Carbon budgets, buildings and Brexit: are Britain's non-EU climate change targets at risk?

Pedro Guertler
enfinn
149C Brooke Road
London E5 8AG
United Kingdom

Jan Rosenow
The Regulatory Assistance Project
Rue de la Science 23
1040 Brussels
Belgium

Keywords

greenhouse gas emission reduction, residential sector, commercial buildings, public buildings, multiple benefits, impact assessment

Abstract

The last 18 months have been a major set-back in the British policy landscape affecting carbon emissions from buildings with several policies being abolished or downgraded. Following the vote to leave the EU, there is now considerable uncertainty around the future of UK energy efficiency policy. This is despite the fact that an increase in policy action is required: In June, the 5th Carbon Budget was adopted by Government setting firm carbon targets for the period from 2028 to 2032. Parliament approved them in July 2016. Reaching those targets will require bold and ambitious policy action across all sectors including buildings.

In this paper, we analyse whether or not the UK is on track to meeting its carbon targets. Through modelling of a range of scenarios for the period 2016–2030, we show that the Government's own projections for abatement indicate that the UK will not meet the 5th Carbon Budget in buildings. Worryingly, a large part of the projected abatement from buildings (85 %) is considered by the Committee on Climate Change to be 'at-risk', and after the vote to leave the EU there is uncertainty around which previously EU driven policies driven will remain. In other words, the majority of projected emissions abatement from buildings is seen as uncertain and may not be achieved.

We also illustrate what would be required in order to meet the carbon targets including the technology mix and potential policy options. Our research shows that the benefits of meeting the 5th Carbon Budget in buildings justify considerable public and private investment to capture them. We quantified the main costs and benefits generally considered for formal policy impact assessments, calculated in accordance with official guidance. We show that there is a strong economic case for investing in upgrading the UK's building stock.

Introduction

Brexit has opened a new era in British politics. After the vote to leave the EU on the 23rd of June 2016 there is considerable uncertainty in all policy areas. Energy efficiency is no different. Many of the UK's energy efficiency policies such as building codes and product policy have been implemented in the context of EU directives. While the EU's Winter Package sets out the potential trajectory for energy efficiency for the EU up to 2030 and beyond (EC 2016), no such long-term pathway currently exists in the UK. The energy efficiency targets set out in the Energy Efficiency Directive may no longer apply after Brexit, although this depends on whether Britain will remain (like Norway) a member of the European Free Trade Association (EFTA) and the European Economic Area (EEA) or become a member of the Energy Community. Members of those organisations are required to implement the energy acquis of the European Union including energy efficiency-related legislation. At the time of writing, the former option seems unlikely given the desire of the British government to discontinue freedom of movement. Membership of the Energy Community, however, may not be open to the UK as its main purpose is to assist countries on the way to greater energy market liberalisation (Froggatt, Raines, and Tomlinson 2016).

However, even after Brexit Britain retains ostensibly strong domestic policy drivers for energy efficiency: in June, the 5th Carbon Budget was adopted by Government setting firm carbon targets for the period from 2028 to 2032. Parliament approved them in July 2016. This follows the 2008 Climate Act that sets a legally binding target for the UK to reduce its greenhouse gas emissions by 80 % by 2050 based on 1990 levels. Reaching those targets requires mitigation action across all sectors with a key role for energy efficiency in buildings.

In this paper, we analyse whether or not the UK is on track to meeting its carbon targets in the building sector. Through modelling of a range of scenarios for the period 2016–2032, we show that the Government's own projections for abatement indicate that the UK will not meet the 5th Carbon Budget in buildings unless further action is taken.

We also illustrate what would be required in order to meet the carbon targets including the technology mix and potential policy options. Our research shows that the benefits of meeting the 5th Carbon Budget in buildings justify considerable public and private investment to capture them. We quantified the main costs and benefits generally considered for formal policy impact assessments, calculated in accordance with official guidance. We show that there is a strong economic case for investing in upgrading the UK's building stock.

The paper is structured as follows: first, we outline the methodology of the modelling approach. Second, we present the results of the modelling exercise. Third, we discuss our findings and link them back to the issue of Brexit before we conclude and provide policy recommendations.

Methodology

The basis for our model is baseline emissions projections from electricity and fossil fuel consumption in residential, commercial and public buildings, from the Committee on Climate Change (CCC). Our start year is 2015 (the latest year for which official (if provisional) greenhouse gas emissions statistics are available (DECC 2016a)) and the cut-off date is 2032, when the 5th Carbon Budget period ends. Progress in reducing emissions is shown through a snapshot of annual emissions and abatement in the year 2030; whereas lifetime emissions and energy savings are considered when quantifying costs and benefits. The picture in a single year is easier to communicate; 2030 is the mid-point of the 5th Carbon Budget and broadly represents the annual average of emissions and emissions abatement over the five-year Budget period from 2028 to 2032. Abatement and abatement gaps in 2030 are shown in relation to the baseline emissions projection for that year.

BASELINE EMISSIONS AND OFFICIAL ABATEMENT PROJECTIONS

The baseline includes the abatement effects of older policies – some of which have achieved abatement that persists to this day and beyond (for example insulation installed under the Energy Efficiency Obligations), and some of which are still having an active effect now (such as Part L of the 2005/6 Building Regulations requiring that replacement boilers are efficient condensing models).

Government-projected and CCC-recommended abatement needs to be subtracted from the same baseline in order to be comparable. The CCC's electricity baseline is identical to the Government's in the latter's latest Updated Emissions Projections (UEP). The UEP includes projections of energy demand and the anticipated greenhouse gas abatement impact of all relevant policies (DECC 2015b). For direct emissions from buildings – which we treat as emissions resulting from fossil fuel space heating and hot water demand in buildings – the baselines and the nature of abatement differs for two reasons. First, the UEP includes F-gas emissions and abatement in the buildings sector; these are treated separately from buildings by the CCC, so we have excluded them. Second, the abatement effects of biomethane injection into the gas grid are included in the UEP's projected emissions for each gas-using sector of the economy, but the abatement is not shown separately for each. The CCC treats biomethane injection as a separate sector, so we do not use the UEP's sectoral emissions projections, but instead subtract its projected abatement from residential, commercial and public buildings policies in the UEP from the common baseline, apportioned proportionately to gas demand in each buildings sub-sector.

