, or attention to household energy usage. Behaviour changes may be aided by manufacturers or by regulation, for example eliminating inefficient light bulbs or power-draining standby modes.

The anticipated electrification of transport has the potential to increase electricity demand, but also to bring about increased distributed electricity storage. In combination with smart grid technology, electric vehicles could act as demand 'smoothers', drawing power at times of low electricity demand (the middle of the night) and perhaps making it available back to the grid at times of peak demand or supply troughs (e.g. low wind speeds). Smart grids could allow similar smoothing of demand from domestic and industrial uses, by enabling power companies to price power depending on demand levels, or even to allow them to pay customers not to use power (as is already standard practice with large customers). Such 'demand-side response' developments reduce the generation capacity required to cover demand-supply peaks. Uncertainty about the future scale of such developments contributes to uncertainty about both future generation capacity needs and the costs of dealing with renewable generation intermittency.

Climate science unknowns

There are a number of levels of uncertainty in relation to climate science. Least uncertain is how the proportion of greenhouse gases will rise over time in response to human activities. Modelling the effects of these increased greenhouse gases is more complex and difficult. Climate models' projected warming from a doubling of CO_2 concentrations by 2100 lies somewhere in a wide range from 1 to 6°C. Furthermore, the effects of a given increase in average global temperatures on Earth's physical processes, such as local weather patterns, are hard to model. Finally, the social economic and environmental costs of given changes in weather patterns are hard to predict. The potential for 'tipping points' or low probability but high impact events add to uncertainty.

In its reporting, the IPCC uses a precisely graded scale to express the degree of uncertainty surrounding each of the risks it discusses, giving some indication of the relative levels of knowledge. In many instances, the IPCC finds it difficult even to assess the extent of the deficit in knowledge. Effects at the global and continental scales, for example, are more certain than are those at a localised level. Freshwater and coastal impacts are more certain than impacts on ecosystems, food and forestry.[13] If the climate system features 'tipping points', their appearance could be sudden and nonlinear (i.e. causing a sharp increase in warming or associated harm to human activity).[14]

12 Brinkley, A (2010), *Carbon Omissions*, Policy Exchange

13 IPCC (2007)

14 Schneider, SH, Turner, BL and Morehouse Garriga H (1998), "Imaginable surprise in global change science", *Journal of Risk Research* Volume 1, Issue 2, pp. 165-185

Scientific understanding of climate change and its impacts will continue to improve. A clearer idea of the local impacts of climate change and their costs should emerge over time. This new information will inform climate policy, for example in terms of the urgency for carbon reduction efforts and the relative priority between spending resources on mitigation and on adaptation.

International carbon commitments

The degree to which other countries commit to, and implement, decarbonisation is another future unknown relevant to the UK's own decarbonisation trajectory.

A world where most countries are implementing effective decarbonisation strengthens the case for the UK to continue with far-reaching action. It also makes such UK action easier. But in an alternative future scenario of low levels of international action, the case for the UK committing large resources to rapid electricity decarbonisation is diminished, since, at 1.7% of total global emissions, the UK cannot on its own have any measurable impact on climate change. The UK's resources could be better spent on adaptation in that scenario. In addition, low levels of international action would make UK decarbonisation more expensive, in terms of the UK's relative international competitiveness, and because there would be a less rapid global rate of innovation in low carbon technologies.

"Between 1990 and 1995, labour productivity doubled. Emissions of CO_2, SO_2 and NOx all fell by more than 25%"

The UK is currently party to two major international arrangements on carbon reduction which have uncertain futures. The period covered by the Kyoto Protocol ends in 2012, while the EU Emissions Trading Scheme's jurisdiction currently only extends as far as 2020, after which there are many questions about its future shape. What happens after each of these agreements expires will affect both the direct policy constraints faced by the UK government, and the international carbon policy environment in which future UK policy and investment decisions are taken.

Accommodating uncertainty

Throughout this chapter, we have emphasised the importance of the unknowns which drive uncertainty about the best approaches to decarbonising electricity over the coming decades. Such uncertainty requires decarbonisation processes that excel at experimentation, information discovery, adaptation to new information and innovation. Central planning approaches struggle to achieve this – "matters rarely turn out as in the plans, nor, as far as plans shape matters, do they turn out to represent the best approach except in the simplest of contexts... There are significant risks from policy and planning based on a supposedly greater understanding of the future than we possess, [and] it is important that electricity policy encourages the continual revelation of new information, through innovation and experiment, and the deployment of that information." [15]

How can effective decarbonisation processes be achieved? Two approaches stand out.

15 Less, S (2011), *Re-Monopolising Power*, Policy Exchange, London

Markets

Across the economy, market processes are the most effective way to experiment, reveal new information, process and transmit it so that decisions may adapt in light of the new information. Given the unknowns and uncertainty, such processes are critical in the effort to decarbonise the generation sector successfully and cost-effectively.

The record in the UK following the opening of the generation sector to competition in 1990 demonstrates the success of markets in practice. Between 1990 and 1995, labour productivity doubled. Emissions of CO_2, SO_2 and NOx all fell by more than 25%.[16] Moreover, the opening to competition led to a number of innovations, with benefits for customers and for the environment. These included new gas turbines, and ongoing innovation in efficiency of turbine design which has led to reduced carbon emissions.

Market processes have also driven improvements to the UK's security of supply position. UK electricity supplies are now among the most reliable in Europe, and supply outages are almost always the result of physical interruption to monopoly transmission or distribution rather than a shortage in the generation market.[17] Companies in the marketplace have also built substantial liquefied natural gas (LNG) import infrastructure and gas storage facilities, ensuring secure supply and turning the British gas market into "Europe's western gas corridor".[18] All of this has occurred while keeping UK energy prices low – Britain has the fourth cheapest electricity prices and the cheapest gas prices among the original 15 EU Member States.

Markets are not magic. For example, they need rules and incentives for reducing externalities such as carbon. But they are much better than alternative central planning approaches to delivering innovation and finding cost-effective approaches to security of supply and reducing carbon emissions.

Where the government needs to regulate, for example, providing incentives to reduce carbon levels, its role should complement market processes, helping them work well, rather than seeking to substitute for them by deciding what to do, when and how to do it, and by whom it is to be done. So for example, policy interventions that price carbon, through caps or taxes, will incentivise the market to locate cost-effective carbon emissions reductions more than the government choosing which technologies to deploy (see Chapter 8).

Research, development and demonstration

As has already been discussed, climate change is at heart an innovation problem. Decarbonising power generation worldwide is going to require a shift in generating technology, reducing the costs and improving the power output of existing scalable technologies while increasing the scalability of juvenile technologies. Unlike previous instances of government mandating major reductions in pollutant emissions, such as the international controls on chlorofluorocarbons (CFCs) following the Montreal Protocol, or the US limiting sulphur dioxide and nitrogen oxide through the 1990 Clean Air Act Amendments, the technologies to achieve the desired change are not all readily available.[19] Improving the performance, affordability and scalability of clean generating technologies (as well as facilitating more fundamental breakthroughs) are the only means by which the ambitious goal of 80% economy-wide carbon reductions can be achieved.

16 Less, S, (2011), *ibid*, pp12-13. Also Newbury, D (1999), *The UK Experience: Privatization with Market Power*, Cambridge University

17 HM Treasury and Department of Energy and Climate Change (2010), *Energy Market Assessment*

18 Noël and Pollitt (2010)

19 Galiana, I and Green C (2010), "Technology-Led Climate Policy" in Lomborg, B (ed.), *Smart Solutions to Climate Change*, Cambridge University Press, Cambridge, p. 293

Competition is the principal driver of innovation across the economy. But there is a strong case for additional intervention focused specifically on addressing market failures relating to research, development and demonstration of new technologies.

An effective carbon-pricing framework is a key way to incentivise low carbon innovation. But in its effects on RD&D, carbon pricing is only part of the overall picture, better at deploying mature technologies than at bringing new ones through the development process.[20] Evidence for carbon pricing alone inducing technological change is weak.[21] Characteristics of many low carbon technologies mean that interventions are needed over and above a carbon-pricing framework, given in particular the challenges in establishing long-term credibility of a significant carbon price.

Stimulating consumer demand for low carbon electricity is more difficult because of the absence of product differentiation. In industries, including pharmaceuticals or information technology, characterised by high levels of innovation, new products often attract customers willing to pay a premium, to recompense innovators. A new product will often do something that no product has previously accomplished, or will do so in a faster way, or with fewer harmful side effects. Zero-carbon electricity, in contrast, will provide power in all other respects identical to high-carbon electricity. This is one reason why a carbon price is needed, though in the long run it may be hoped that low carbon electricity could be cheaper than current generation technologies.

But the politics of carbon pricing and technology development suffer to a degree from a 'chicken and egg' problem. Carbon prices are intended to drive technological development. But in the absence of some assurance that rising carbon prices can be alleviated by technological breakthroughs, governments are likely to be reluctant to pass laws substantially pricing carbon. Montgomery and Smith show that the difficulty of reaching an optimal and consistent policy over long periods limits the effectiveness of a solely carbon-price led policy on spurring innovative activity. A carbon price creates demand for carbon-reducing products, but further government action is required to produce the degree of technological advancement needed.[22]

Timescales also pose problems for RD&D investment in a number of sectors (not just low carbon) with the distance between the upfront investment and its recovery being lengthy. R&D is a risky process with a high failure rate. And successes may be imitated before the high R&D investment costs have been recouped. Granting intellectual property rights (patents) is one approach, and is generally successful in pharmaceuticals. Another is reducing the burden on any one would-be innovator through subsidies or incentives, which can facilitate more R&D activity across the sector. Government supports early stage R&D across a range of sectors through such things as university finance and research grants. Government may also target any gaps in commercial support, after basic proof-of-concept R&D has been carried out, but before the product has attained full commercial viability, for example supporting demonstration (e.g. the CCS demonstration) and sometimes pre-commercial rollout to assess a technology's viability out of the laboratory and in the marketplace.

Such interventions are an appropriate complement to the market and carbon-pricing framework for many technologies.

20 Blanford, GJ (2009), "R&D investment strategy for climate change" in *Energy Economics*, Vol 31, Supplement 1, pp. 27-36

21 Nemet, G (2009), "Demand-pull, technology-push, and government-led incentives for non-incremental technical change" in *Research Policy* Vol 38, No. 5, pp. 700-709, and others cited therein.

22 Montgomery, WD and Smith, A (2007), "Price, quantity and technology strategies for climate change policy" in Schlesinger M et al (eds), Human-Induced *Climate Change: An Interdisciplinary Assessment,* Cambridge University Press, Cambridge, pp. 337-338

But they should not replace the market. They should be kept distinct from the process of full-scale market deployment, focusing on accelerating innovation through demonstration and perhaps early stage deployment support. They should thus be confined to a modest part of the overall market because they are experimenting with currently expensive technologies to learn about them and reduce their costs, rather than subsidising their deployment. They should be time-limited because not all innovations will turn out to meet the cost and output levels needed to be preferable to other alternatives in the market.

Establishing the point at which support is withdrawn and technologies made to compete openly is an important component of a successful innovation policy. Without this step, the costs of policy escalate, market processes are damaged, and the incentive for increased competitiveness is lost.

5
Current UK Electricity Decarbonisation Policy

UK policy relevant to electricity decarbonisation is characterised by a number of different economy-wide carbon targets and a renewable energy target. While there are no binding targets in relation to electricity decarbonisation alone, current government policy is largely based on achieving a certain level of renewable electricity generation by 2020, as the main contributor to the binding EU renewable energy target. The government also assesses that decarbonising most of the electricity sector by the 2030s is a necessary stage in meeting the economy-wide 2050 carbon reduction target.

There are a large number of different interventions in the electricity market aimed at ensuring delivery of these targets, including the Renewables Obligation (RO), Feed in Tariffs for small-scale renewables, dedicated levies to fund demonstrations of carbon capture and storage, as well as the EU Emissions Trading System (ETS). With the government recently consulting on plans for Electricity Market Reform (EMR), these policies could be restructured and added to.[23]

Targets

In 2008, on the recommendation of the Committee on Climate Change (CCC), the government committed the UK to an 80% reduction in GHG emissions compared with 1990 levels by 2050, tightening a previous objective of 60%.[24] The Climate Change Act 2008 established the 80% commitment, alongside intermediate targets for the carbon budget period including the year 2020 (see Table 2), and a process for setting additional five-year 'carbon budgets' to delimit the future emissions trajectory.

At the end of 2008, the European Union approved its Climate Change Package. A summit of Heads of State approved proposals to set three targets to meet by 2020, collectively known as the 20-20-20 targets:

- a reduction in EU greenhouse gas emissions of at least 20% below 1990 levels;[25]
- 20% of EU energy consumption to come from renewable resources;
- a 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency (this final target is not legally binding).

23 Department of Energy and Climate Change (2010), Consultation on Electricity Market Reform, http://www.decc.gov.uk/en/content/cms/consultations/emr/emr.aspx

24 The Committee on Climate Change (2008)

25 At time of writing, the Commission is discussing raising the carbon reduction target for 2020 from 20% to 25% or even 30%.

Table 2: Targets for UK climate change policy

Year to achieve target	Target	Source
2050	80% reduction in GHG emissions compared with 1990 levels	UK self imposed, based on Committee on Climate Change recommendations
2050	Halve global emissions	G8 non-binding aspiration
2018-2022	34% reduction in GHG emissions compared with 1990 levels (third carbon budget period)	UK self imposed based on Committee on Climate Change recommendations
2020	15% of total energy, 10% of transport fuel, to come from renewable sources (implies approximately 30-35% of electricity from renewable sources)	UK binding contribution to EU 2020 renewable energy target, applied in Renewable Energy Strategy
2020	20% reduction EU-wide in total GHG emissions compared with 1990 levels	EU 2020 GHG target (implemented through the ETS and other measures, no national-level targets)
2020	A 20% reduction in EU-wide primary energy use compared with projected levels, to be achieved by improving energy efficiency.	EU 2020 target (non-binding)
2020	16% reduction in GHG emissions compared with 2005 levels from non-ETS sectors	EU 'Effort Sharing' Decision[26]
2012-2017	28% reduction in GHG emissions compared with 1990 levels (second carbon budget period)	UK self imposed based on Committee on Climate Change recommendations
2012	12.5% reduction in GHG emissions compared with 1990 levels	Kyoto Protocol

Because of the difficulties and cost of introducing renewable fuels in transport and heating in the short timeframe of the target, the electricity system must deliver the majority of the 2020 renewable energy target. Furthermore, the government has made electricity decarbonisation the starting point for its broader decarbonisation strategy to 2050, based on the advice of the CCC, which finds it to be more suited to early action than transport or heating. As will be shown in Chapter 7, the CCC's *Building a Low Carbon Economy* report (which provided much of the backing for government decarbonisation policy) provides a more aggressive timetable for electricity decarbonisation than any of the other models we analysed, although its conclusion that decarbonisation of electricity should precede other sectors is broadly supported by others.

Taken together, the UK is subject to a long list of targets related to renewables and carbon (see Table 2), most of which impact on the electricity sector.

Policy interventions

There are a large number of interventions in the electricity market aimed at delivering the various targets for carbon and renewables. Current policies in the UK include:

- **EU ETS** – The EU ETS is a cap-and-trade carbon permitting scheme to reduce CO_2 emissions in the EU. The policy establishes an EU-wide limit on eligible

26 European Commission (2008) *Effort Sharing Decision*, http://ec.europa.eu/clima/policies/effort/index_en.htm

carbon emissions, allocates emissions allowances to the sectors covered including electricity generation, and allows participants to trade allowances within the cap. The EU ETS covers about 43% of total UK GHG emissions, covering energy intensive industries and electricity generation. The electricity sector accounts for 71% of emissions covered by the ETS.

- **Renewables Obligation** – The Renewables Obligation (RO) establishes a minimum percentage of suppliers' electricity to be acquired from specific renewable sources. The proportion increases year on year, intended to stimulate a steady increase in the uptake of renewables. When it was first introduced in 2002, the RO was designed to reward deployment of lowest cost renewables. Its primary beneficiary, as the most cost-effective renewable technology at the time, was onshore wind. However, this system rapidly ran into difficulties, as wind farms kept being rejected for planning permission. In 2009, the Renewables Obligation was reformed. One change was to include a system of 'banding' (re-adjusted at regular intervals). Banding differentiated levels of subsidy between different technologies, ostensibly to reflect different technology maturities. But in fact banding was driven by the need to respond to renewable energy targets. The major effect of banding was to target massive additional subsidies to offshore wind, an expensive technology but one which did not suffer from the planning barriers suffered by onshore wind. Offshore wind was needed quickly – quicker than its maturity and cost indicated – to meet the EU renewable energy target. The changes, and additional complexity and expense, have taken the RO to being about ten times more expensive than the EU ETS per tonne of CO_2 saved.
- **Feed-in Tariffs for small-scale renewables** – Since April 2010 the government has offered a 'feed in tariff' to support the deployment of small-scale renewables. The tariff is an above-market rate paid for electricity generated from qualifying renewable generation sources (with capacity of less than 5MW). The programme has been subject to a number of further announcements since its inception last year. It was capped at £360 million per year in the 2010 Spending Review. A fast track review was announced in early 2011 to investigate whether support should continue to be offered for projects larger than 50kW, with a comprehensive review of the programme also due to start in 2012 (or earlier if uptake exceeds government expectations).
- **Climate Change Levy and Climate Change Agreements** – The Climate Change Levy is an energy tax on non-domestic users, based only in part on the carbon content of fuels used. Energy-intensive industries have been able to negotiate out of the CCL, drawing up sectoral agreements with the DTI to meet energy efficiency targets (CCAs) in exchange for an 80% discount on the CCL.
- **Carbon Capture and Storage** – The government has committed £1 billion for the first CCS demonstration, with £7-8 billion potentially available for up to three subsequent facilities.
- **CRC Energy Efficiency Scheme** – The CRC is a carbon permitting scheme for large and mid-size non-energy intensive organisations, with an additional component requiring reporting of energy usage. It has the effect of further pricing the carbon content of electricity, for some users. Initially, revenue from the scheme was intended to be recycled to good performers, but this part of the Scheme was scrapped in the 2010 Spending Review, creating an additional carbon tax.[27]

27 Most of these policy interventions have been subject to a number of changes during their lifetime. Many of the UK's decarbonisation policies were analysed in the Policy Exchange report *Greener, Cheaper*. *Greener, Cheaper* made a number of recommendations including scrapping FiTs, because its cost per tonne of carbon saved was excessively high compared to other policies (£460/tonne of CO_2 saved, compared with approximately £14/tonne through the ETS), and the resources devoted to the policy could be better used elsewhere to deliver more carbon reduction or more effective support for innovation. *Greener, Cheaper* also recommended further analysis of the Renewables Obligation and renewable energy target, which were also considered a very expensive way to decarbonise, with the RO carbon price estimated at £130/tonne of CO_2. This report therefore builds on *Greener, Cheaper*, by examining the EU's 20-20-20 targets with a focus on the impact of the renewable energy target on UK electricity. McIlveen, R. (2010), pp. 26-46

The government is in the process of developing a new structure for electricity market interventions, though its Electricity Market Reform programme. The EMR consultation documents outline several policy proposals, aimed at reshaping the way the electricity market functions, intended to foster investment in new, low-carbon and renewable generation. The government has proposed for consultation policy options for driving investment in low-carbon generation: an emission performance standard (EPS); and contracts for difference (CfD) guaranteeing electricity prices for low carbon generation or premium payments. A carbon price support mechanism (CPS) was included in the 2011 Budget, starting at around £16 per tonne of carbon dioxide in 2013 and following a linear path to £30 per tonne in 2020. In addition, the government is considering the merits of a targeted capacity market, aimed at improving security of supply under conditions of greater generation intermittency. Which of these policies will be implemented and their interactions with existing ones are not yet clear. The government will be making decisions over the coming months. This is not the place for detailed analysis of the EMR proposals. However, it is worth noting that the requirement to meet the 2020 renewable energy target accounts for at least a part of the rationale behind the reforms and proposals for new policy interventions.

The landscape of policy interventions in the electricity market is complex, and may become increasingly so. There are a number of policy interventions with major costs and impacts on the electricity market. The largest of these focus on promoting rapid increases in renewable generation in a short timescale to meet the 2020 renewable energy target.

6

Assessing the Renewable Energy Target

While the 2020 renewable energy target (RET) is not the only driver of the government's current policy mix related to electricity decarbonisation, it is the dominant one. The analysis in this chapter therefore focuses on that target.

The target has a number of design flaws, which lead to detrimental consequences for overall decarbonisation, and other energy policy objectives.

Design features

Technology specific focus

There are a wide range of ways to reduce carbon emissions on both the demand and supply side. Installing renewables are just one set of low carbon supply side technologies. Setting a binding target in relation to one approach to carbon reduction only, rather than encompassing a wider set of approaches, will tend to result in resources being allocated to less promising and more expensive measures than would otherwise be the case.

Focus on expensive technologies

Many renewable generation technologies are very expensive compared to other options for reducing carbon emissions in the current decade. This appears particularly to be the case in the UK, where the strategy for meeting the RET relies heavily on very expensive offshore wind, a technology yet to approach the cost-competitiveness of other approaches to cutting carbon emissions. For example, meeting targets for carbon emissions reduction this decade would be much cheaper using onshore wind or gas to replace coal generation – perhaps half as expensive as using offshore wind (see Table 1 in Chapter 4 and Box 3 in Chapter 8).[28] Very expensive technologies such as offshore wind should be the focus of efforts to try to reduce their costs, including through limited 'learning by doing' deployment. But they are not ready to be the focus of mass deployed to meet carbon reduction targets.

Box 1: Costs of intermittency

The problems with targeting renewables are not solely about the costs of building generating capacity. Costs resulting from intermittency, perhaps better described as variability, are also an issue. Wind turbines generate when there is a breeze (with a broad enough portfolio of turbines. There is usually wind somewhere, but the capacity generating

28 UK Energy Research Centre (2010)

at any given time can vary widely). Solar photovoltaics generate only during daylight, and vary depending on the brightness. If the government's ambition to build as much as 33 GW of wind capacity (onshore and offshore) are to be fulfilled, additional investment in managing its variability will be required.

The UK Energy Research Centre (UKERC) identifies two major costs associated with increasing intermittency. System balancing costs derive from the need to respond quickly to fluctuations in supply from wind by swiftly increasing or decreasing production from backup generation. The provision of backup generation itself also has costs – building the necessary capacity to cope with peak demand during low wind spells. UKERC assesses the total costs of intermittency, after an expansion of wind to 20% of supply, to be around 0.1-0.15p per kWh on the price of electricity, as intermittency adds about 15% to the cost of wind generation.[29] The wider the geographical spread of wind turbines and the greater the degree of interconnection between regions (nationally and internationally) the less the burden of intermittency becomes. The amount of interconnectivity with grids across Europe could be increased, either through the touted North Sea 'Supergrid' project (with estimated costs of £26.5 billion) or by building more conventional interconnectors to continental grids.[30] However, constructing those interconnections and transmission networks, including new offshore transmission, is a further potential cost of renewable generation.

Traditionally, most backup capacity has come from fossil fuel generation. Another method is to increase the availability of pumped storage. Pumping large quantities of water uphill allows some of its energy to be recovered when it is released through hydroelectric dams. A large quantity of new facilities would be required to cover a substantial loss of wind power due to still weather, and sites in the UK are limited.[31]

A third option is to use other forms of storage, for example distributed storage using batteries in the anticipated future fleet of electric cars. Combined with Smart Grid technology, such vehicles could potentially provide a backup source of electricity for the grid that could be called on in periods of low wind. Demand side management through more sophisticated contracting methods, enabled by the Smart Grid, is a further possibility for managing short period variability.

The additional costs of whichever approaches are used to deal with intermittency need to be included in weighing up the full costs of meeting the RET.

Short time frame

Setting a sharp short-term deadline for achieving the desired deployment of renewables at 2020 creates further problems.

Firstly, without a longer period to reveal more information about the technologies available and their future costs, the government has largely to make policy decisions based on what they know at the beginning of the period, and has limited flexibility to adjust that while remaining on course to meet the objective.

Secondly, the short-term target means that available resources have to be focused on meeting the target in 2020, rather than on supporting the innovation required to meet the decarbonisation target in 2050. In other words, resources are spent on deploying existing expensive technologies rather than innovation, to identify better cheaper future technologies.

Thirdly, such a short timescale reduces many of the possible learning benefits of supporting renewable deployment. One justification for subsidising

29 Gross, R. et al (2006), *The Costs and Impacts of Intermittency*, UK Energy Research Council, London, p. vii

30 Jha, Alok (2010), "Sun, wind and wave-powered: Europe unites to build renewable energy 'supergrid'" in *The Observer*, (3 January 2010), http://www.guardian.co.uk/environment/2010/jan/03/european-unites-renewable-energy-supergrid

31 MacKay (2008), pp. 190-194

deployment of expensive renewable generation such as offshore wind is to reduce its costs through learning by doing. But deploying an additional 11 GW of offshore wind in nine years gives insufficient time for the cycle of learning to operate. Deploying a lot of capacity simultaneously prevents what is learnt following deployment of each set of turbines – and any cost reductions – from being fully exploited in the next phase of deployment. Offshore wind deployment, as part of electricity decarbonisation to meet the 2050 carbon target, will therefore be even more expensive than it needs to be.

The shortage of time makes addressing other problems associated with renewables difficult. Issues of public acceptance of renewable technologies (for example, hostility to onshore wind farms) are unlikely to be eased and may be exacerbated by pressure to rush their rollout. Likewise, the time needed to adjust other policy areas that strongly affect the cost-effectiveness of renewable deployment, such as planning barriers, may not be compatible with the haste to deploy as much capacity as possible as quickly as possible to meet the target. The lack of time to address public concerns and reform the planning regime raises the cost of meeting the target, as a greater contribution from offshore wind is required.

Inflationary pressures

Attempting to force through rollout of one set of technologies across all of Europe in a short timescale leads to a huge ramping-up of demand. Countries and companies bid against each other for limited supplies of relevant capacity, skills and equipment, causing prices to escalate and suppliers to receive inflated rents.

In relation to offshore wind, the availability of specialised ships, steel, manufactured components and skilled workers constitute potential chokepoints which drive up prices and rents. There is also a limited effective number of competing suppliers of offshore wind turbines at present, potentially adding market power to the list of factors driving up prices.

Interaction with the EU ETS

The renewable energy target undermines the EU Emissions Trading Scheme. Electricity generation is among the industries covered by the ETS. When electricity firms are compelled to buy expensive renewable generation, it means they require fewer carbon permits, thereby reducing the price of such permits.

This has the consequence of achieving carbon savings (through renewables) at a much higher cost than necessary. Carbon savings (cheaper than renewables) which would have been made at a higher carbon permit price, are not undertaken at the lower permit price. Therefore, the RET reduces emissions no further by 2020 than would have delivered by the ETS alone – just more expensively.

Infeasibility

We have approached the government's renewable policy so far with a critical eye, but on the assumption that it is feasible to meet the RET. But is this assumption justified? Reconsidering this premise, we consider the 2020 renewables target highly unlikely to be reached under any realistic policy strategy, barring rates of intervention that would be inconceivable in any other sector in peacetime.

A few writers have attempted to chronicle the construction ambitions implied by the current set of policies. The scale of effort that they document is vast – the mobilisation during World War II appears to be one of few (if any) historical precedents with which they can draw comparisons.[32] MacKay estimates that to erect 10,000 3MW offshore turbines over the space of a decade would require around 50 jack-up barges (specialised ships) full time – just one illustrative potential bottleneck in the system. Assuming that to meet the RET, 'only' 3,500 additional offshore turbines were needed (around 11 GW), perhaps a dozen new jack-up barges would be needed (at a cost of around £60m each to build) as well as a variety of other specialist vessels.[33] Mackay draws an analogy for building 10,000 turbines in a decade: given the quantity of steel and concrete required, the effort would be "as big a feat as building the Liberty ships", the 2,751 vessels built in American shipyards during World War II.[34]

"The costs of the renewables target are its biggest problem. Put simply, it costs far too much to achieve far too little decarbonisation by focusing so heavily on deploying renewables"

Writing in *Nature*, Gert Jan Kramer and Martin Haigh argue that largely immutable laws exist governing energy-technology deployment, and that rollout rates cannot exceed the constraints imposed by 'learning by doing' speeds, industrial capacity and the low replacement rates for long-lasting energy system infrastructure, even in the presence of a nurturing policy environment.[35]

There appear to be few, if any, in major energy companies who do not privately concede that the UK is very unlikely to meet its binding renewable energy target.

Consequences

There are a number of important consequences of the design features of the RET discussed above, which together damage overall decarbonisation efforts, and the achievement of other energy policy objectives.

Huge costs

The UK's share of the RET requires it to increase renewable energy's share of total primary energy use from 1.3% in 2005 to 15% in 2020, implying roughly 30-35% of electricity coming from renewables.[36] This target is legally binding on the UK. Pöyry Consulting found that the UK bears by far the highest cost burden of all EU countries of the target – around a quarter of the cost across the whole EU.[37] The costs of the renewables target are its biggest problem. Put simply, it costs far too much to achieve far too little decarbonisation by focusing so heavily on deploying renewables.

The Impact Assessment of the UK Renewable Energy Strategy assessed the costs of an option that resembles present policy closest at £66 billion NPV, £69 billion in costs offset by modest benefits. A parliamentary written answer from January 2011 provided the following forecast of spending between 2011 and 2020: "The spending is estimated at £32 billion from 2011 to 2020 under the Renewables Obligation; £3.6 billion under small-scale feed-in tariffs; £9.8 billion under the Renewable Heat Incentive; and £8.9 billion under the Renewable Transport Fuels Obligation."[38] Of the total being spent, £35.6 billion is in the electricity sector.