SCENARIOS

Our model for the new scenarios is based on the CCC's Fifth Carbon Budget Dataset (CCC 2016a), which presents technologies deployed annually between now and 2035 in each sector (buildings, power, transport etc.), along with associated emissions abatement and changes in energy use. We have analysed and used the relationship between technologies deployed and emissions and energy savings to extrapolate the impact of our alternative scenarios on emissions and energy. We recognise the limitations of this approach, but have selected it as the best method that suited our constraints (on time and budget) and our objectives (to explore the different levels of abatement arising from the deployment of technologies at different scales and in different mixes).

Table 1 provides an overview of the scenarios used in this report. The abatement in the 'UEP replicated', 'UEP extended' and 'ACE' scenarios has been modelled. The others have either been fully adopted or slightly adapted (as described above).

COSTS AND BENEFITS OF SCENARIOS

A wide range of benefits are associated with energy efficiency improvements in buildings, not all of which can be quantified. We have calculated estimates of the present capital costs of the measures deployed between now and 2032, and calculated the present benefits of these in accordance with Central Government's official guidance for policy appraisal[1] for energy savings, emissions abatement, air quality and comfort using the Interdepartmental Analyst Group's accompanying spreadsheet toolkit (IAG 2015).

Sources used for the analysis were wide-ranging (BEIS 2016; Cluett and Amann 2015; David Willis (Electric Ireland) 2015; DECC 2013b; DECC 2014; DECC 2013a; Frontier Economics 2015; IEA 2014; IPCC 2014; Janssen and Staniaszek 2012; Lazar and Colburn 2013; LBNL Indoor Environment Group 2016; Rosenow, Platt, and Demurtas 2014; Sustainable Homes

1. In particular BEIS's supplementary guidance to the Treasury's Green Book, on 'valuation of energy use and greenhouse gas emissions for appraisal'(DECC 2015a).

Table 1. Scenarios included and developed.

Scenario name	Scenario details	Residential	Commercial	Public
Baseline	*Adopted*: The CCC's baseline scenario, used as a universal baseline in this report (CCC 2016a)	✓	✓	✓
CCC	*Adopted*: The CCC's central abatement scenario, or 'cost-effective pathway'	✓	✓	✓
UEP	*Adapted*: The Department for Business, Energy & Industrial Strategy's (BEIS, formerly DECC) Updated Emissions Projections reference scenario, adjusted to account for F-gases and biomethane grid injection as mentioned above, so that it is compatible with the Baseline used here (DECC 2015b)	✓	✓	✓
UEP replicated	*New*: The UEP scenario translated: *From* emissions abatement from individual policies (excluding policy that abates F-gases)… …*to* technologies deployed based on official impact assessments and our best estimates… which is then modelled using the CCC's dataset to provide new estimates of abatement (now attributed to technologies instead of policies). Necessary for fuller exploratory comparison of the CCC and ACE scenarios (see below for latter) with the government's current and planned policy projections. Needed to build 'UEP extended' scenario (also below). Not produced for non-residential buildings as CCC dataset does not include number of technology units deployed; UEP scenario used as basis for commercial and public sectors' UEP extended scenario instead	✓		
UEP extended	*New*: The same scenario as UEP replicated, but technologies continue to be deployed in residential buildings at the same rate beyond current and planned policies' expiry dates through to 2032 (the end of the 5th Carbon Budget period). For commercial and public buildings, UEP extended continues abatement trajectories of UEP scenario after policy impact ends	✓	✓	✓
ACE	*New*: Our scenario, intended to explore the possibilities of going further than the CCC recommends. It deploys efficiency measures at a level in relation to their technical potential which is similar to the relationship between the CCC's deployment of low carbon heat and heat networks in relation to their technical potential	✓		
EDR	*Adapted*: Scenario based on electricity savings potentials in 2030 identified by McKinsey for the Department of Energy & Climate Change (now BEIS) in 2012 (McKinsey & Co 2012). Only used in relation to commercial and public sectors. Savings have been slightly adjusted to fit the electricity baseline used here		✓	✓

2016; UCL Energy Institute 2013). Given the space constraints we cannot reproduce the assumptions made and calculations performed in this paper.

ASSESSMENT OF POLICY OPTIONS

Without quantifying their possible impacts in our scenarios, we have prepared an assessment of policy options available to decision-makers to close the abatement gap in buildings emissions to meet the 5th Carbon Budget. We present these for residential, non-residential (commercial and public) buildings and heat networks[2] separately. For each of these three groups, our assessment systematically considers targets, regulation, fiscal and financial incentives, access to finance, and information and behaviour. It establishes whether the action to be taken involves 'de-risking' (making more certain, e.g. through stronger enforcement) the abatement from existing policies, policy reform, extension (over time), expansion (in ambition), or involves introducing new instruments. For each option, we have provided an indication of impact, technical feasibility, political acceptability, implementation speed and cost.

Results

OVERALL ABATEMENT GAP

The majority of the abatement gap between the Government's projection and the CCC's recommended pathway results from direct emissions. This is because of the dominant effect of power supply-side decarbonisation on electricity emissions, and the similarity between the CCC and Government projections for this decarbonisation.

Taken together, policies as they currently stand are projected by the Department of Business, Energy & Industrial Strategy (BEIS) to achieve a 21 % cut (21,7 $MtCO_2e$) in annual direct

2. Heat networks range from localised multi-building heating to large scale, longer distance heat networks.

emissions from buildings by 2030 (the mid-point of the 5th Carbon Budget period) compared to 1990. At 83,4 $MtCO_2e$, this is just 12 % below the 'business as usual' emissions (94,4 $MtCO_2e$) for 2030. In this scenario, emissions exceed those recommended by the CCC for the 5th Carbon Budget by 17 %.

There are two very important caveats. First, these data do not take account of Government-projected abatement considered by the CCC to be 'at-risk', that is where there is uncertainty over whether a policy actually ends up delivering the abatement it is projected to. This may occur due to poor enforcement, low take-up, or technological under-performance. In 2030, 'at-risk' encompasses 85 % of direct abatement from policies for buildings (CCC 2016b). In other words, the majority of projected emissions abatement from buildings is seen as uncertain and may not be achieved. The conferment of 'at-risk' status is ultimately a judgement, as all risk assessment is. Specific examples of this include non-compliance with building regulations and the relatively uncertain behavioural abatement effects of the smart meter rollout.

Second, the Government's projections for abatement do not yet include the possible effects of any new policies, or extending existing policies beyond the early to mid-2020s (the point in time beyond which numerous policies have not yet been renewed), which one might reasonably expect to see set out in the forthcoming (at time of writing) Emissions Reduction Plan in response to the adoption of the 5th Carbon Budget.

Figure 1 below breaks down the abatement shortfall in 2030 on the optimistic assumption that current(ly planned) policies achieve the abatement they are projected to (i.e. ignoring 'at-risk' status), but (less optimistically) are not extended at the same level of ambition beyond the mid-2020s. Given the first caveat noted, we believe that this presents a very conservative estimate of the gap that must be filled in 2030.

As mentioned above, the majority of the abatement gap lies in direct emissions, and the largest sectoral abatement gap in 2030 is in residential buildings, followed by commercial and public sector buildings. Whilst the abatement gap for other buildings sectors is small relative to the residential sector's gap in absolute terms, in relative terms, abatement in commercial and public buildings is further off track. Under Government projections of direct emissions abatement in 2030:

- CCC recommended emissions from residential buildings are exceeded by 12 %
- Recommended emissions from commercial buildings are exceeded by 42 %
- And those from public buildings are exceeded by 34 %
- The picture for emissions from electricity use in buildings in 2030 is different:
- Recommended emissions from residential buildings are exceeded by 24 %
- Those from commercial buildings are exceeded by 21 %
- And those from public buildings are exceeded by 67 %
- Across all sectors – especially taking into account the uncertainty of Government-projected abatement – the present abatement gap in 2030 looms large over the UK's ability to meet the 5th Carbon Budget.

RESIDENTIAL BUILDINGS

Current Government projections (UEP line in Figure 2) exceed the CCC's recommended emissions from residential buildings by 9,9 $MtCO_2e$ in 2030, with 7,4 $MtCO_2e$ of this as a result of direct residential buildings emissions. The overall picture for direct emissions and electricity demand to 2032 is shown in Figure 2.

Our assessment of Government direct emissions abatement ('UEP' line on left side of Figure 2) against the baseline in 2030 is 5,3 $MtCO_2e$, 58 % short of the 12,7 $MtCO_2e$ savings recommended by the CCC. This is the largest abatement gap amongst the building sectors. Emissions will have risen again from 2026, back to levels required for the 3rd Carbon Budget (2018 to 2022). If current and planned government policies

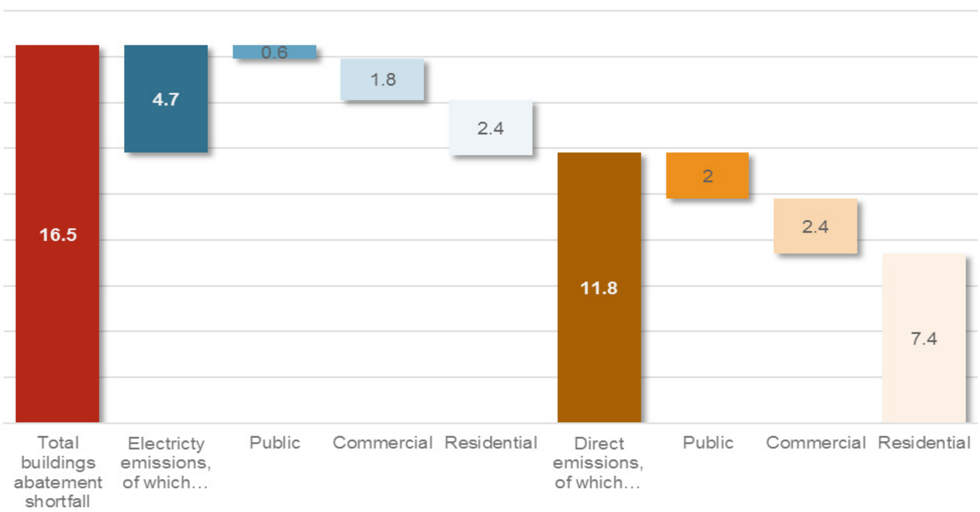

Figure 1. Government emissions abatement shortfall compared to 5th Carbon Budget trajectory in 2030 [MtCO2e].

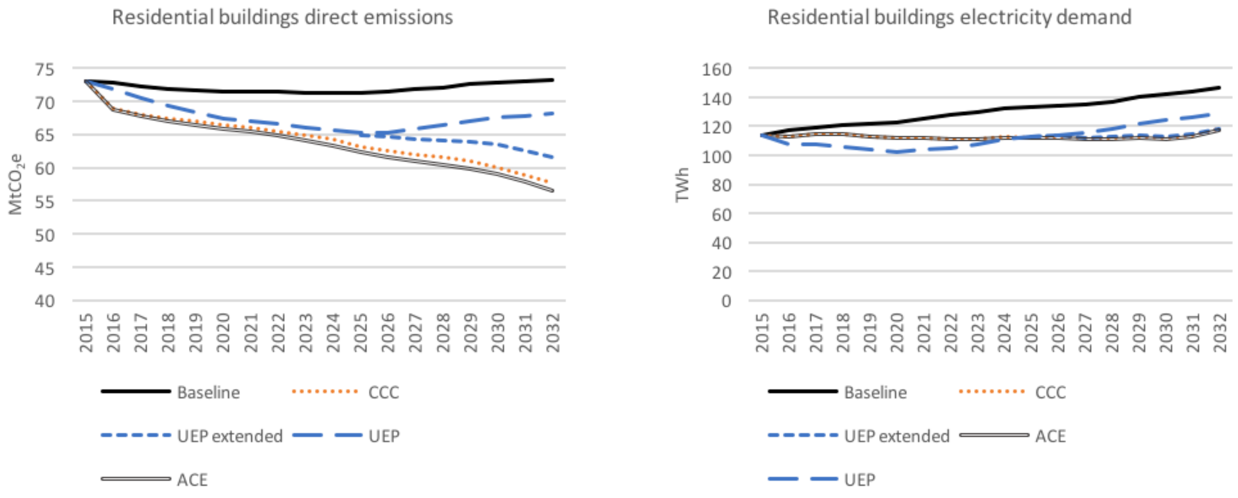

Figure 2. Residential buildings direct emissions and electricity demand under different scenarios.