32 White, N and Hartley, M (2010), "Realigning UK Energy Policy" in *Arthur D Little Energy & Utilities Viewpoint*, http://www.adlittle.com/uploads/tx_extthoughtleadership/ADL_Realigning_UK_Energy_Policy.pdf, pp. 2-3. Jacobson, M and Delucchi, M (2009), "A Path to Sustainable Energy by 2030" in *Scientific American* (Vol. 301, Issue 5), pp. 58-59. MacKay (2008) pp. 60-63, 265.

33 Marsh, George (2010), 'Vessel supply chain shapes up for offshore wind' at *Renewable Energy Focus*, http://www.renewableenergyfocus.com/view/11231/vessel-supply-chain-shapes-up-for-offshore-wind

34 MacKay (2008).

35 Kramer, GJ and Haigh, M (2009), "No quick switch to low-carbon energy" in *Nature* (Vol. 462, Issue 3), p. 568

36 See Note 1.

37 Pöyry (2008), *Compliance Costs for meeting the 20% renewable energy target in 2020*, http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file45238.pdf, p. 28 and European Commission (2008), *Proposal for a Directive of the European Parliament and of the Council on the Promotion of the Use of Energy from Renewable Sources*, Brussels, Annex 1

38 Hendry, Charles (2011) *Commons Hansard*, 18 January 2011 Written Answers, http://services.parliament.uk/hansard/Commons/ByDate/20110118/writtenanswers/part021.html

DECC figures show renewables policies adding £23/MWh to the price of domestic electricity in 2020, an increase of approximately 20% over their expected baseline, and £22/MWh for non-domestic users, increasing the price by over 25%. The same report shows the total costs of renewables policies levied through electricity bills accounting for £7.4 billion, again in 2020, taken from domestic and non-domestic users combined.[39]

We will show in Chapter 8 (Option 3) a number of proposals for reducing these costs without compromising on decarbonisation or technological learning rates.

The unnecessarily huge costs are directly a drain on the economy, increasing businesses' costs and reducing household disposable income. They also have a number of knock-on consequences, set out below.

Setting a poor example

Since, as discussed in Chapter 3, the main objective of UK electricity decarbonisation must be to set a compelling example to other countries, there is a risk from unnecessarily expensive decarbonisation policies driven by the renewable target. They fail to set a compelling example that decarbonisation can be achieved at acceptable economic cost, nor demonstrate a process for decarbonisation which other countries might want to imitate.

Deterred electrification

The effects of unnecessarily expensive renewable electricity policy are not confined only to decarbonisation of the electricity sector. Together heating and transport constitute the majority of the UK's carbon emissions, and for both of these, switching to electrical power is likely to be an important part of reducing their carbon emissions. This may occur using heat pumps for heating, and battery-powered vehicles. Unnecessarily increasing the price of electricity will tend to deter electrification of heating and transport and make the process of wider decarbonisation more expensive.

Competitiveness and carbon leakage

There is a general concern that UK climate policy could drive energy- or carbon-intensive industries overseas, risking both damage to the UK economy and potentially higher overall carbon emissions than if the industries had remained in the UK ('carbon leakage'). The latter could occur if industries moved to a more carbon-intensive economy, such as China. Policy Exchange's study, *Carbon Omissions* found that the UK's carbon *consumption* has expanded dramatically since 1990, going up by over 30%, driven by increasing imports of our goods from other countries, in particular China.[40]

Clearly an unnecessarily high cost decarbonisation policy, such as current policies driven by the RET, carries greater risks in this respect than more cost-effective policies.

The carbon leakage problem also emphasises the importance of UK policy focusing on global impact. A key way to achieve this is for the UK to capitalise on its traditional strengths in R&D, and to develop low-carbon technologies with potentially wide global applicability. A new technology that can help China or India significantly reduce their emissions would make a far greater difference to

39 Department of Energy and Climate Change (2010), *Estimated Impacts of energy andclimate change policies on energy prices and bills,* London, http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/236-impacts-energy-climate-change-policies.pdf pp. 28-29 and DECC (2010), Updated energy and emissions projections.

40 Brinkley (2010)

the climate than simply reducing UK domestic emissions. It is far from clear that offshore wind, the main beneficiary of current UK renewable energy policy, is an example of such a technology. Furthermore, evidence of major industries relocating abroad will do little to raise the appeal of decarbonisation to other countries even more dependent on manufacturing sectors than the UK.

Resource allocation

As discussed in Chapter 3, there is a limit to the resources available for addressing climate change. To the extent that resources are allocated to unnecessarily expensive approaches to decarbonisation, fewer resources are available for other approaches and the rate of decarbonisation is reduced.

In particular, allocating resources to mass deployment now of still highly expensive technologies reduces (all other things being equal) the resources available for other supporting innovation. Since innovation and reducing the costs of globally-promising low carbon technologies are critical policies for securing global decarbonisation, wasting resources on deploying expensive renewables domestically risks holding back the overall process of decarbonisation. The 2020 renewables target risks making achievement of the 2050 target of 80% economy-wide decarbonisation, the ultimate intended destination of UK climate policy, more difficult.

Regulatory uncertainty

Failure to achieve the renewable energy target seems unavoidable. The question investors are therefore left asking is: what will happen next? At the moment, no one seems to know. The government, for obvious reasons, does not acknowledge that the target is unlikely to be met. This creates regulatory uncertainty with firms aware that the policy framework underpinning and incentivising renewable investments is headed for failure, which could in future lead to higher subsidies or alternatively abandonment of the target. Such regulatory uncertainty will tend to lead to higher risks and costs, as well as a tendency for companies to wait and see, delaying overall energy investment.

Central planning and innovation

A final problem with the design of the target, and indeed for any very specific binding target with associated sanctions or reputational consequences, is that the pressure to meet it can lead governments to adopt central planning approaches in order to try to achieve certainty of outcome and timing. Any increased confidence in the ability to precisely meet the target comes at the price of increased costs and less innovation relative to a market-based approach. Paradoxically, these consequences may end up reducing, not increasing the country's ability to meet the target in question.

For example, the Renewables Obligation has developed into an instrument which increasingly tries to centrally plan outcomes, in terms of renewable capacity, the mix of renewable technologies and the prices paid for each, driven by the need to deliver the RET.

The 2020 target, and the more centrally planned policy response to it, disrupts the ability of market processes to reveal new information, and hinder low-carbon innovation. Chapter 4 showed the importance of market processes for uncovering and disseminating new information, about technologies and business processes.

Countervailing arguments in favour of the renewable energy target

Backers of the renewables target might argue that the concerns outlined above are outweighed by other arguments for the RET. Here we analyse some of the arguments made in favour of the target.

Urgency

Argument: The problem of climate change is so serious that delaying action is intolerable. As a result, it is important to speed up the rollout of renewable generation.

One problem with this reasoning is that urgency, in this situation, relates to GHG emissions, not renewables. Indeed, to the extent that paying a premium to deploy unnecessarily expensive renewables reduces the resources for better measures to promote decarbonisation, the case for urgency could be seen as counter to the renewables target.

Furthermore, the case for urgent action to tackle climate change requires that such action is effective in mitigating climate change. That requires that any UK action help secure further action by other countries around the world. As we have argued, actions to meet the renewable energy target in the UK neither set a compelling example of how to go about decarbonising cost-effectively, nor focus most resources on developing technologies with the greatest global potential.

Deployment support brings down costs

Argument: Deployment under the renewable energy target will help pull technologies down the cost curve faster than would have been the case otherwise, enabling their mass deployment earlier and ultimately achieving carbon reduction more rapidly.

Given the particular barriers to low carbon generation innovation (deficiencies in the current carbon pricing framework, the lack of product differentiation between carbon emitting and non-emitting electricity), public support to help promising early stage technologies overcome the barriers to deployment may well be an effective use of government funds. But the measure of success should not be the quantity of inevitably expensive technologies deployed, but the learning rate resulting from those deployments. If it turns out that a technology does not progress adequately towards cost-competitiveness, then it is unlikely to be a significant part of a global solution to climate change and therefore a waste of further resources. Such support should therefore be proportionate and time-limited, and not predicated on a deployment target.

The renewable energy target does not help target UK resources on maximising learning and cost reductions; indeed, it is likely to waste resources which could be better focused on pulling a range of low-carbon technologies through a learning cycle. Spending huge sums on installing 11 extra GW of offshore wind capacity in only nine years is not the optimal way to maximise new knowledge.

Compounding the problem, as mentioned earlier, the renewable energy target drives down the price of carbon in the ETS. This has a potentially damaging impact on R&D in both the generating and other industrial sectors. By reducing the value of carbon reductions, the policy reduces the value of R&D that could result in carbon reductions.

We already have the knowledge we need

Argument: The obstacle to having a decarbonised electricity system is not lack of knowledge; it is lack of will to get on with applying what we already know using technologies that are already available. The RET drives such deployment.

Others in the past have believed they have the knowledge to predict future energy needs and technologies. In the 1950s and 1960s it was predicted that nuclear power would be too cheap to meter. In 1970 the Central Electricity Planning Board predicted demand of 100 GW for 1995 – the actual quantity required was just over half that. When Sizewell B nuclear power station was being planned in the 1980s, none of the consulted experts predicted a significant role for gas turbine generation, which a decade later was the only generation being built. In 2003, the energy White Paper concluded that nuclear power was unnecessary, but by 2006 the government had reversed that position and concluded that it had to be part of the generation mix.[41]

Even before 2020, there is much scope for critical new information to be revealed about the best approaches to decarbonisation, and for breakthroughs to occur. The rapid emergence of unconventional gas as a potential source of cheap lower carbon energy, which will slow the global deployment of high carbon coal generation, is an example of how quickly innovations and new knowledge can have an impact. However, the more important objective is 80% decarbonisation by 2050. The renewable target stifles processes for revealing new information which may be vital in meeting the 2050 target. It focuses market players and resources on a narrow set of preferred technologies and reduces the flexibility of markets to innovate. Having a target for renewables reduces the range of options available for achieving decarbonisation targets in 2020 and 2050.

Export promotion and green jobs

Argument: Encouraging early investment in renewables will make British businesses into market leaders in renewable technologies. They will be able to export their expertise and products, yielding jobs for British workers and extra growth for the British economy.

There are several assumptions underlying this proposition which are at best questionable. The first is the assumption that being a 'world leader in renewables' is more desirable in terms of growth than boosting alternative sectors through the employment of the same economic resources, but allocated wherever the market would steer them. The second is the assertion that government policy is capable of creating such world leaders. The third is the assumption that the renewable target is the best available approach to accomplishing world leadership in renewable energy.

As Noël and Pollitt argue, "There is no reason to think that any subsidy creates any net new jobs in the long run; they only shift jobs around the economy. Subsidies are even positively dangerous if they suck highly-skilled employees out of non-subsidised sectors and shift them from more productive jobs into less productive ones."[42] Even within the clean energy sector, there is no guarantee that prospective export markets – presumably predominantly the countries outside the EU whose nascent decarbonisation efforts will expand in coming years – will be looking to renewable energy, and in particular to the UK's chosen areas of offshore wind and some forms of marine energy, rather than, say potentially more widely applicable nuclear or CCS, to meet their own emissions reduction

41 Less (2011)

42 Noël and Pollitt (2010). C.f. also Marsh, Richard and Miers, Tom (2011), *Worth The Candle? The Economic Impact of Renewable Energy Policy in Scotland and the UK*, Verso Economics

objectives. The history of government 'picking winners' in terms of future export industries is not good, and such policies have often resulted in huge waste of resources.

Supply shocks and energy independence

Argument: Having a large renewable generating base helps protect consumers from future high fossil fuel prices, and price volatility caused by supply disruptions (such as when Russia cut off gas supplies to Ukraine in January 2009, or when OPEC oil exporters embargoed Western nations during the 1973 oil crisis).

There are two problems with this thesis. The first is that insulating customers from price volatility by locking in to a guaranteed high price for renewable energy is not particularly attractive. As economist Dieter Helm told an Energy and Climate Change Select Committee hearing, "people like stability in prices. But if they have stable very high prices, they prefer volatile low ones."[43] If supplies of gas (the relevant fossil fuel for electricity prices) become more abundant, with 'tight' and shale gas and other unconventional supply sources, and are traded more widely (with increased LNG trade, and opening up the Panama Canal to LNG shipping to merge the Atlantic and Pacific trades), prices could well move down rather than up. Importantly, the government has no particular additional information unavailable to the market to predict the future course of prices. The market is able to respond to future price expectations and to provide products to smooth and hedge price risks, if there is a demand from customers.

Risk of 'lock-in' to gas

Argument: Given that we have to rebuild a substantial proportion of generating capacity in the next 10-20 years, as a result of the closure of ageing coal and nuclear power stations, we should build renewables, because if we build gas we will be stuck with it, making it harder to meet decarbonisation targets in 2050.

The timeframe to the 2050 target allows for a wide range of possible pathways and the policy environment ought to reflect that. Reports by the AEA/CCC, the CBI/McKinsey, and the Energy Networks Association all illustrate that building gas (half the emissions of coal) between now and 2020 would be compatible with 80% decarbonisation by 2050, while being cheaper than offshore wind (see Chapter 7). In these scenarios, newly built gas would act as a bridging technology, replacing departing coal in the 2010s (while providing a net decarbonisation effect), and filling a gap until offshore wind and other technologies are deployed in force in the 2030s and 2040s.

In the latter years of its expected life span, gas generation built in the 2010s might be switched to a reduced role, providing dispatchable peaking capacity. It could be retrofitted with CCS if the technology is successful, or could be 'stranded' (i.e. closed ahead of its 'natural' end of life) in the later part of the period, having paid back its capital costs over the intervening years. Particularly if the alternative is hugely expensive offshore wind in the 2010s (which would anyway need to be replanted after 20 years of operation in the 2030s), then gas generation is likely to be an cost-effective proposition, even if it did not operate for all of its potential lifetime. The levelised costs of gas generation (without CCS) are half those of even the cheapest offshore wind projects (see Table 1).

43 Helm, Dieter (2011), Minutes of Evidence Taken Before the Energy and Climate Change Committee, http://www.publications.parliament.uk/pa/cm201011/cmselect/cmenergy/uc742-ii/uc74201.htm

Global leadership

Argument: Investing aggressively in renewable generation demonstrates leadership to other countries, and encourages them to follow our path towards decarbonising their economies.

As we argued in Chapter 3, the likelihood of other countries wanting to imitate the UK and European examples will increase if emissions reduction is shown to be achievable at reasonable costs. Conversely, unnecessarily expensive electricity decarbonisation policies would not offer a credible or compelling example to other countries.[44] By promoting more costly processes of decarbonisation, and indeed muddling decarbonisation with advocacy for a specific subset of technologies that can be used to achieve it, the UK and EU can hardly be seen to be setting a precedent the rest of the world is desperate to follow. While the failures of recent international climate negotiations have many causes, they indicate that, so far at least, emulating Europe's climate policies is far from most nations' policy agendas.

44 Less (2011). See also Nicholson J (2010), remarks at CBI Energy conference, London.

7

Review of 2050 Modelling Studies

So far, this report has highlighted the importance of cost-effectiveness in tackling decarbonisation, and in particular for accommodating uncertainty and the need to have processes for discovering and adapting to new information and innovations. The previous chapter analysed some of the ways in which current UK and EU policy fails in these respects.

To reinforce this analysis, in this chapter we have undertaken a 'meta analysis' of many of the models that have been developed to project possible UK decarbonisation trajectories through to the 2050 target. This meta analysis provides further evidence on whether current policies meet the criteria for cost-effectiveness and about the prevalence of uncertainty.

We find:

- The range of models' projections emphasises the degree of uncertainty about the future;
- Significant decarbonisation of electricity is modelled for the 2020s and 2030s, but the technologies used vary widely depending on models' assumptions;
- In modelling achievement of 80% decarbonisation of the economy by 2050, the models find a very wide range of possible contributions from renewables, ranging from 10% to 75% of electricity generation. None of those models that do not assume achievement of the 2020 renewable target find that it needs to be met as part of meeting the 2050 goal;
- The timing of deployment of different technologies, particularly for renewables and nuclear, is dependent on expected rates of technological development and carbon prices.

Methodology

We reviewed decarbonisation model runs from six separate reports, choosing those runs which, like this paper, take 80% decarbonisation by 2050 as their target. The reports come from a variety of organisations, including government departments and regulators, industry associations and research centres, and all present findings for the UK. The reports are:

- UK Energy Research Centre, *Pathways to a Low Carbon Economy*[45]
- UK Energy Research Centre, *Decarbonising the UK Energy System: Accelerated Development of Low Carbon Energy Supply Technologies*[46]
- The Committee on Climate Change, *Building a Low Carbon Economy*[47]

45 UK Energy Research Centre (2008), *Pathways to a Low Carbon Economy: Energy Systems Modelling*, http://www.ukerc.ac.uk/Downloads/PDF/U/UKERCEnergy2050/281108UKERC2050PathwaysLowCarbonEconomy.pdf

46 UK Energy Research Centre (2009), *Decarbonising the UK Energy System: Accelerated Development of Low Carbon Energy Supply Technologies*, www.ukerc.ac.uk/support/tiki-download_file.php?fileId=166

47 Committee on Climate Change (2008) and http://www.theccc.org.uk/pdfs/MARKAL-MED%20model%20runs%20of%20long%20term%20carbon%20reduction%20targets%20in%20the%20UK%20-%20AEA%20-%20Phase%201%20report.pdf

- Department of Energy and Climate Change, 2050 *Pathways Analysis*[48]
- Department of Energy and Climate Change, *The Low Carbon Transition Plan*[49]
- Energy Networks Association, *Gas Future Scenarios*[50]

In addition, we have reviewed four key documents which do not model as far as 2050, but which offer insight into the early part of that period. Their runs are not used for quantitative comparison. They are:

- Redpoint and Trilemma, *Implementation of the EU 2020 Renewables Target in the UK Electricity Sector: RO Reform*[51]
- Ofgem, *Project Discovery*[52]
- Confederation of British Industry, *Decision Time*[53]
- Pöyry Consulting and Greenpeace, *Implications of the UK Meeting its 2020 Renewable Energy Target*[54]

Each report contains multiple model runs, based on different sets of input assumptions, output targets, or to test the model's sensitivity to changes to particular variables (for example, the price of carbon or the learning-cost trajectory of a particular technology). Each of the models provides a quantitative assessment of economic and energy systems. We used the results of 16 different model runs spread across the six reports. Only runs which targeted 80% decarbonisation in 2050 were used. Those that excluded any technology already in use (in practice, anything but CCS) were not incorporated in the analysis, as such exclusions seemed arbitrary and unrealistic, while there are genuine concerns about whether CCS can become technically and economically viable. The reports we reviewed all incorporate the electricity sector into models of the broader economy. Beyond broad similarities of methodology and purpose (i.e. to model the UK electricity/energy system over the next decades), the various reports had qualitatively different functions, which affect both the assumptions that went into them, the analysis conducted, and the types and quantity of output information presented. These differences affected the findings of the models, and this should be borne in mind when reading the subsequent analysis. Some models were used to assess specific policies or policy packages (DECC, Ofgem, CCC); others tried to assess the implications for technology deployment and market composition of different targets (CBI, ENA). Some reports emphasised readability and conciseness, and presented less information; others were more comprehensive in reporting all their results. Some reported 'renewables' as a group; others broke down the various different renewable technologies and showed outputs for each. DECC's 2050 *Pathways* models did not cost-optimise, emphasising technical over economic feasibility. Without access to the raw data, we can judge only what is presented in an assortment of charts, tables and technical annexes.

We analysed the chosen models in the following ways:

- Assumptions – we looked at how decisions taken by modelling teams affected the results they generated;
- Forecast outputs in 2050 – we looked at what the models found about the size of the generating sector in 2050, its composition, the timings of deployment of generating capacity, and the technology mix;

48 Department of Energy and Climate Change (2010), *2050 Pathways Analysis,* http://www.decc.gov.uk/assets/decc/What%20we%20do/A%20low%20carbon%20UK/2050/216-2050-pathways-analysis-report.pdf

49 Department of Energy and Climate Change (2008), *The UK Low Carbon Transition Plan,* http://www.decc.gov.uk/assets/decc/White%20Papers/UK%20Low%20Carbon%20Transition%20Plan%20WP09/1_20090724153238_e_@@_lowcarbontransitionplan.pdf and *The UK Low Carbon Transition Plan Technical Annex,* http://www.decc.gov.uk/assets/decc/White%20Papers/UK%20Low%20Carbon%20Transition%20Plan%20WP09/1_20090727143501_e_@@_uklctpanalysis.PDF

50 Energy Networks Association (2010), *Gas Future Scenarios Project – Final Report,* http://energynetworks.squarespace.com/storage/ena_publications/ena_gas_future_scenarios_report.pdf

51 Redpoint and Trilemma (2009), *Implementation of the EU 2020 Renewables Target in the UK Electricity Sector: RO Reform,*

52 Ofgem (2009), *Project Discovery Energy Market Scenarios,* http://www.ofgem.gov.uk/MARKETS/WHLMKTS/DISCOVERY/Documents1/Discovery_Scenarios_ConDoc_FINAL.pdf

53 Confederation of British Industry (2009), *Decision Time,* London

54 Pöyry Consulting (2008), *Implications of the UK Meeting its 2020 Renewable Energy Target,* http://www.ilexenergy.com/pages/Documents/Reports/Renewables/July08_2020RenewablesTarget.pdf

- Decarbonisation trajectories – we looked at the models' findings about the shape of decarbonisation trajectories;
- Costs – we looked at the models' findings (and limitations) when it came to making predictions about overall cost.

For more detailed information on their modelled outcomes, the original sources should be consulted.

Models' assumptions

The assumptions made in different modelling runs are instructive about uncertainty and about the range of views modellers held.

Table 3 presents some of the key assumptions in those model runs analysed. Most of the models built in some requirements about renewables deployment in the next decade, reflecting either the EU 2020 target (15% of all UK energy to come from renewables, or about 35% of electricity) or the now-superseded Renewables Obligation target of 15% of electricity from renewables – all of them achieved 80% economy-wide decarbonisation by 2050.

Table 3: Key assumptions for decarbonisation trajectory model runs

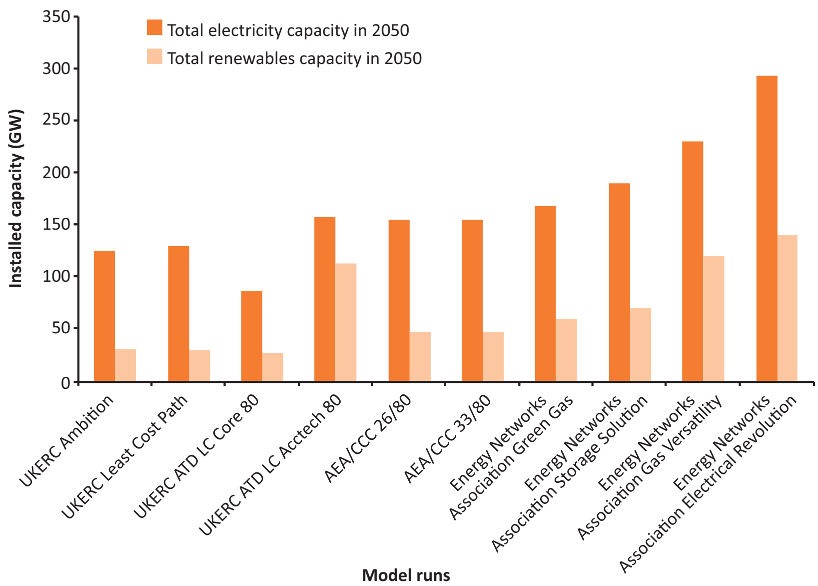
Report	Model run	Renewables assumptions	Technology assumptions	Decarbonisation trajectory assumptions	Other key assumptions
UKERC	"Ambition"	15% of electricity from renewables by 2020 (EU target not met)		26% by 2020, 80% by 2050	
	"Least Cost Path"	"		80% by 2050. Total (cumulative) emissions to 2050 constrained to be equal to route modelled with 32% carbon reductions before 2020	High social discount rate (leads to late decarbonisation)
	"Socially Optimal Least Cost"	"		"	Higher technological innovation rate, lower discount rate
UKERC ATD	"LC Core 80"	15% of electricity from renewables by 2020 (EU target not met)		26% by 2020, 80% by 2050	
	"LC Renew 80"	"	Renewables have accelerated learning rate	"	
	"LC Acctech 80"	"	All technologies have accelerated learning rate	"	
CCC /AEA	"26/80"	15% of electricity from renewables by 2020 (EU target not met)		26% by 2020, 80% by 2050	
	"33/80"	"		33% by 2020, 80% by 2050	

Report	Model run	Renewables assumptions	Technology assumptions	Decarbonisation trajectory assumptions	Other key assumptions
DECC 2050 Pathways	"Pathway Alpha"				No cost optimisation
	"Pathway Beta"		CCS unavailable beyond demonstration plants		"
	"Pathway Zeta"		Low behaviour change		"
DECC Low Carbon Transition Plan	"80% RES"	EU 2020 Renewables target must be met		29% by 2020, 80% by 2050	
Energy Networks Association/ Redpoint	"Green Gas"	EU 2020 Renewables target must be met		Meet carbon budgets for 2022, 80% by 2050	Low gas prices
	"Storage Solution"	"		"	Heat and transport electrified
	"Gas Versatility"	"	CCS Unavailable	"	
	"Electrical Revolution"	"	Gas networks decommissioned by 2050	"	High gas prices

Models' 2050 outputs

Both the amount of electricity generating capacity projected by 2050, and the amount of it that is projected to be comprised of renewable technologies vary substantially between models, dependent on assumptions about the evolution of technologies, their costs, and demand patterns. As can be seen in Figure 1, the

Figure 1: Variation between models in total generating capacity and renewable capacity, 2050



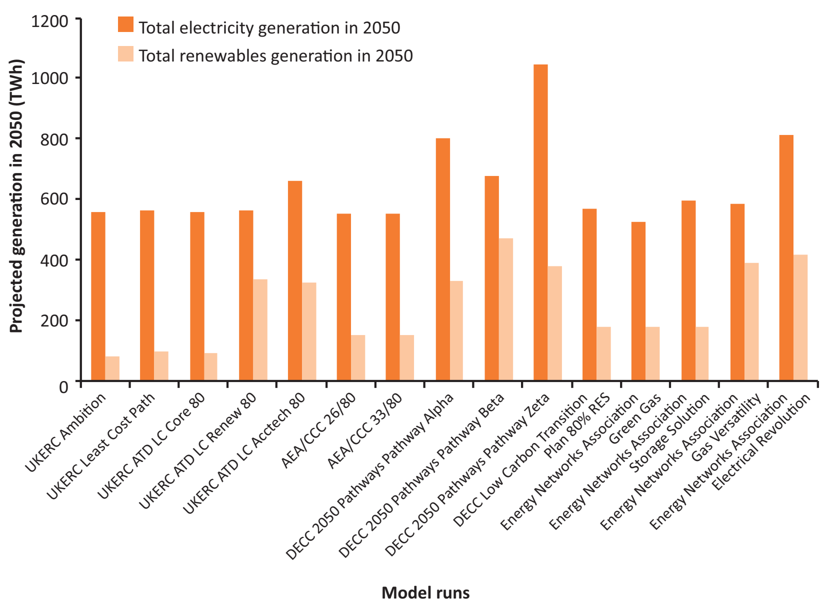
range of installed capacity projected for 2050 varies widely, from around 80 GW at the low end, to nearly 300 GW in a scenario where electricity is used much more widely, including for almost all transport and heating.

A wide range of modelled outcomes is also seen in Figure 2, which shows expected actual total generation and renewable generation, also in 2050. There is more agreement between models about total expected generation, than the proportion expected to be renewable.

In some scenarios, renewables make up more than half of capacity; in others, only around a tenth. Likewise, in some models renewables account for nearly 75% of generation output; in others they account for just over 10%. Variations in modelled outcomes are driven by a range of model assumptions including assumptions about rates of electrification of transport and heating (which in turn are driven by relative costs of relevant technologies), rates of energy efficiency improvement, the carbon price, and electricity/fossil fuel prices, as well as macroeconomic factors such as GDP growth rates.

In addition, the variations in modelled proportions of renewables in part reflects different assumptions about future costs of renewables compared with other generating sources, including nuclear and CCS; as well as assumptions about technological developments in relation to storage, such as in electric vehicle batteries, and demand-side response. Such technologies reduce the need for, and costs of, back-up capacity for intermittent renewable generation.