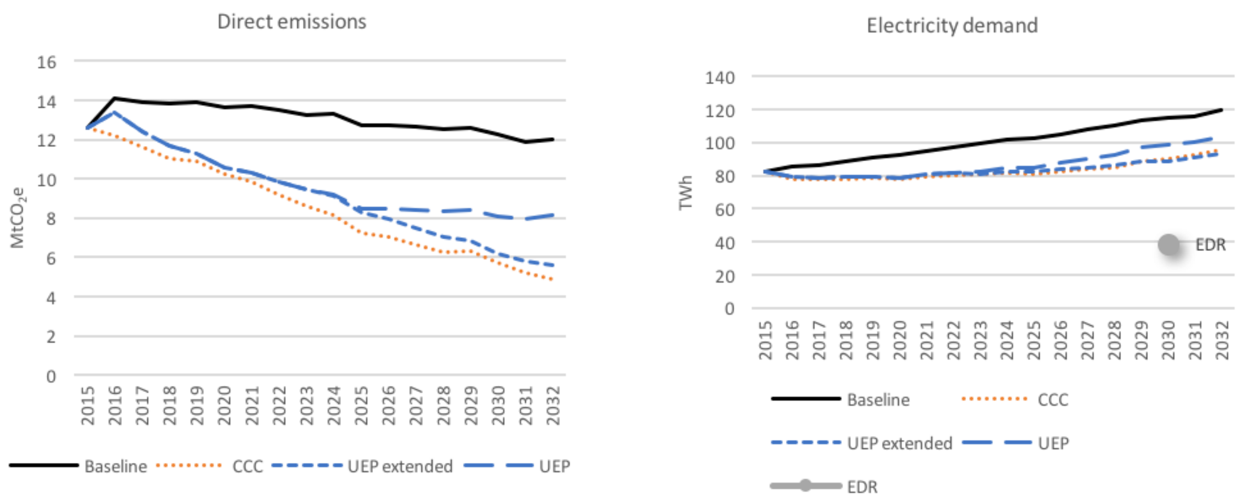

Figure 3. Commercial buildings direct emissions and electricity demand under different scenarios.

were to be extended pro-rata to 2032[3] – shown by the 'UEP extended' line on the left-hand side of Figure 2 – direct emissions abatement would still fall 26 % short. This makes clear that in addition to making abatement from Government policies more certain (by 'de-risking' existing policies through (say) enforcing better compliance) and extending policies out to 2032, a combination of greater ambition for existing policies and the introduction of and new instruments will be needed to meet the 5th Carbon Budget in the residential sector. Looking at electricity demand, on the right-hand side of Figure 2, Government policies will only keep electricity demand growth in check from 2020[4]. Pro-rata extension to 2032[5] of the Government's current and currently planned policies for reducing electricity demand in residential buildings sees the CCC's pathway for electricity demand being matched.

3. I.e. continuing the rate of abatement policies are projected to achieve beyond the date they are presently set to expire.

4. Moreover, as can be seen on the right-hand side of Figure 2, there are clearly differing assumptions between the Government and the CCC about how electricity demand in the next few years.

5. That is to continue the pace abatement seen from policies beyond the dates at which they are currently projected to expire.

COMMERCIAL BUILDINGS

Current Government projections see the CCC's recommended emissions from commercial buildings being exceeded by 4,1 $MtCO_2e$ in 2030, with 2,4 $MtCO_2e$ of this as a result of direct emissions. The overall picture for direct emissions and electricity demand to 2032 is shown in Figure 3.

Our assessment of Government direct emissions abatement ('UEP' on left side of Figure 3) against the baseline in 2030 is 4,2 $MtCO_2e$, 35 % short of the 6,5 $MtCO_2e$ savings recommended by the CCC. Emissions plateau from 2025. If current and planned government policies were to be extended pro-rata to 2032 – shown by the 'UEP extended' line on the left-hand side of Figure 3 – direct emissions abatement would fall just 7 % short (ignoring abatement at risk). Regarding projected electricity savings, the UEP extended scenario

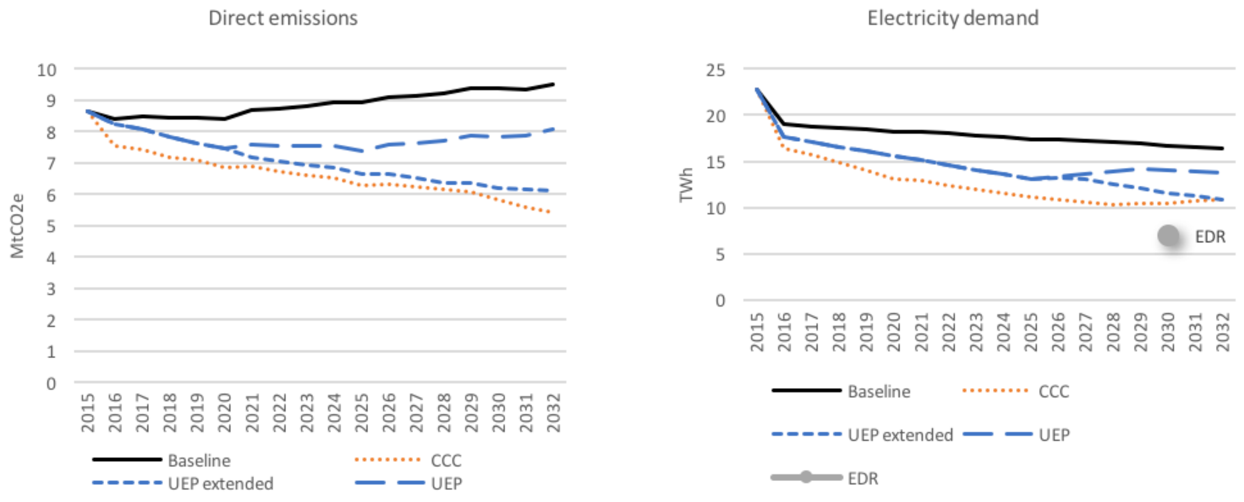

Figure 4. Public buildings direct emissions and electricity demand under different scenarios.

virtually achieves parity with the CCC scenario. Electricity demand in the commercial sector is projected to grow under all scenarios. However, research into cost-effective electricity demand reduction (EDR) potential in 2030 provided to DECC (as it was then) by McKinsey in 2012 suggests this need not happen and that electricity demand could fall considerably[6] – as indicated by the blue 'EDR' point on the right-hand side of Figure 3.