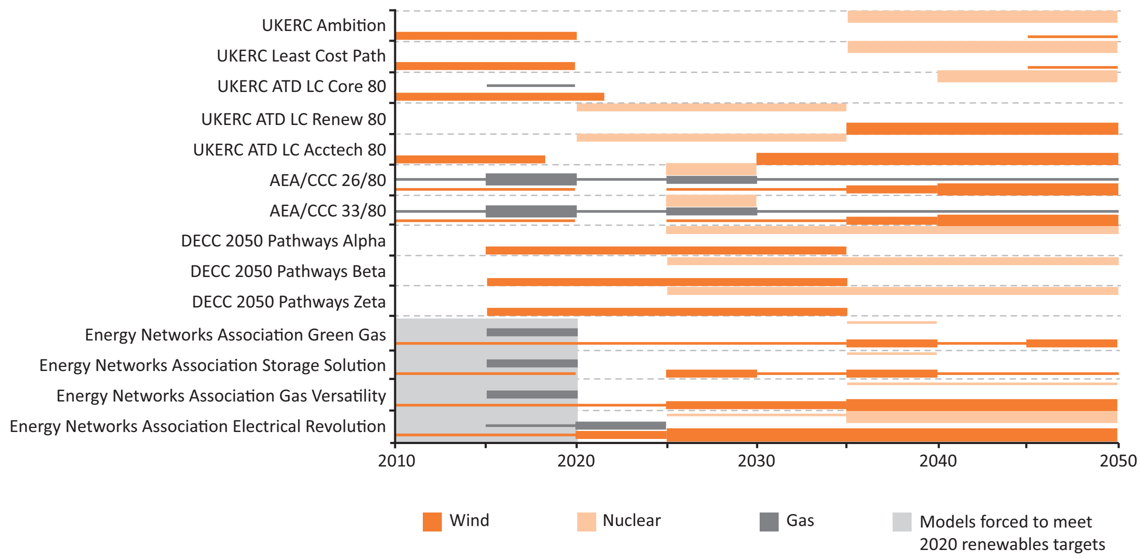
Figure 2: Variation between models in projected total and renewable electricity generation, 2050



Timing of deployment

The timelines for deployment of different technologies show some broad trends but many important differences between models (Figure 3 shows the modelled deployment trajectories of three key technologies – gas, nuclear and wind). Onshore wind tends to be deployed in earlier periods (especially in models which assumed the need to meet the RET target), while offshore wind tends to be brought online after 2030, reflecting expectations about future reductions in its cost and a rising carbon price. Gas capacity is deployed more variably – some models deploy significant unabated gas capacity before 2020, usually coming online replacing closing coal and nuclear facilities. The AEA/CCC model sees a further burst of gas construction concluding in the late 2020s, as well as a steady low-level of capacity being added all the way through to 2050. No other analysed models deploy so much gas beyond 2020. How that capacity is used in the later stages of its operational life is not clear from these data, although the emissions trajectories discussed later in the chapter imply a lessened baseload role and instead use as peaking plant or in lulls in renewable output.

Figure 3: Timeline showing development of nuclear, gas, and wind generation across different models (thickness of line indicates scale of new connections added – thicker lines mean more new capacity attached to grid). Data for CCS not shown, but is deployed in all models where it is not proscribed. Because of widely assumed constraints in developing the technology, CCS is only available after 2030 in all models



Models tend to deploy nuclear rapidly in the 2030s and 2040s. In part, nuclear's modelled rate of deployment depends on assumptions about the availability and cost of CCS, which competes as a baseload supplier in several models, renewables and grid storage. In models where nuclear is unavailable, large quantities of CCS are required. Because of widely assumed constraints in developing the technology, CCS is only available after 2030 in all models. It is deployed except where specifically assumed to be unavailable, but with significant variation in rates of deployment between models.

The models indicate the importance of CCS and nuclear. Without one or the other, the costs of decarbonisation rise extensively. Without both (i.e. using solely renewables for generation), the possibility reaching the 2050 decarbonisation objective is thrown into serious doubt. The obstacles facing CCS at present are primarily about technical and economic feasibility. The obstacles to nuclear, on the other hand, are predominantly political and economic, as seen in the differing national responses to the Fukushima disaster, with moratoria being declared in Germany and Switzerland, but other countries including China and the USA indicating their intent to press ahead with planned construction. Some runs assume CCS and/or nuclear are unavailable for construction at any time. It is notable that, by 2040, the models tend to have 'picked a winner' between wind (by that point both onshore and offshore are cost-competitive) and nuclear – whichever one has lowest assumed costs by then accounts for the majority of additional deployment – though this may reflect modelling limitations more than reality.

Decarbonisation trajectories

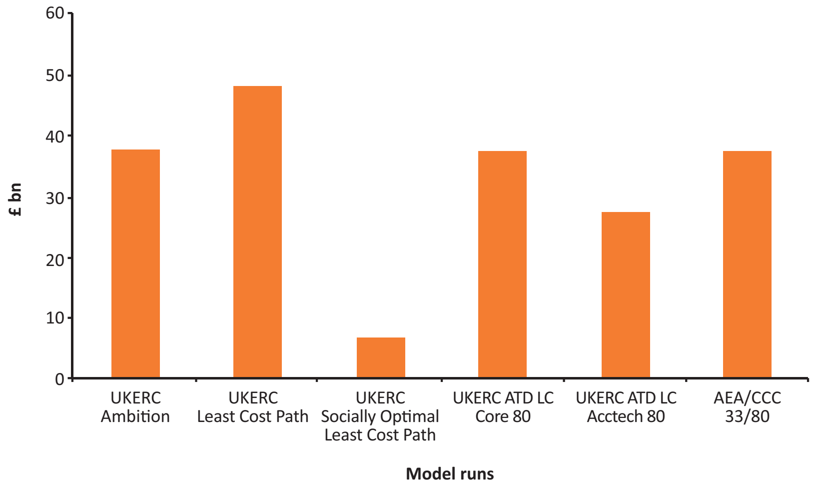
Economy-wide decarbonisation trajectories appear broadly similar across the models. This is in large part because they are all aiming at the same destination (80% by 2050) and increasing the decarbonisation rate in one sector of the economy allows decarbonisation in another sector to slow. Beneath the economy-wide trajectories, however, some more specific conclusions are also visible. Big reductions in carbon emissions from the electricity sector occur in the 2020s, so that by 2030-2035, all models with available data have decarbonised electricity substantially. Not all do so with renewables – nuclear and CCS account for the non-renewable parts of the mix (see previous section) and some legacy fossil plants (mostly gas CCGTs) remain on the system.

Costs

Because of the diversity of the models and the limitations of the available data, it is more difficult to compare costs fairly between models. Of the reports analysed, most cost-optimise to some extent, although many are tightly constrained to match authors' scripted scenarios (e.g. the role of a particular technology, or the amount of lifting done by a certain policy, such as carbon pricing or renewables targets) assumptions about particular technologies and learning curves, or other factors. DECC's *2050 Pathways* report is designed as a study of feasibility, rather than cost-optimal policy planning, and so does not give cost-optimised results. It is easier to compare cost estimates between different runs of the same model (e.g. UKERC's model), than across models. It is with these caveats that we present the following data.

For the models which work to minimise 'social welfare' costs (i.e. changes in consumer and producer surplus), they project emissions reductions at a far lower assessed cost than is otherwise seen (Figure 4). UKERC's Socially Optimal Least Cost Path has by far the lowest costs in 2050. It identifies a combination of early and rapid energy efficiency action, and an increased focus on supporting transport innovation as key. It also deploys more onshore wind early relative to less cost-competitive early nuclear technologies. The Least Cost run from the same report gives higher social welfare costs in 2050 by causing action to be delayed much later in the period, but has lower cumulative costs over the entire period to 2050. The run from UKERC's Accelerated Technological Development report shows that action to speed development of all technology types also yields a social cost estimate which is lower than the average.

Figure 4: Social welfare costs (2050)



The data on costs that are presented in the analysed reports again demonstrates the level of uncertainty, in particular about this most important variable. Indeed, it is perhaps telling that several of the reports refrain from discussing cost, or make only the most perfunctory mentions of it. The interaction of so many uncertain estimates makes cost-based modelling over long periods largely speculative; perhaps useful for cross-comparisons between similar runs with many similar assumptions, but less useful for inter-model comparison or for predicting likely cost outcomes. This reinforces that policy approaches based on central planning are unlikely to minimise costs, since the knowledge at the beginning of the planning period has little hope of corresponding with the reality later on.

2020 target

None of the models plotting routes to 80% decarbonisation of the economy by 2050 would achieve the renewable generating capacity required to meet the RET target, unless specifically scripted to do so by their modellers. They find meeting the 2020 renewables target unnecessary for meeting the 2050 carbon target, and scripting to do so would increase overall costs.

Most of the runs not scripted to reach the current EU target were still built to reach the previous RO target of 15% electricity from renewable sources by 2020. Consequently, all deliver at least this baseline quantity. These all fall considerably short of the 30-35% of electricity in 2020 from renewables implied by the RET target.

Overall findings of models review

The 2050 decarbonisation target has dramatic implications for electricity generation. Most projections suggest meeting the 80% reduction in overall GHG emissions by 2050 will require the near-total decarbonisation of the generating sector as areas such as transport are expected to prove more difficult to decarbonise completely.[55]

At the same time, the various models we have analysed illustrate the wide range of ways in which such decarbonisation might be achieved. The outcomes of the models ranged widely in terms of future electricity capacity and generation needed (from 80-290 GW of capacity, from 540-1060 TWh of generation) and mix of generation technologies (with widely varying proportions of nuclear, CCS and wind (on- and offshore) accounting for the bulk of supply in 2050 in all models). The proportion of renewable generation varied widely between models (from barely 10% of generation to as high as 75%).

> “Our analysis of decarbonisation models indicates that meeting the 2020 renewable energy target is not a necessary or desirable step towards meeting the 2050 target for reduction UK carbon emissions by 80%”

Clearly all of the models rely on current information and knowledge. As discussed earlier in this report, an effective process of decarbonisation should mean that new information is continually being discovered. This will include information about the feasibility of new generation and other technologies and relative costs of technologies. The discovery and development of unexpected 'disruptive' technological breakthroughs could even more dramatically reshape our understanding about the future. So, the actual path of decarbonisation will certainly not conform to any of the models surveyed. It could well lie outside the parameters of any of the models.

None of the models, which did not start off with an input assumption of needing to meet the 2020 renewable energy target, found that it needs to be met as part of achieving 80% decarbonisation by 2050. In addition, there is a range of projected levels of 2020 renewable generation deployment among these models.

UKERC's Accelerated Technological Development study suggests that early investment in renewable research development and demonstration, rather than the current focus on mass deployment of renewable generation in this next decade, would prove more cost-effective in the long run while achieving comparable emissions reductions. This model sees the rate of decarbonisation accelerating later in the period as low carbon technologies become cheaper.[56]

This contrasts with the findings of the Committee on Climate Change/AEA study, as well as the initial UKERC *Pathways to a Low-Carbon Economy* report, which both project the need for larger scale early renewable generation deployment in the 2010s, before nuclear becomes available in the 2020s. These models assume that there needs to be a more or less steady rate of decarbonisation through the period to 2050, in contrast to the UKERC Accelerated Technological Development study.

Assumptions about achievable innovation rates over the next few decades, and about the capacity for investment to accelerate decarbonisation when low carbon technologies become cheaper, can fundamentally reshape the projected views of

55 The Committee on Climate Change (2008), chapters 2 and 5. Also European Climate Foundation (ECF) (2010), *Roadmap 2050 Technical Analysis*, The Hague

56 In large part this is a function of relaxing constraints on learning rates for different technologies, as exemplified by the differences between the Accelerated Technology and the baseline models. It shows the impact that changes to the assumptions surrounding learning rates can have. It also indicates the potential rewards available if effort on technological development can be enhanced.

the future, and thus preferred policy. To justify rapid and expensive early rollout of renewable generation, and particularly offshore wind, as the UK is currently planning, would require much more pessimistic assumptions about the scope for innovation than are present in any of the models.

No one can currently know what the best pathway to electricity decarbonisation is, given uncertainty about the future. This chapter has illustrated the range of possible pathways, based on current information. A decarbonisation process that enables the most cost-effective pathway to emerge, promoting the innovation and discovery of new information and flexibility of markets to adapt to this information, is needed. The current focus of policy on rapidly rolling out a chosen subset of expensive technologies is at odds with this.

Moreover, even on current information, our analysis of decarbonisation models indicates that meeting the 2020 renewable energy target is not a necessary or desirable step towards meeting the 2050 target for reduction UK carbon emissions by 80%.

8
Policy Options

As outlined in Chapter 6, there are a number of reasons to want to move away from the 2020 renewable energy target in the UK. This section sets out options for reducing the cost of renewables policy, and thus freeing up resources to better focus on carbon reduction.

While the renewable energy target relates to all final energy consumption, in the UK the main impact of the target is on the electricity sector – the scope in the heat and transport sectors to deploy renewable energy by 2020 is more constrained. This report and the following policy options therefore focus on renewable electricity policy.

To summarise the arguments against the renewable energy target:

- The focus on selected renewable generation technologies unnecessarily narrows the range of options for pursuing decarbonisation. By contrast, modelling studies find renewable generation could account for as little as 10% of total electricity generation or as much as 75% in 2050 while still being compatible with an 80% decarbonisation rate by 2050;
- The target requires mass deployment of a number of still very expensive technologies at an earlier date, and thus more expensively, than would occur under a technology neutral approach. The costs of the target – £66 billion (NPV) according to the government's own figures – are hugely and unnecessarily expensive, and achieve far too little for the money;
- The target's short timeframe and narrow technological focus causes a spike in demand for certain technologies across the EU, leading countries to bid prices up as they scramble to meet their own contribution to the target, granting a windfall in rents to suppliers;
- It diverts resources away from a real focus on low carbon innovation for meeting the 2050 carbon target in favour of rapid deployment of certain renewable technologies now;
- The target depresses the EU ETS price by forcing companies to make carbon reductions through expensive renewable deployment, *without delivering any additional carbon reduction by* 2020. In other words, it disincentivises relatively cheaper carbon reduction measures;
- The level of ambition for renewable deployment in the UK is infeasible, leading to regulatory uncertainty deriving from concerns the target will not be met;
- Even meeting the target would present a far-from compelling example to other countries of an approach to decarbonisation – an excessively expensive one;

- By unnecessarily raising the cost of electricity, the renewables target may deter electrification of other sectors, such as space heating and transport, as part of economy-wide decarbonsation to meet the 2050 target;
- By unnecessarily raising the cost of electricity, it could have the effect of driving large energy users overseas, into jurisdictions where power is produced more carbon-intensively than in the UK;
- It uses up the public's willingness to pay extra for energy for relatively little return, squandering the total resources available for decarbonisation, and damaging the prospects for meeting the ultimate 2050 carbon target.

Climate policy needs urgently to be refocused back onto global carbon emissions, rather than short-term, expensive domestic renewable deployment.

We first outline, at a general level, the shape of policy which should be driving decarbonisation, before looking at options for dealing with the problem of the renewables target, including considering renegotiating the target, simply ignoring it, or finding ways of meeting the target at least cost.

General shape of policy to drive electricity decarbonisation

Much of the focus of this report is on critiquing the current strategy for electricity decarbonisation, and thus focuses on the, dominant, renewable energy target. This section briefly outlines, in general terms, the key elements of an improved, more cost-effective electricity decarbonisation policy.