PUBLIC BUILDINGS

Current Government projections see the CCC's recommended emissions from public buildings being exceeded by 2,6 $MtCO_2e$ in 2030, with 2 $MtCO_2e$ of this as a result of direct emissions. The overall picture for direct emissions and electricity demand to 2032 is shown in Figure 4.

Our assessment of Government direct emissions abatement (UEP on left side of Figure 4) against the baseline in 2030 is 1,5 $MtCO_2e$, 57 % short of the 3,5 $MtCO_2e$ savings recommended by the CCC. Direct emissions start to rise from 2025. If current and planned government policies were to be extended pro-rata to 2032 – shown by the dashed yellow line on the left-hand side of Figure 4 – direct emissions abatement would fall 11 % short (ignoring abatement at risk). Regarding projected electricity savings, the UEP extended scenario falls somewhat short of the CCC scenario in 2030, but catches up by 2032. The EDR scenario (shown by the blue dot on the right-hand side) suggests additional cost-effective electricity saving potential in the sector in 2030, but not to the additional extent seen in the commercial sector.

COSTS AND BENEFITS OF DOING MORE

There is an emerging and growing body of evidence on the multiple benefits of energy efficiency (IEA 2014a). They include a wide range of impacts from air quality improvements to fiscal benefits and significantly add to the savings on energy costs. The multiple benefits of energy efficiency programmes can be grouped into three distinct categories(Cluett and Amann 2015; Lazar and Colburn 2013; Rosenow and Bayer 2016), encompassing 22 separate types of benefit:

- Participant benefits: the benefits that accrue directly to the participating individual households, businesses and public authorities that install energy efficiency improvements.
- Utility system benefits: the benefits that accrue to the energy system through reduced costs in providing energy services to end-users.
- Societal benefits: the benefits that accrue more broadly to society – the community, the region, the nation, or the planet – rather than to a specific energy system.

Restricting ourselves to the main benefits generally quantified for formal policy impact assessments, calculated in accordance with official guidance, all three residential buildings scenarios result in positive benefit/cost ratios. The less ambitious scenarios (CCC and UEP extended, previously shown) provide a benefit-cost-ratio of around 1,5. The most ambitious scenario (ACE, developed for this research) shows a benefit/cost-ratio of 1,3. These results are consistent with those of other studies, and similar to that calculated for the High Speed 2 project (a prestigious British rail infrastructure project) and the smart meter rollout. Figure 5 presents the main benefits and costs for all three scenarios in residential buildings.

ACE's scenario chiefly differs from the CCC's in deploying more insulation measures – a level which the authors have judged to be commensurate with the CCC scenario's deployment of low carbon heat (which ACE's scenario matches). This keeps one eye on the abatement pathway needed to 2050, whereby the pace of abatement seen in the CCC scenario will need to gather significant pace after 2032. A higher level of deployment of solid wall insulation in particular means the ACE scenario is more capital and labour-intensive in relation to the benefits quantified here, which explains the lower benefit/cost ratio of 1,3. The employment impact of the residential buildings

6. The EDR study's TWh savings potentials in 2030 have been adjusted to the CCC's/UEP's baseline 2030 electricity demand in the commercial and public buildings sectors, but it is worth noting that the EDR and CCC/UEP baselines are similar. The CCC/UEP baseline 2030 demand is 143 TWh (CCC 2016a; DECC 2015b), and the EDR study's was 136 TWh (McKinsey & Co 2012).

scenarios, and a selection of additional benefits not usually part of formal policy appraisal, is shown in Table 2.

The widely geographically distributed nature of the employment needed to deliver the scenarios potentially carries with it a range of additional benefits not quantified here, relating to regional and local regeneration and skills development and, nationally to the extent that any employment would be additional, avoided welfare costs.

Quantifying costs for the non-residential (commercial and public buildings) sector was not possible within the scope of this project. Instead, for the non-residential sector we present the benefits we have been able to quantify in Table 3. In the broadest sense, the ratio of benefits to costs can be expected to outperform the residential sector as the level of abatement recommended in the CCC's cost-effective path is greater.

Also not quantified here are competitiveness, productivity and profitability benefits. Energy cost savings directly improve businesses' bottom line and save public money more usefully expended or invested in public services. More energy efficient buildings also enhance staff productivity as they are more likely to sustain comfortable working environments at lower cost through optimal indoor temperatures, better ventilation and better lighting. As such, reducing carbon emissions from buildings by improving their energy efficiency should be fully integrated into the Government's plan for boosting the UK's productivity.