The key must be to focus on carbon reduction. The most important element is an effective, long-term carbon-pricing framework. By altering the relative prices of electricity generated by carbon emitting and non-emitting methods, more carbon-intensive energy would be disincentivised. When the carbon-pricing framework is applied across the economy, the most cost-effective carbon reduction measures may be discovered wherever they may be located. When the framework is given long-term stability, it can make a difference to investment decisions made now regarding capital with long lifetimes.[57]

An effective carbon-pricing framework would properly put carbon at the heart of policy, rather than focusing on selected intermediate and tangential targets. Doing so is appropriate given all the unknowns outlined earlier. No-one knows the best future carbon reducing measures, their relative costs, or the order they should be deployed, among other factors. Focusing policy on carbon avoids policy makers making decisions they do not have the necessary information to make.

An effective carbon-pricing framework would allow the market flexibility to function effectively, providing information revelation processes that enable participants to locate new options and efficiencies. A focus on carbon pricing also sends price signals to incentivise demand side approaches to carbon reduction, broadening the scope for savings to be found. It has the potential through its simplicity, if bolstered with appropriate long-term commitments, to reduce current regulatory and political uncertainty and associated investment risks.[58]

There are a number of ways a carbon-pricing framework could be implemented. In a theoretical ideal, a global approach would eliminate competitiveness problems and carbon leakage. However this is currently a

57 Edwards, Rupert and Maxwell, Dominic (2011), *The UK carbon price floor: how to enhance its credibility with investors*, Climate Change Capital, http://www.climatechangecapital.com/media/198658/ccc%20thinktank%20-%20uk%20carbon%20price%20floor%20-%20how%20to%20enhance%20its%20credibility%20with%20investors%20-%20final.pdf

58 See also Helm (2010) pp 73-78

non-starter. At the EU level, the chosen approach is broadly to set a quantity of carbon which may be emitted, and allocate carbon permits, with price a function of trading. As the ETS expands its remit to cover more of the emitting sectors of the EU economy, it has the theoretical potential with continued reform to be a more comprehensive European carbon-pricing framework. Focusing policy on establishing property rights – quantities of carbon which may be emitted, and letting the carbon price emerge from trading is a theoretically sound approach. Businesses and consumers pay no more for emitting carbon than is needed to meet carbon targets. There is a risk that this price could be higher than expected, and too high to be politically sustainable. One remedy for this would be a maximum price ceiling, above which additional permits are allocated. But it is also possible and probably more likely that the market, left to operate flexibly within a carbon cap, reveals carbon reduction opportunities that are cheaper than expected. Under an effective carbon permitting arrangement, a low traded carbon price while meeting the carbon cap, is a sign of success.

But, the ETS currently is not a fully effective system. It suffers from practical and political limitations, as discussed in Policy Exchange's report *Greener, Cheaper*. Relatively short permitting periods, the need to negotiate rules across 27 Member States, lobbying from industrial sectors for special treatment and rents and the overlaying of the ETS with renewables policies and other policy interventions have hitherto weakened the ETS as an effective carbon pricing framework.

It is not yet clear whether the practical weaknesses of the EU ETS will be resolved. Therefore, the Treasury's initiative to underwrite the ETS price in the UK with a Carbon Price Support taxation measure has merit. It is clearly a second best option, not least because it covers only the UK, creating some risks for a number of large UK industrial energy consumers. The Treasury's approach has a number of deficiencies: it only covers electricity emissions; it could be longer term, going beyond 2020 and more could be done to give investors long-term certainty about the carbon price, for example through some form of contractual guarantee to keep to the Treasury's proposed carbon price trajectory. But overall, an approach focusing simply on carbon pricing is still much preferable to the current UK policy mix based on the technology specific subsidies and targets.

Some objections to a carbon pricing approach are addressed in Re-Monopolising Power.[59] It is important in developing a credible long-term carbon-pricing framework that concerns about the credibility of the commitment to the framework, the impact on competitiveness, and windfalls to existing subsidy recipients are resolved. However, none of these problems are insurmountable.

The second critical element of decarbonisation policy is additional support for innovation. Innovation is what will eventually deliver our challenging long-term decarbonisation objectives. As we saw in Chapter 4, low carbon research, development, demonstration and, often, early stage deployment, are not fully responsive to carbon price-driven market pressures. So support is needed to complement any effective carbon pricing framework (and more so in the absence of a fully effective carbon pricing framework). Support interventions could take many forms – tax breaks, R&D credits, prizes, subsidies or government procurement programmes. Critically, however, interventions should be distinct and separate from the business of mass deploying low carbon generation.

59 Less, S (2011) *Re-Monopolising Power*, Policy Exchange, London

Innovation interventions must be focused on maximising learning, not on meeting carbon reduction targets. It is for markets operating flexibly within an effective carbon-pricing framework (carbon cap or tax) to make least cost deployment decisions.

At a general level, an effective carbon-pricing framework and focused RD&D support(as well as behavioural interventions to promote energy efficiency) are the important elements of an electricity, and wider, decarbonisation policy. Here we are saying nothing more than Nicholas Stern's review in 2007. (In addition, government has various enabling roles, such as achieving an effective planning system, and putting into place regimes for very long-term liabilities relating to nuclear waste or stored carbon dioxide.)

This section has set out the general policy interventions which should be developed and pursued to achieve electricity decarbonisation as cost-effectively as possible. However, the UK already has a range of existing policies with different or competing aims, in particular renewable generation deployment subsidies driven by the EU renewable energy target.

The next two sections explore the options for abandoning this damaging target, and related policies, paving the way for the improved policy landscape discussed above (Options 1 and 2). We then discuss the options, if the renewable energy target is retained, for wasting fewer resources on it (Option 3). Under any of these options, developing an improved overall framework based on effective carbon pricing and focused support for RD&D should in any case be pursued.

Even if the renewables target is not to be abandoned quickly, neither the EU nor UK should repeat the error by creating further renewables targets, or other distorting intermediate targets, for the period beyond 2020. The focus of decarbonisation policy must instead be on long-term, credible instruments, for pricing carbon and supporting a range of low carbon innovation.

Renewable energy policy options

We discuss three options for addressing the problem of renewable energy target:

Option 1: Renegotiate the renewables target

What does the option involve?

The UK could seek to negotiate the abandonment, downgrading, or its exit from, the EU renewable energy target.

As the biggest obstacle to an effective and efficient decarbonisation policy, getting out of the renewable energy target is clearly the most direct way of escaping its costs and distortions, as outlined in Chapter 6. The UK could argue, correctly, that the RET damages the emissions reduction agenda by imposing hugely disproportionate costs and diverting resources from better measures, and by undermining the EU's flagship ETS programme. By putting emissions reductions, not renewables, at the centre of climate policy, the EU could focus its efforts on making the greatest climate impact.

The UK government has been at the forefront of moves to tighten the emissions cap component of the 20-20-20 package. Any tightening of the carbon cap could go hand in hand with a loosening or removing the technological (renewables) requirements for its achievement. In this way, it could be demonstrated clearly that loosening the stranglehold of the renewables target was not about backing away from carbon emissions reductions. Quite the opposite: additional carbon emissions reduction could be secured, but at lower cost.[60]

The politics of renegotiation would be easier if other countries shared similar concerns about meeting the target. We note that in their National Renewable Energy Action Plans, Belgium, Estonia, Italy and Luxembourg all reported serious concerns about their ability to make their targets without using the 'flexibility mechanisms' which allow purchasing renewable generation from other countries.[61]

Implications for domestic policy

UK subsidies for renewable generation – in particular the Renewables Obligation and the feed-in-tariff for small-scale renewable generation – could be heavily reformed if the renewable energy target were no longer in place. The focus should be switched to carbon pricing and learning and innovation. This would include supporting demonstration and where appropriate early stage deployment of a range of low carbon technologies. Technology-specific subsidies should no longer be focused on mass rollout to meet short-term deployment targets. (Pre-existing commitments to projects should still be honoured). This might be achieved through reform of the RO, or by a new programme designed for the job.

Pros

The main benefit of this option is the amount of money it would save, with no loss of carbon reduction. It is very difficult to estimate precisely how much this amounts to. The savings will depend on the scale of projects already contractually committed to, the effect of scrapping the renewable energy target on the carbon price, how much the government chooses to spend supporting genuine learning innovation, and other factors. Given that renewable energy has only crept up from 5.6% of electricity generation in 2008 to 6.6% in 2010, we still have time to save a large proportion of the wasted spending on the £66 billion target.

Those savings could be used to support decarbonisation in a variety of other ways, for example by supporting increased energy efficiency measures, as the cheapest route to short-term carbon reductions, or by investing in low carbon innovation which could increase the chances of success of meeting the 2050 target. Given the wasteful spending driven by the RET, a significant proportion of savings could simply be taken as lower future energy bills, without damaging expected decarbonisation. Depending on how savings were used, this option could deliver savings now as well as enabling more effective future decarbonisation. And an electricity market less constrained and distorted towards particular technologies and by particular subsidy levels, would be better able to innovate and find the most cost effective routes to decarbonisation. Demonstrating better processes for meeting the UK's carbon reduction targets more cheaply would also set a more compelling example to other countries.

Cons

It will not be easy to negotiate change to the EU target now. There is also the risk that UK political capital expended on this would necessitate concessions elsewhere, in the horse-trading of European Council decision making. The UK

60 Although this option would lead to an increase in the ETS price (or direct costs of greater support for innovation) the savings from reductions to renewables subsidy would more than pay for the difference.

61 Denmark, Bulgaria, and Malta also reported similar concerns in the preliminary Forecast Documents. European Commission (2010), Forecast Documents [various], http://ec.europa.eu/energy/renewables/transparency_platform/forecast_documents_en.htm and National Renewable Energy Action Plans [various], http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm

may have to concede ground on other policy areas of priority in order to get its way here.

There may also be domestic political cost, if a UK attempt to renegotiate were perceived, wrongly, as downgrading the importance of climate change mitigation. Unfortunately, the renewable energy has gained symbolic importance within debates about decarbonisation. Renewable technologies should be seen as a number of potentially important approaches to reducing carbon emissions, but alongside a range of others.

These risks are greater if the UK were acting unilaterally. It should be remembered, even at this stage where the UK and some other nations appear to be struggling to reach their targets, that the EU-wide ambition of 20% renewable generation still looks achievable. That context may discourage Member States and the Commission from renegotiation, although it should also mean enough renewable capacity is available that nations could use the 'flexibility mechanism' to trade excesses and shortfalls (see Option 3). As 2020 approaches and the ability of each nation to reach its contribution to the target becomes clearer, it may be easier to open up for renegotiation. As it becomes increasingly clear that the UK will not meet its target, there may be little choice but to discuss the option. But by that time, huge levels of resources will have been wasted.

Box 3: Is a reduced role for the renewables obligation compatible with meeting carbon budgets?

We saw in Chapter 7 how, according to all the relevant models, failing to meet the 2020 target for renewable energy remained consistent with long-term decarbonisation by 2050.

However, the government is operating under its own tighter constraints, with carbon budgets in place for the years up to 2022, and budgets for the subsequent period due to be set soon. Can the government reach these intermediate emissions reductions targets while fundamentally reshaping renewable policy, as described in Option 1?

Certainly the pool of available technologies is smaller over the next few years, than over the longer period the models in Chapter 7 analysed to achieve their emissions reductions. For example, it is hard to see CCS as a significant early contributor, while the lead times for the construction of nuclear power mean that projects will need approval in the current parliament to be online by 2022. However, gas, while being a carbon emitting generating technology, still has much lower emissions than the current grid average and can keep the UK on its decarbonisation path.

Models analysed in Chapter 7 suggested a reduced level of renewables deployment support (delivering less renewable generation than in Option 3), can also reach the 2022 carbon budget.[62]

In particular, analysis conducted by McKinsey for the CBI showed the consequences of building gas to replace departing coal and nuclear, in their Business as Usual scenario.[63] They found that the 2018-22 carbon budget would remain achievable. However, they raised concerns that 'lock-in' to gas generation would put at risk the indicative trajectory of electricity decarbonisation to 2030 (not yet part of a binding carbon budget) set out by the Committee on Climate Change. On the other hand, in

62 The CCC/AEA 33/80, and the UKERC Socially Optimal Least Cost models both achieve 33% carbon reductions by 2020 while only delivering 15% of electricity from renewables in that year.

63 CBI (2010), pp. 10-13

their Balanced Pathway scenario (with a 2020 renewable energy ambition well below the RET), McKinsey showed that keeping some large coal plants active longer into the 2020s, using coal rather than gas to bridge the gap to nuclear enables both the 2020-22 carbon budget and the indicative 2030 target to be reached. Another possible trajectory could see CCS retrofitted to gas in the late 2020s, if that technology became cost competitive. A third option would be stranding some gas generation, or its use only as back-up for intermittent renewable generation in the 2030s. (The CCC still envisages a contribution from unabated gas in 2030). Such stranding of gas before the end of its full lifetime is likely still to be cheaper than much of the proposed offshore wind (which in any case would need to be replanted in the 2030s).

Overall, perhaps the key observation to make is whether it is necessary or sensible to base policy on trying to achieve certainty in precisely meeting a particular point on a decarbonisation trajectory by certain dates (e.g. 2030) for one specific sector of the economy (electricity). The focus should be more on developing effective carbon policy instruments and processes to promote innovation and incentivise carbon reduction, rather than on precisely meeting intermediate targets.

Option 2: Ignore renewables target

What does the option involve?

If renegotiation of the renewables target proved impossible, the next option would be simply to disregard the target. The UK would still pursue decarbonisation objectives, both to meet the EU-wide 2020 target (largely through ETS-based methods, also including the 'Effort Sharing' objectives in non-ETS sectors – see Chapter 5), the domestically set 2050 target for 80% decarbonisation of the economy and its carbon budgets. If, as seems virtually certain, achieving the renewable energy target is beyond reach, the question that remains is how much effort to put in while not meeting it. As discussed for Option 1, the costs of meeting the target are huge and unnecessary, hindering the chances of ultimate decarbonisation. So the case for disregarding is that it is better to stop wasting money now rather than later.

Implications for domestic policy

The implications for domestic policy would be the same as Option 1, enabling reorientation of policy towards more cost-effective near-term carbon measures and towards greater support for innovation.

Pros

As Option 1.

Cons

As well as the political risks discussed under Option 1, a key risk associated with ignoring the target unilaterally is that the European Commission could launch infraction proceedings against the UK.

It seems likely however that, even if the UK were ultimately fined (a big if), this would be less costly and wasteful of the UK's resources than pursuing achievement of the target (see Box 4). And the Commission may not in fact pursue enforcement, particularly if the EU as a whole achieves the target, a number of countries fail to meet the their contributions and the UK shows itself to have done well on actual carbon emissions reduction.

Nonetheless, deliberately setting out to break a legal commitment is problematic because the rule of law is a great and distinctive aspect of British life. It is a risky option, and one that is very much inferior to Option 1.

Box 4: EU infraction

If the UK fails to meet its obligations under EU law, it may face 'infraction' proceedings – the process of being legally pursued by the European Commission in the European Court of Justice (ECJ) for failure to implement Community law.