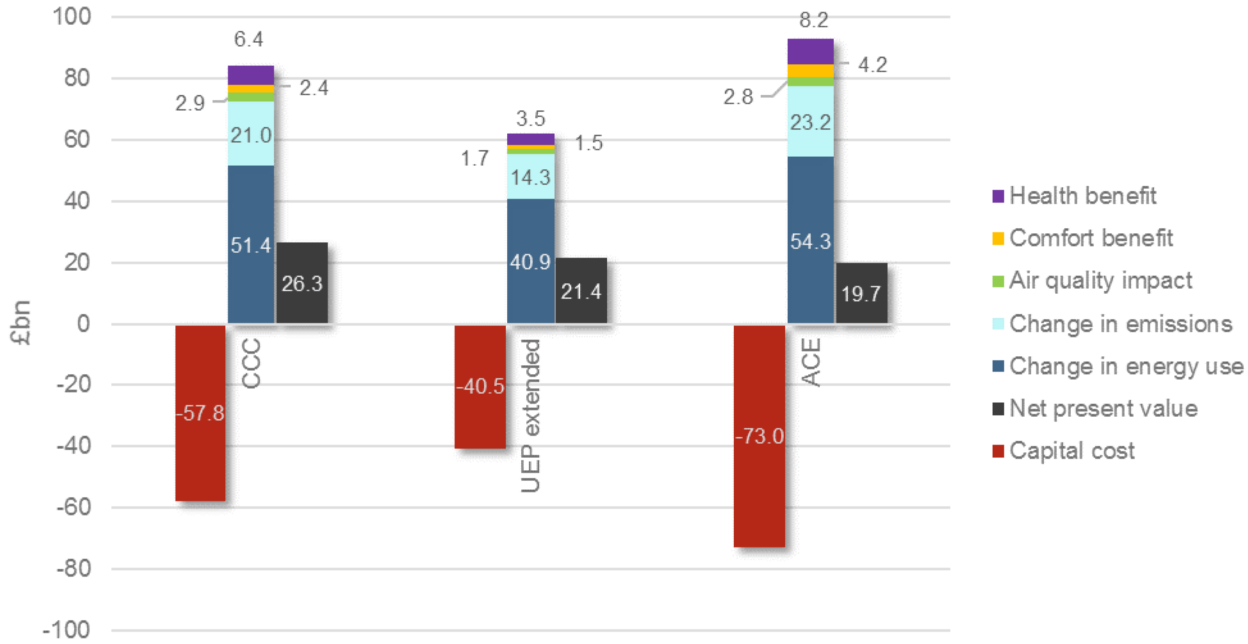

Figure 5. Residential buildings present capital costs and benefits of deployment between now and 2032.

Table 2. Present value of additional benefits of deployment between now and 2032, scenarios compared to baseline.

	CCC	UEP extended	ACE
Employment [number of FTE jobs supported in average year]	66,000	40,500	86,000
Electricity utility system benefits [£bn]	8,0	8,2	7,1
GDP effect: Gross Value Added of capital works [£bn]	25,3	17,9	31,4
GDP effect: Reduced imports of gas [£bn]	6,1	4,8	6,7
Government revenue benefit from above GDP effects [£bn]	14,5	10,5	17,5

Table 3. Selected present values of benefits of deployment between now and 2032, scenarios compared to baseline [£bn].

	CCC	UEP extended
Change in energy use	38,5	31,9
Change in emissions	17,8	8,5
Net air quality impact	1,1	0,9
Electricity utility system benefits	6,8	7,2
GDP effect: reduced imports of gas	10,0	7,8
Government revenue from GDP effects	4,6	3,6

Discussion

We investigated the impacts of a range of alternative scenarios that achieve more emissions abatement from residential, commercial and public buildings. Our chief comparison with the CCC scenario is the effect of extending policies at the same level of ambition beyond they date they are currently set to expire. The combined impact of this for all buildings' direct emissions is shown as the 'UEP extended' line in Figure 6. The solid yellow line shows the Government's current projection (with a visible kink upwards from the mid-2020s).

Contrasting both with the 'UEP savings not at risk' dotted yellow line (just below the baseline, which excludes the Government's projected abatement deemed by the CCC to be 'at risk'), stresses the importance of both 'de-risking' projected savings and extending the currently projected rate of abatement beyond that seen to the mid-2020s.

It is important to note also that beyond the 5th Carbon Budget period, the pace of building emissions abatement to 2050 will need to accelerate considerably. The dashed dark blue line in Figure 2 shows this: it is the 2050 pathway that the CCC has put forward, reflecting the necessary contribution to abatement that the buildings sector must achieve for our overall emissions target to be met across the whole economy.

While 'UEP extended' gets us closer to the 5th Carbon Budget, it is still not met. Moreover, as the growing divergence between this extended rate of abatement and the CCC's path to the 2050 goal shows, the rate of abatement will need to increase significantly, requiring greater ambition from existing policies and/or new instruments to be introduced as well.

Current and currently planned policies for carbon abatement from buildings will not achieve what is needed to meet the 5th Carbon Budget. It may not be technically possible, and it is certainly not economical, to close this abatement gap in the power, transport and industrial sectors instead: the Government's own appraisal of the least-cost path to meeting the 5th Carbon Budget saw emissions from buildings being 10 % lower than the CCC has put forward (DECC 2016b). Moreover, most of the currently projected carbon abatement from buildings is very far from certain, and with every tonne of CO_2 unabated, policies must subsequently work harder within a shorter space of time to meet our climate change targets. The worst-case scenario – of emissions abatement from policies classified by the CCC as 'at risk' not materialising – is that direct emissions barely reduce at all from today's levels.

There is a considerable range of policy options available to the UK government that can shore up current abatement projections and increase the pace of emissions reduction to meet the 5th Carbon Budget get on track to 2050. These encompass targets, regulation and standards, fiscal and financial incentives, access to finance, and information and behaviour. The study underpinning this paper identified 48 options – of varying political and financial acceptability – applicable to the residential, commercial and public buildings sectors, and heat networks. In order to shape such a large array of possibilities into a coherent strategy for reducing emissions from buildings in the long-term from the UK's current position, they need to be systematically considered in terms of the policy-making actions that need to be taken. In keeping with the approach taken in our quantitative analysis, we therefore propose that policy options for emissions abatement are considered according to the following hierarchy – touched upon earlier – which ensures that the current policy framework can be built on:

- De-risking (e.g. by ensuring compliance)
- Reform (e.g. of design or means of delivery)
- Extending (beyond the current programme expiry date)
- Expansion (in abatement ambition)
- Introduction (of new policy instruments)

Those policies that are currently being implemented within the context of European Union legislation deserve special attention.