This is an arduous process, with multiple stages. Accused states must be notified of an alleged breach, and given two months to respond. After this period, the Commission can issue a formal opinion that a breach has occurred, which is followed by another two-month response period. At this stage, the case can be referred to the ECJ for hearings to be held. After these hearings, which can take several months, the Court may issue its judgment that the state has broken rules, and must implement the law as in the Directive. After a further grace period for the Member State to apply the ruling, if it is still in breach further proceedings may be undertaken and which may find that the Member State has failed to uphold the judgment of the Court. Only at the end of this part of the process can a fine be imposed.

The size of the fine is based on three criteria – the seriousness of the infringement, its duration, and the need to deter future infringements. The size of the penalties in the hypothetical case of the RET would depend on the extent to which the Commission believed the UK tried to achieve the target. The maximum possible fine the Commission could impose on the UK (and bear in mind it would need first to go through a long and politically charged process to reach this point) is just over €240 million (£200 million) a year, until the Commission determines the UK to be compliant. (The largest Member State fine appears however to be only €20 million.)

The question of duration of non-compliance in the case of the renewable target is unclear. The Directive provides for compliance "in" 2020, rather than "by" or "from." It is not clear that failing to meet the target in the period *after* 2020 would constitute noncompliance. Consequently, the justification for an ongoing annual penalty structure is questionable.

Furthermore, it is hard to see what the Commission might gain from an infraction process particularly in the case where it failed to deliver a judgment until the latter part of 2022 or 2023 for UK underperformance on renewables in 2020, and the UK's record on decarbonisation over the same period were good.

As well as the cost of any fine, there may be reputational costs to consider. The Commission has never previously fined the UK. It might be argued that the UK's diplomatic capital in unrelated policy areas would be undermined by being subject to a fine. However, the historical evidence for such a fear is not strong: other countries have faced fines without obvious loss of influence within the EU as a result – for example France faced the EU's largest ever fine of €20 million yet has not appeared to lose influence.

Option 3: A cheaper plan for meeting the target

If the target is not renegotiated and if it were not considered desirable simply to disregard the target, could the UK significantly reduce the unnecessary costs which attempting to meet the target currently imposes?

Rather than treating the RET as a key part of the UK's decarbonisation strategy, it should be considered a burden to be addressed with minimum wasted resources and minimal market distortion. Such an approach could signpost a number of ways to reduce the costs including:

a) scaling back the current Renewable Energy Strategy (RES) so that the probability of meeting the target is reduced but the plan is still acceptable to the Commission; and in particular scaling back the Renewable Energy Strategy simply to reflect lower 2020 GDP and energy usage forecasts than when it was drafted in 2008 (pre-recession);
b) using cheaper renewable technologies instead of more expensive ones;
c) increasing energy efficiency effort; and
d) planning to make use of the Renewable Energy Directive's 'flexibility mechanisms' to trade renewable 'capacity'.

We make the assumption, under Option 3, that the basic RO (or similar) policy framework remains in place, i.e. one which subsidises all renewable generation.

(a) Scaling back the RES ambition

A deliberate, stated policy of noncompliance risks infraction proceedings, as discussed above. However a policy that showed sufficient intent to comply, but ultimately failed to reach the target, would be likely to avoid infraction. No policies can guarantee meeting the target, and indeed the UK's current Renewable Energy Strategy seems, to most observers, unlikely to meet the target. This appears to be largely because of obstacles including the planning regime and the practical feasibility of planting the sheer numbers of offshore wind turbines needed. There are a number of reasons to believe that there is scope for the RES to be scaled-back, reducing the wasteful expenditure, while still providing a plan sufficient to pass muster with the Commission. The Netherlands has already set a precedent recently by unilaterally scaling back its subsidies for renewables from €4 billion per year to €1.5bn per year, committing to focus only on cost-effective technologies such as onshore wind and biomass.[64]

A more specific reason to scale back subsidies is that, when the Renewable Energy Strategy was written, electricity demand for 2020 was projected to be 386 TWh.[65] Since the recession, recent estimates have revised that figure down to 375 TWh (a range of 371-379 TWh).[66] There is consequently reason to believe that the implementation measures in the RES could be scaled-back, while maintaining the probability of meeting the EU target. Even though there is good reason to doubt that the Renewable Energy Strategy as it stands will deliver the 2020 target, the Commission has approved it. Given that the projections that the RES was based on have been revised down, it is hard to see how the Commission could reject a change made to reflect the new projections.

64 Gassmann, Michael (2011), 'Holland plant strahlende Zukunft' (Holland plans bright future) in *Financial Times Deutschland,* http://www.ftd.de/unternehmen/industrie/:energiepolitik-holland-plant-strahlende-zukunft/60008920.html

65 DECC (2009), The UK Renewables Energy Strategy, http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/renewable%20energy/renewable%20energy%20strategy/1_20090717120647_e_@@_theukrenewableenergystrategy2009.pdf

66 DECC (2010), *Updated Energy Projections: Annex E,* http://www.decc.gov.uk/en/content/cms/statistics/projections/projections.aspx

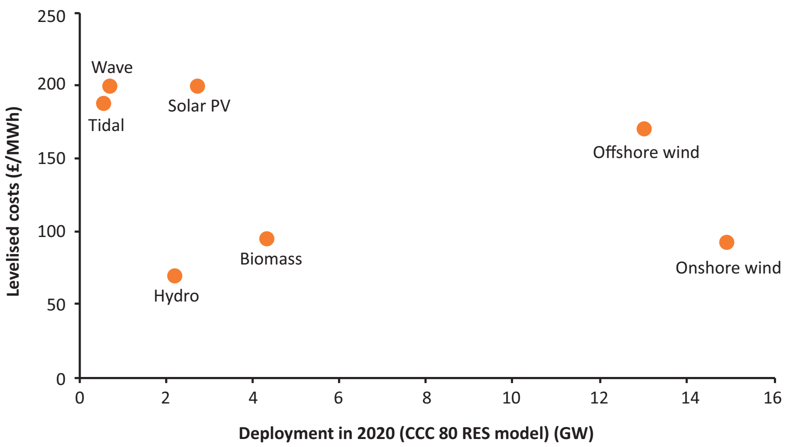
The loss of 11 TWh of demand implies a decline of 3.85 TWh of renewable generation required or approximately 1.3 GW of installed renewable capacity in 2020 (assuming offshore wind is the technology foregone). This amounts to a capital cost saving of £3.9 billion (at an assumed rate of £3 billion per GW capacity of offshore wind capacity).[67]

Equivalent savings could potentially also be viable in other renewable policy areas – heat and transport – but these are beyond the scope of this paper.

(b) Cheaper renewable technologies instead of more expensive ones

There is considerable scope for the UK to scale back subsidies for some of the most expensive technologies, such as small-scale renewables and offshore wind, and deploying greater quantities of cheaper renewable technologies instead.

Figure 5: Technology costs and deployment rates for different renewable technologies



The current RES has the effect of promoting the very large scale deployment of one currently very expensive renewable generation technology in particular, while not exploiting the potential, or deliberately holding back, a number of cheaper renewable technologies. Figure 5 shows how offshore wind is an outlier in the proposed UK renewables mix, having costs similar to still experimental technologies, such as wave power, but currently being promoted and subsidised to try to achieve an expected deployment scale by 2020 in line with, or even greater than, more mature and cheaper technologies such as onshore wind and biomass. The high subsidy levels and ambitions for deployment of offshore wind by 2020 are a significant driver of RET costs in the UK.

There are a number of ways in which the need to build expensive offshore wind in particular to meet the target might be reduced, focusing on:

- co-firing biomass
- onshore wind
- cheaper renewable generation technologies in general

67 Costs per Mott MacDonald (2010). Assumes a 33% capacity factor for offshore wind, as per 2009, the last year with available data, from DUKES 2010.

Co-firing biomass

The government appears to be deliberately holding back at least one relatively cheap renewable technology: co-fired biomass. There are several ways in which co-fired biomass generation is discriminated against compared to other renewable technologies within the current RO structure (see Box 5).

Box 5: Biomass co-firing and the renewables obligation

Biomass is currently the UK's largest source of renewable energy. In electricity production, biomass can either be burned in dedicated facilities, or co-fired with coal. Biomass co-firing is the process of burning biomass fuels (typically wood pellets or compacted agricultural residues) in place of a proportion of the coal used in a typical coal-burning generator.

Co-firing is one of the cheapest renewable generation technologies (currently in the lowest RO subsidy band). But it is unique among renewable technologies governed by the Renewables Obligation, in that it is the only one where subsidies are capped by UK legislation. No electricity supply company may source more than 12.5% of its presented ROCs from co-firing installations.

The cap arises in large part because of fears that co-fired ROCs could 'flood the market', driving down investment in preferred but more expensive renewable technologies. This argument appears logical if one sees the aim of the policy as maximizing renewable generation beyond 2020, since co-firing in coal furnaces is unlikely to be a long-term generation technology.

However, as we have argued, renewable deployment *per se* should not be the objective of policy; the relevant objective must be cost-effective decarbonisation through to 2050. In this context, the renewable energy target should addressed in the least costly and damaging way, and thus co-firing levels in 2020 should be maximised. Co-firing is a potentially useful as a bridging technology to meet the renewable energy target cheaply and buy time for cheaper low-emissions generation after 2020. It also potentially provides a way to support the conversion of coal generation to biomass, with co-firing as a stage on the transition to help phase out coal more quickly.

Further concerns about allowing larger quantities of co-firing include (a) that co-fired generation levels could fluctuate from one period to the next, based on changes in the relative prices of coal and biomass fuel, introducing volatility into the wider ROC market; and (b) co-firing encourages higher carbon emissions as coal is burnt alongside biomass Such concerns are overblown. The number of pre-existing coal facilities, and the technical processes involved, naturally limit the amount of co-firing (albeit higher than the 12.5% cap allows).[68] And carbon emissions in the electricity sector are governed by the EU ETS cap to 2020, and are not affected by micro-management of the Renewables Obligation.

No other EU country has constrained itself in this way.

In their analysis of the co-firing cap, consultants Oxera found that relieving the cap would reduce the price of ROCs by about 7%, and enable gains of up to 4 TWh of renewable generation per year between 2013 and 2020 from co-firing alone (increasing renewables as a proportion of total generation by 0.7-0.8%/year).[69] Removing the cap on co-firing could yield a small but cheap

68 Oxera (2009), *What Is the Impact of Changes to the Co-Firing Cap?* http://www.decc.gov.uk/assets/decc/consultations/renewable%20electricity%20financial%20incentives/1_20090921145439_e_@@_implicationsofchangestothecofiringcap2.pdf, pp. ii-iii.

69 Ibid, p. iv, 38

step towards the renewable energy target, which would negate the need to build some of the expensive Round 3 offshore wind projects, as well as the associated grid extensions, saving an estimated £0.5 billion.[70]

Building up the supply chain (from planting the energy crops through establishment of pelletisation, transport, and storage facilities) creates a lead-time of four to five years for investments. The Industrial Emissions Directive coming into force in 2016 creates a hard deadline on decisions about the future of the relevant coal plants that are candidates for co-firing adaptation. So without policy clarity this year, the opportunity to expand this low cost renewable bridge could be lost.

Onshore wind

The UK planning system is the major barrier to wider expansion of one of the other cheaper renewable technologies, onshore wind. Other EU countries, including Germany and Spain, have been able to develop far larger quantities of onshore wind generation. The barriers to onshore wind in the UK are a key driver for the promotion of offshore wind to meet the renewable energy target. Yet onshore wind is around half the cost. Statistics produced by industry group Renewables UK show around 6.8GW of onshore wind applications are held up in planning processes.[71] Historically, the planning approval rate for onshore wind projects is only about 40%. Improving this to 60% would allow about 1.4GW of additional capacity to be brought onshore by 2020 – yielding a saving of around £1.6 billion compared to building the equivalent capacity offshore.[72] Planning reform to facilitate energy infrastructure developments, including wind farms but also waste-to-power projects, is therefore a priority. The approach should not be to ignore or simply override the legitimate concerns of local people about such developments. Instead, a successful approach would recognise the costs to local people of some new developments, and enable communities to agree appropriate benefits or compensation in return. The enormous additional cost of the 'next best alternative' (offshore wind), means that there is large scope for granting compensation to local communities, while still making savings for society overall.

The government is proposing a package of planning reforms in the draft Localism Bill. But the proposals for giving local communities greater say over developments in their area will only deliver better outcomes for society as a whole if there is also an effective mechanism for those communities to trade off the costs with an appropriate share of the benefits. Without such a mechanism, the proposed reforms could simply strengthen NIMBYism. The government is developing mechanisms to incentivise communities to welcome developments, such as onshore wind farms, including returning to communities a portion of additional business rates generated.[73] The eventual mechanism needs to enable compensation at sufficient levels to reflect the savings to society from building more onshore wind and energy from waste developments instead of offshore wind. If an additional 200 MW onshore development was built, saving £230 compared to its offshore equivalent, then using only 10% of this saving to compensate local people would create a large pot of £23 million. For a more modest 10 MW development, the saving would be £11 million – giving a £1 million compensation pot (enough to fund a local library for 10 years).[74]

70 Co-firing is a short-term option to help meet the renewables target. We assume it runs from an opening year of 2015 for all additional co-firing (coming in before the Industrial Emissions Directive comes into effect) with plants closing soon after the target has been passed in 2020. That capacity would need to be replaced thereafter. We assume that capacity, whether onshore wind, gas or whatever, would be about half the cost of offshore wind. In addition, we have subtracted the five year cost of co-fired ROCs. We based our figures on Oxera estimates for generating output (4 TWh/year), and a cost of ROCs based on the 2011 buyout price, discounted by the 7% estimated cost reduction to £34.40, and at a ROC band of 0.5 ROCs for co-firing. This resulted in an estimated saving of £0.5 billion.

71 Renewables UK (2011), *Statistics*, http://www.bwea.com/statistics/

72 Costs and capacities are adjusted throughout the paper at 2009 capacity factors, based on DUKES 2010, of 27% for onshore and 33% for offshore wind.

73 This idea was previously suggested in the Coalition agreement drafted in May 2010. C.f. Pickard, Jim (2011), 'Local incentives proposed for wind farms' in *Financial Times*, http://www.ft.com/cms/s/0/6a391816-3503-11e0-9810-00144feabdc0.html#axzz1G2Kz0OXh

74 As per Note 72, based on capacity factors of 27% for onshore and 33% for offshore wind.

Cheaper renewable generation technologies in general

In addition to removing some of the specific barriers to the deployment of cheaper renewable generation technologies, there is likely to be scope for generally incentivising a greater proportion of cheaper renewable generation through change to the RO banding arrangements.

A full review of desirable banding adjustments is beyond the scope of this paper. Indeed, it is far from clear that banding itself is a desirable feature of a policy focused on mass deployment of generation. (In contrast, support for demonstrating and, where appropriate, genuinely early stage deployment focused on learning about new technologies (e.g. wave power) should be tailored to particular technologies, possibly through RO bands.)

Nevertheless, levelling or removing the differences between bands could replace some of the more expensive generation with cheaper technologies at lower overall cost. It is hard to gauge or quantify the scope for such substitution and cost savings, due to many of the uncertainties outlined in Chapter 4, lack of information about feasible levels of deployment of cheaper renewable technologies, uncertain 'deadweight' costs, as well as unpredictable investor responses. As discussed earlier, onshore wind is more constrained by planning barriers than its ROC band, but other technologies such as biomass (both co-fired and dedicated), energy from waste and sewage gas all have lower costs and subsidies than offshore wind. For example, industry estimates suggest that up to 5 GW of biomass capacity is feasible by 2020 (including both co-firing and dedicated facilities), but under current ROC arrangements only 4 GW is likely to be brought forward (including 1.9 GW currently).[75]

Providing additional subsidy to renewable technologies which, while cheaper than offshore wind, are still expensive compared to other means of carbon emissions reduction is far from ideal. However, Option 3, by definition, operates within the constraint of the renewable energy target, aiming to respond to it at the lowest possible cost.

(c) Increased energy efficiency effort

Reducing overall energy demand through greater energy efficiency effort is another important way to reduce the cost of the renewable energy target.

If total energy consumption is lower, then 15% of a lower number needs to be renewable energy. For every MWh reduction in energy consumption, 0.15 MWh less renewable energy needs to be deployed by 2020. That makes energy efficiency projects costing up to around £29 per MWh saved more cost-effective – *in terms of meeting the renewable energy target alone* – than equivalent spending on Round 3 offshore wind.[76] Many energy efficiency measures, considered relatively expensive, would cost still less than this. For example, solid wall home insulation, which is generally considered too expensive to be part of the Green Deal, has broadly comparable costs to offshore wind in terms of contribution towards the renewable target *alone*. In addition, an energy efficiency approach to the renewable energy target delivers around *seven times* the carbon emissions reduction as an offshore wind based approach, and would save the cost of energy generation for the other 85% of each saved MWh.

The government is bringing forward a number of measures which should help reduce energy demand including the Green Deal and the reforms to CRC Energy

75 Jamasb, T, Nuttall, W et al (2008). Current expectations based on CCC modelling. Other models place the amount of biomass delivered under current support at lower levels.

76 To offset the need for 1 MWh of renewable energy in 2020 requires saving 6.66 MWh of total energy demand. Using a cost of £190 per MWh (based on the Mott MacDonald figures from Table 1) for offshore wind, one could spend up to £28.50 per MWh of energy saved on efficiency measures and still break even.

Efficiency Scheme. These focus on improving energy efficiency in households, businesses and other organisations. Their purpose is to promote cost-beneficial energy efficiency measures (ones which save money net). The government in placing an obligation to fund more expensive energy efficiency measures in 'hard to heat' homes. The government should ensure the chosen level of overall efforts and resources on promoting energy efficiency takes into account savings on the RET.

However, as discussed above, numerous, even relatively expensive, energy efficiency measures beyond the scope of the existing policy are still more cost-effective than the equivalent investment in renewable generation. They represent a more cost-effective approach to meeting the renewable energy target, and deliver much larger carbon emissions reductions than the option of building renewable generation.

(d) Planned trading with other countries

There is a provision for trading between EU Member States of contributions to the RET. The Renewable Energy Directive provides a facility for making 'statistical transfers' of renewable energy, as well as co-operating on joint projects, and on renewable energy projects with third party countries. The statistical transfers allow one Member State to acquire the permission to have renewable energy used in another Member State count towards its allocation. Member States themselves may conduct such transfers on a bilaterally agreed basis. The Commission does not formally set out the system by which this should occur.

The mechanism operates at the government level rather than a more efficient and flexible trading system which allowed companies to site renewable energy wherever in the EU it is most cost-effective to do so. This approach arises because each Member State has its own renewable subsidy policies, and greater flexibility would simply direct investment to those states with the largest subsidies.

Maximising the use of trading systems within the RET, both between members, and also between EU members and third party nations should increase the overall cost-effectiveness of meeting the EU target. Renewable generation would be able to be sited where it is cheapest to do so as a result of sunshine levels, farmland, better sites for wind farms, or fewer regulatory barriers. For example, it is likely to be cheaper, at the margin, to build additional onshore wind or biomass generation in Germany, in Poland or Romania than equivalent Round 3 offshore wind projects, by around £100/MWh for German onshore wind, or around 50% of total costs for a project.

> "An energy efficiency approach to the renewable energy target delivers around *seven* times the carbon emissions reduction as an offshore wind based approach, and would save the cost of energy generation for the other 85% of each saved MWh"

Based on the projections in the National Renewable Energy Action Plans, a net surplus of just less than 70 TWh of renewable energy in 2020 is anticipated across the EU, with two countries, Germany and Spain, predicting the highest surpluses (see Table 4). Currently, four countries (not including the UK) are specifically planning to make some use of trading to make up shortfalls from domestic renewable energy in 2020.[77]

77 The four are Belgium, Estonia, Italy and Luxembourg. European Commission (2010), Forecast Documents and National Renewable Energy Action Plans

Table 4: Predicted national surplus/deficit of renewable energy in 2020

Country	Predicted surplus/deficit in 2020 (NREAP)
Austria	0
Belgium	-2.3 TWh
Bulgaria	3.9 TWh
Cyprus	0
Czech Republic	0
Estonia	-0.01 TWh
Finland	0
France	0
Germany	35.65 TWh
Greece	N/A
Hungary	3.78 TWh
Ireland	0
Italy	-13.1 TWh
Latvia	No figure
Lithuania	0.71 TWh
Luxembourg	-1.08 TWh
Malta	0.01 TWh
Netherlands	0
Poland	4.01 TWh
Portugal	0
Romania	0
Slovakia	1.66 TWh
Slovenia	0
Spain	30.80 TWh
Sweden	5.65 TWh
UK	0
TOTAL EU-27	**69.68 TWh**

The UK's initial estimate in its Forecast Document in 2009 was to trade for only a very small proportion (the last 0.12 TWh) of its contribution to the target. But even this was revised out in its subsequent National Renewable Energy Action Plan in 2010, where it projected reaching the target using domestic measures alone.

The UK could take an alternative approach of buying from surplus countries such as Germany or Spain, statistical transfers of renewable energy. This would almost certainly be substantially cheaper than building our own offshore wind. The existence of projected surplus renewable energy over and above the target across the EU supports the case for this approach. But even if this were not the case, it would be worth paying, say, Poland a contribution to build more onshore wind and biomass than they were planning, rather than build our own much more expensive offshore wind. The Renewable Energy Strategy states that "if there was a fully liberalised and perfectly efficient cross-EU trading system, using joint projects to meet the last percentage point of our target could potentially save up to 9-15% of total costs". i.e. perhaps £6-10 billion NPV.[78] And trading could go beyond the last percentage point. While the available mechanism is not perfectly efficient, there appears to be huge scope for savings through the UK government making more use of trading as part of its plan for meeting the renewables target.

78 DECC, Renewable Energy Strategy, p. 192

The basis for calculating payments to another Member State to statistically transfer in some of their surplus contribution to the renewable energy target is unclear. On the one hand, if surplus projects were expected to go ahead regardless of revenues from statistical transfers, then there is no obvious intrinsic cost to be compensated. Any additional revenues such projects made would be a bonus. However countries would clearly seek a positive payment, though if there was competition between surplus-holding countries, this would constrain payment levels. As a worst-case scenario, we assume that the UK needed to share 50% of the gains from trade with the surplus countries. Table 5 sets out the sorts of savings which might be achievable through trading. (Statistical trading of renewable energy would enable the UK to avoid needing to build offshore wind, but the generation capacity would still need to be built. We assume that capacity would be gas generation and would be about half the whole life cost of offshore wind).

Table 5: Potential savings from trading of renewable energy requirement

Statistical quantity of renewables bought from abroad	Saving (difference between offshore wind and alternative, e.g. gas)	Saving split 50/50 with negotiating partner
1% of UK energy demand in 2020 (5.7 GW/16.8 TWh (assumes a 33% capacity factor as per most recent (2009) figures)	£6.7 billion	£3.4 billion
Enough to eliminate Round 3 offshore wind (11GW/38TWh)	£13 billion	£6.4billion

We believe several countries will miss the target, and that the target will be softened in the run up to 2020 or that little action will be taken, post-2020, against those countries who fail to meet it. There seems no reason to write contracts now for the trading – it seems feasible that the UK could end up incurring no costs as a result of taking the option of incorporating trading into the plan.

Total potential savings

Table 6 summarises the savings potentially available from the measures set out as part of Option 3. Added together, Option 3 changes could produce estimated savings of £9-12.5 billion by 2020.

We consider there is significant potential for cheaper ways to meet the electricity portion of the renewable energy target. These measures could largely negate the need for the mass rollout of more expensively subsidised renewable technologies.

Offshore wind is the expensive renewable technology with by far the largest proposed deployment. While there should be proportionate support for new technologies to encourage demonstration and learning, including limited deployment of offshore wind, the government's massive proposed levels of expensive offshore wind deployment over the next nine years cannot be justified. Table 6 therefore assumes that it is largely offshore wind which is offset by the various measures.

Table 6: Summary of some of the potential cost savings under Option 3

Policy measure	Estimated new capacity of offshore wind saved or reallocated	Estimated cost saving by 2020
Removal of cap on co-firing biomass	1.4 GW	£0.5 billion
Planning reform (20 percentage pt increase in granting permission for onshore wind)	1.4 GW	£1.4 billion
Use of flexibility (trading) mechanisms	5.7GW	£3.4 to 6.7 billion
Cutting support for capacity no longer needed, due to reduced energy demand post-recession	1.3 GW	£3.9 billion
TOTAL	**9.8 GW**	**£9.2-12.5 billion**

Measures could be pursued individually or as a package. Should some individual measures prove unachievable, there is scope for others, in particular trading, to be pursued with greater ambition than assumed in Table 6, in order to maintain the ambition of the package as a whole.

9
Recommendations

To effectively contribute to carbon emissions reduction, both to meet the UK's 2050 target for 80% emissions reduction and globally, there needs to be an exemplary and cost-effective process of UK electricity decarbonisation. This report has argued that the current UK strategy, dominated by the EU renewable energy target, is a hugely costly obstacle to such a process. We make the following recommendations for change to current policy.

Under any circumstances:

1. **The key focus for electricity decarbonisation policy needs to be building a more credible long-term carbon pricing framework. The Treasury's proposal for a new Carbon Pricing Support Mechanism is a reasonable approach (given the current EU context), but it needs to be given greater long-term credibility, for example through contractual guarantees of the carbon price and a longer timeframe.**
2. **No further targets for renewable generation deployment levels, or any other specific technologies, should be set for the period after 2020. European and UK policy must instead focus on carbon.**

The costs of the renewable energy target need to be tackled, ideally through adopting Policy Option 1, renegotiation of the target:

3. **As a first priority, the UK should explore the scope for renegotiating the 2020 renewable energy target, which currently drives huge and unnecessary spending in the UK and which damages the prospects for overall electricity decarbonisation.**
4. **UK support for any moves to extend the ambition of the EU 2020 carbon reduction target should be contingent on removing the technology constraints on its achievement, by scrapping renewable energy targets.**
5. **Having removed the constraint of the renewable energy target, the government should reform its renewable support policies to instead focus on low carbon innovation and learning, by focusing on developing, demonstrating and, where appropriate, limited early stage deployment of new technologies which hold out the promise of a substantial global impact. Such support programmes should not be mixed up with mass deployment of generation, which should be governed by market choices subject to a credible, long-term carbon pricing framework.**

We do not recommend Policy Option 2, simply disregarding the EU target, given the serious implications of a deliberate policy to abandon a UK legal commitment.

6. **If renegotiation of the EU renewables target proves unachievable quickly, then a package of measures should be brought forward to minimise the cost of the response to the renewable energy target, with the potential to save £9-12.5 billion by 2020. Measures include following:**
   a) **Electricity demand in 2020 is forecast to be 11 TWh less than forecast when the Renewable Energy Strategy was developed in 2008, as a result of the recession. There is no case for doing more than the minimum necessary to meet the renewable energy target. So the generosity of renewable generation subsidy levels should be scaled back to produce proportionately less renewable capacity in 2020, potentially saving £3.9 billion by 2020.**
   b) **The cap on the amount of co-fired biomass which qualifies for renewable subsidies should be lifted, bringing forward a relatively cheap source of short-term renewable generation as a bridge to the 2020 renewable target, saving a potential £0.5 billion.**
   c) **Planning barriers to onshore wind and other generation should be urgently addressed. Mechanisms for rewarding or compensating local communities for accepting onshore wind or other generation developments should take into account the huge savings from securing such planning consents compared to the alternative of offshore wind. Increasing the success of onshore wind planning applications alone by 20 percentage points could save £1.6 billion by 2020.**
   d) **The huge costs of meeting the renewable energy target should be fully taken into account in setting the level of ambition for energy efficiency policies, including the Energy Supplier Obligation for supporting energy efficiency improvements in 'hard to heat' homes.**
   e) **The government should plan to use the flexibility provisions of the Renewable Energy Directive to buy cheaper renewable generation credit towards the UK's target from other countries, saving £3.4 to £6.7 billion if only one percentage point of the UK's target were traded.**

The UK has adopted a number of policies promoting decarbonisation of the electricity sector, as part of meeting the target for reducing overall UK greenhouse gas emissions by 80% by 2050. The dominant policies are those aimed at deploying renewable electricity generation by 2020. These policies are in large part driven by a European Union directive which mandates that the UK supply 15% of its total energy demand from renewable sources by 2020. There is broad consensus that meeting this target will require the UK to produce 30-35% of its electricity from renewables by 2020, because of the constraints on using renewable sources in other areas of energy consumption, such as transport and heating.

The renewable energy target (RET) has focused public spending on climate change policy towards renewable generation deployment, but has been the subject of widespread criticism, particularly in relation to its massive cost.

This report examines whether this strategy, focused on delivering renewable generation by 2020, is the best approach towards achieving electricity decarbonisation as part of meeting the 2050 target. As part of the research, we have drawn together the work of a number of research groups who have modelled decarbonisation of the UK energy system to 2050, to understand the range of possible trajectories and the potential role of renewables.

2020 Hindsight finds that the renewable energy target is hugely and unnecessarily expensive. The RET also risks damaging the prospects for UK decarbonisation to meet the 2050 target and limits the UK's impact on encouraging a global decarbonisation process. It uses up the public's willingness to pay extra for energy for relatively little return, and squanders the total resources otherwise available for decarbonisation and the low carbon innovation we will need to slow climate change.

£10.00
ISBN: 978-1-907689-00-0

Policy Exchange
Clutha House
10 Storey's Gate
London SW1P 3AY

www.policyexchange.org.uk