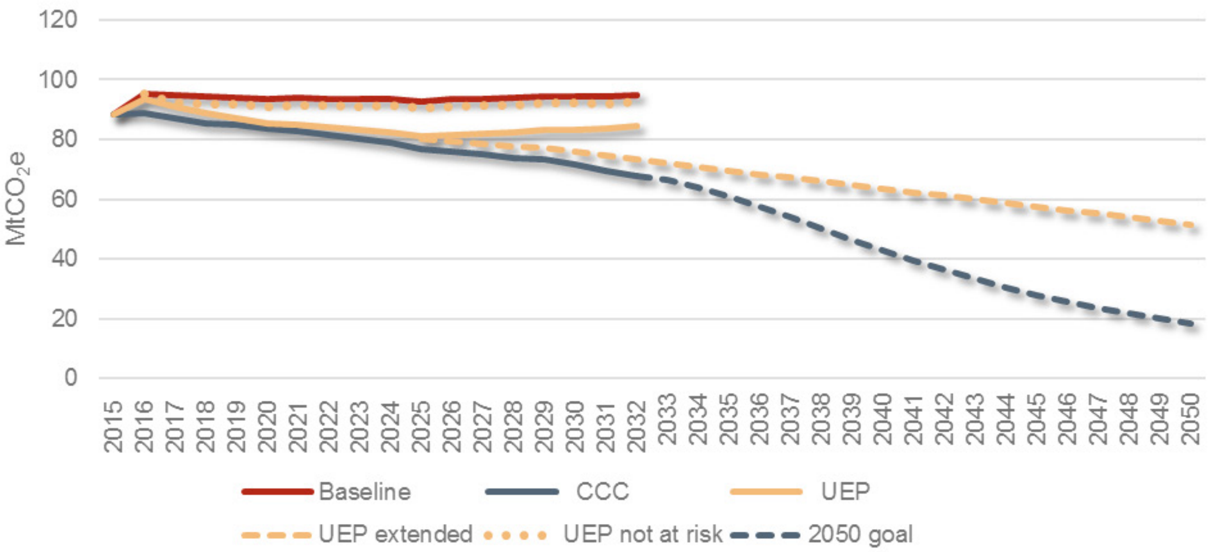

Figure 6. Direct emissions from all buildings, projection including path to 2050 and Government abatement not at risk.

Although much of this is speculation at this stage, we can make some observations around the potential risks for key energy efficiency policies. Product Policy (which is largely related to the Ecodesign Directive) has been a major driver for energy efficiency improvements both in the electric appliances markets and heating systems. After Brexit, there is a question mark as to whether the UK will retain energy efficiency standards at similar ambition level as defined by the Ecodesign Directive or opt for a less ambitious set of standards as requested by some. Equally, building regulations have had an important role in improving the energy performance of new buildings in the UK. The recent abolishment of the Zero Carbon Homes Target (a British target for new homes constructed after 2016) indicates that while Europe moves towards nearly zero energy buildings through the Energy Performance in Buildings Directive (EPBD), Britain may take a different approach. The housing shortage and calls to make it easier to build more homes more quickly appear to have been put pressure on the British government to further backtrack on energy performance standards set by the building regulations. There are also forces working in the other direction; most notably, Britain's mandatory minimum energy efficiency standards for the private-rented sector (for both residential and non-residential buildings; not a result of EU legislation) are based on the Energy Performance Certificate (EPC) rating of the property. Seeing this implemented could help entrench the EPC regime in the UK's energy efficiency policy landscape, even if the EPBD were not to apply to the UK in future.

As set out in the introduction, how Britain's energy efficiency policy landscape will evolve post-Brexit is also highly dependent on whether or not Britain will remain a member of the European Free Trade Association (EFTA) and the European Economic Area (EEA) or become a member of the Energy Community. The current political debate and the purpose of the Energy Community suggests this may not be the case and the risks sketched out above could therefore be significant.

Conclusions

The benefits of compliance with the 5th Carbon Budget, partially assessed here, are considerable and justify significant investment from both the public and private sectors for them to materialise. Carbon abatement from buildings is acknowledged to bring a wide range of persistent wider benefits, such as improved health, comfort, productivity, skilled employment and electricity system benefits – all are hallmarks of a modern, low carbon infrastructure and all serve numerous other public policy objectives. More so than abatement in other sectors, these benefits from investing in our buildings accrue directly to people everywhere in the UK. In order to leverage the necessary private investment for them to be captured, there needs to be significant policy change and public investment. The most strategic opportunity at which such a step-change can be signalled is in the forthcoming (at time of writing) Emissions Reduction Plan; the Building Renovation Strategy to be submitted to the European Commission – despite the limitations it may face due to Brexit – due next spring, also presents an opportunity.

Set the right framework conditions – the energy efficiency of, and heat supply to, our buildings are an integral part of our energy infrastructure and have a vast impact on the extent to which our energy system is low carbon, affordable and secure. They need to be formally recognised as a national infrastructure investment priority, and abatement targets for buildings need to be set, reflecting a shared vision of what successful decarbonisation of buildings means.

Increase credibility – much of currently projected emissions abatement from buildings is highly uncertain. Present-day policies need to be de-risked by ensuring they are implemented and complied with as intended: this means continuing to secure successful implementation of Products Policy for efficient appliances; ensuring strong compliance with the Building Regulations; and ensuring strong compliance with the Energy Performance Certificates regime.

Increase effectiveness – some present-day policy instruments need to be reformed so that they can support higher levels of abatement: this means fostering more attractive and more widely available finance; transforming Energy Performance Certificates into the information hub of low carbon retrofit; and levelling the regulatory and investment playing field for heat networks.

Increase timescale – there are a number of present-day policy instruments that need to be extended or renewed beyond their current expiry dates: this means extending the Renewable Heat Incentive to 2032; extending the Supplier Obligation to 2032; and continually renewing Greening Government Commitments to drive abatement in public sector buildings.

Increase ambition – the ambition and level of support provided by some policy instruments needs to be increased: this means increasing the Minimum Energy Efficiency Standard for private-rented sector buildings; expanding the remit of the BEIS' Heat Networks Delivery Unit to support local authorities with project planning and delivery, not just feasibility studies; and the roll out of electricity demand reduction and response incentives from the pilot underway since 2015.

Introduce new policy – new policy instruments will be needed to tackle segments of the buildings sector left unaddressed by the present-day scope of policies: this means introducing Minimum Energy Efficiency Standards at point-of-sale; tightening new build standards towards zero carbon or nearly zero energy; and introducing long-term incentives for low carbon buildings retrofit.

The policy recommendations put forward here – ranging from 'no-brainers' to 'inconvenient but necessary' and everything in between – are available and practicable, with many of them planned, tried and tested in other advanced economies.

Bibliography

BEIS. 2016. 'ECO: Help to Heat - Transitioning to a New Fuel Poverty Focussed Obligation | Consultation Stage Impact Assessment'. London: Department for Business, Energy & Industrial Strategy. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/534669/ECO_Transition_Consultation_IA.PDF.

CCC. 2016a. 'Fifth Carbon Budget Dataset'. Committee on Climate Change. June 7. https://www.theccc.org.uk/publication/fifth-carbon-budget-dataset/.

———. 2016b. 'Meeting Carbon Budgets – 2016 Progress Report to Parliament | Supporting Data Chapter 3: Buildings'. Committee on Climate Change. https://documents.

theccc.org.uk/wp-content/uploads/2016/07/03-Exhibits-Buildings-PR2016.xlsx.

Cluett, Rachel, and Jennifer Amann. 2015. 'Multiple Benefits of Multifamily Energy Efficiency for Cost-Effectiveness Screening'. Washington D.C.: American Council for an Energy-Efficient Economy. http://www.ourenergypolicy.org/wp-content/uploads/2015/06/a1502.pdf.

David Willis (Electric Ireland). 2015. 'Electric Ireland ...challenges and Opportunities from the National Energy Efficiency Obligation Scheme'. presented at the Green Building Conference, Dublin. https://www.igbc.ie/wp-content/uploads/2015/05/Electric-Ireland-David-Willis.pdf.

DECC. 2013a. 'Energy Saving Measures Boost House Prices'. GOV.UK. June 17. https://www.gov.uk/government/news/energy-saving-measures-boost-house-prices.

———. 2013b. 'Fuel Poverty: A Framework for Future Action - Analytical Annex'. London: Department of Energy & Climate Change. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/211137/fuel_poverty_strategic_framework_analytical_annex.pdf.

———. 2014. 'The Future of the Energy Company Obligation: Final Impact Assessment'. London: Department of Energy & Climate Change. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/373650/ECO_IA_with_SoS_e-sigf_v2.pdf.

———. 2015a. 'Valuation of Energy Use and Greenhouse Gas (GHG) Emissions - Supplementary Guidance to the HM Treasury Green Book on Appraisal and Evaluation in Central Government'. London: Department of Energy & Climate Change. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/483278/Valuation_of_energy_use_and_greenhouse_gas_emissions_for_appraisal.pdf.

———. 2015b. 'Updated Energy and Emissions Projections: 2015'. GOV.UK. November 18. https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2015.

———. 2016a. 'Provisional UK Greenhouse Gas Emissions National Statistics 2015'. GOV.UK. March 31. https://www.gov.uk/government/statistics/provisional-uk-greenhouse-gas-emissions-national-statistics-2015.

———. 2016b. 'Impact Assessment for the Level of the Fifth Carbon Budget'. London: Department of Energy & Climate Change. http://www.legislation.gov.uk/ukia/2016/152/pdfs/ukia_20160152_en.pdf.

EC. 2016. 'Commission Proposes New Rules for Consumer Centred Clean Energy Transition'. European Commission. November 30. https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition.

Froggatt, Anthony, Thomas Raines, and Shane Tomlinson. 2016. 'UK Unplugged? The Impacts of Brexit on Energy and Climate Policy'. London: Chatham House. https://www.chathamhouse.org/sites/files/chathamhouse/publications/research/2016-05-26-uk-unplugged-brexit-energy-froggatt-raines-tomlinson.pdf.

Frontier Economics. 2015. 'Energy Efficiency: An Infrastructure Priority'. London: Frontier Economics. http://www.frontier-economics.com/documents/2015/09/energy-efficiency-infrastructure-priority.pdf.

IAG. 2015. IAG Spreadsheet Toolkit for Valuing Changes in Greenhouse Gas Emissions (version 2015). Microsoft Excel. London: Interdepartmental Analysts' Group. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/483281/IAG_spreadsheet_toolkit_for_valuing_changes_in_greenhouse_gas_emissions.xlsm.

IEA. 2014. 'Global Energy Efficiency Market "an Invisible Powerhouse" Worth at Least USD 310 Billion per Year'. International Energy Agency. August 10. http://www.iea.org/newsroomandevents/pressreleases/2014/october/global-energy-efficiency-market-an-invisible-powerhouse-at-least-usd-310byr.html.

IPCC. 2014. 'Climate Change 2014: Mitigation of Climate Change | Technical Summary'. Geneva: Intergovernmental Panel on Climate Change. http://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_technical-summary.pdf.

Janssen, Rod, and Dan Staniaszek. 2012. 'How Many Jobs? A Survey of the Employment Effects of Investment in Energy Efficiency of Buildings'. Brussels: Energy Efficiency Industrial Forum. http://docplayer.net/9975903-How-many-jobs-a-survey-of-the-employment-effects-of-investment-in-energy-efficiency-of-buildings.html.

Lazar, Jim, and Ken Colburn. 2013. 'Recognizing the Full Value of Energy Efficiency (What's Under the Feel-Good Frosting of the World's Most Valuable Layer Cake of Benefits)'. Vermont: Regulatory Assistance Project. http://www.raponline.org/wp-content/uploads/2016/05/rap-lazarcolburn-layercakepaper-2013-sept-9.pdf.

LBNL Indoor Environment Group. 2016. 'Cost Effectiveness of Improving Indoor Environments to Increase Productivity | Indoor Air Quality (IAQ) Scientific Findings Resource Bank (IAQ-SFRB)'. Lawrence Berkeley National Laboratory. https://iaqscience.lbl.gov/si/performance-cost.

McKinsey & Co. 2012. 'Capturing the Full Electricity Efficiency Potential of the UK'. London: Department of Energy & Climate Change. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65626/7035-capturing-full-elec-eff-potential-edr.pdf.

Rosenow, Jan, and Edith Bayer. 2016. 'Costs and Benefits of Energy Efficiency Obligation Schemes'. Brussels: Regulatory Assistance Project. https://ec.europa.eu/energy/sites/ener/files/documents/final_report_on_study_on_costs_and_benefits_of_eeos_0.pdf.

Rosenow, Jan, Reg Platt, and Andrea Demurtas. 2014. 'Fiscal Impacts of Energy Efficiency programmes—The Example of Solid Wall Insulation Investment in the UK'. Energy Policy 74 (November): 610–20. doi:10.1016/j.enpol.2014.08.007.

Sustainable Homes. 2016. 'Touching the Voids: The Impact of Energy Efficiency on Social Landlord Income and Business Plans'. Kingston-upon-Thames: Sustainable Homes. http://www.sustainablehomes.co.uk/publications-library#sthash.zd5nNMVR.dpbs.

UCL Energy Institute. 2013. 'Health Impact of Domestic Energy Efficiency Measures (HIDEEM) Model'. University College London. https://www.ucl.ac.uk/energy-models/models/hideem.