Capturing the "multiple benefits" of energy efficiency in practice: the UK example

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Abstract

It is widely recognised that investment in energy efficiency can deliver many different social and economic impacts, beyond those most obviously considered. In a recent study the IEA highlighted that that energy efficiency can have "multiple benefits", with domestic impacts ranging from growth and employment, to healthier public balance sheets, to greater health and wellbeing amongst residents. In the UK, energy efficiency is a core part of meeting legally binding emissions targets, increasing security of supply, and alleviating fuel poverty. However recent progress towards improving the energy efficiency of homes has fallen behind some expectations, leading to calls for energy efficiency to be made a national infrastructure priority.

In this paper we use the UK as a case study, to analyse how these wider benefits are recognised within a national policy context. Applying the IEA approach, we discuss key evidence for the macroeconomic, fiscal and wellbeing impacts of domestic energy efficiency programmes in the UK. The UK has a wide evidence base evaluating the impacts of retrofit interventions, although this varies in complexity and approach. Reviewing three regulatory impact assessments undertaken for recent policy initiatives, we discuss the extent to which current policy appraisal frameworks are identifying and valuing these impacts. The headline benefit-cost focus of these remains the energy and carbon impacts, although progress has been made towards recognising health impacts. The multiple benefits approach presents a powerful case for the inclusion of wider benefits, but we should be realistic over the depth and robustness of the evidence base to date and how this can be used to galvanize investment. We should also consider what other supporting evidence and narratives may be necessary to sell the case to different stakeholders.

Introduction

There has never been clearer international acknowledgement that energy efficiency can be a powerful lever to achieve greenhouse gas emissions reductions, whilst pursuing sustainable economic growth and energy security. The IEA frame energy efficiency as a major energy resource, described as the "first fuel"[1]. Their recent study investigating the "multiple benefits" of energy efficiency raises the profile of the overlooked potential that remains in delivering against the domestic social and economic development priorities of all countries (IEA, 2014). In this paper we apply a multiple benefits lens to the UK domestic energy efficiency landscape. Building from the thinking developed by the IEA, we review how well these impacts are understood in the UK, and how far the current policy framework goes to recognise these and deliver against their public value. The UK case provides a useful example within which to explore the "multiple benefits" approach within a national policy framework.

1. In IEA member countries, the energy saved through improved efficiency is estimated to be larger than that consumed from any other single fuel source, including oil, gas, coal and electricity.

DOMESTIC ENERGY EFFICIENCY POLICY IN THE UK

The UK Government describe energy efficiency as fundamental to decarbonising the economy, maintaining secure energy supplies, and increasing the productivity of businesses (DECC, 2012a). In addition to delivering energy and CO2 savings, acknowledged benefits of investment include: job creation and economic growth, UK green innovation and business productivity, alleviation of fuel poverty, and reduction of health risk resulting from exposure to cold. The UK is a net importer of natural gas (the most common heating fuel), and reductions in energy consumption can also contribute to energy security by reducing demand for foreign imports. Analysis in the UK suggests that energy efficiency investments appear to be self-financing to the public exchequer when macroeconomic impacts are considered, with high value-for-money compared to other infrastructure projects (Cambridge Econometrics & Verco, 2014).

Energy efficiency is a central part of meeting the UK Government's legally binding greenhouse gas emissions target of 80 % by 2050, required to deliver savings of around 21–47 % in final energy consumption per capita[2]. However, despite this, recent UK policy action has fallen short of expectations, with momentum in the energy efficiency market dropping off with the introduction of new policy measures: the Green Deal and Energy Company Obligation (ACE, 2014).

The Green Deal and Energy Company Obligation (ECO) form the current primary policy initiatives tasked with achieving large scale reductions in greenhouse gas emissions from the UK housing stock. The focus of the Green Deal is on financing cost-effective measures for the able to pay, whilst ECO supports this by providing targeted funding where the Green Deal is inappropriate[3]. In the Green Deal a household takes out a loan to cover the up-front cost of a measure, repaying this investment through the savings that it is estimated to achieve on their energy bills[4]. According to recommendations towards meeting the UK's carbon targets from the Committee on Climate Change[5] all remaining cavity walls and lofts should be insulated by 2015, and 2.2 million solid walls insulated by 2022 (CCC, 2014). The Green Deal and ECO were projected to deliver 147,000 solid walls, 830,000 cavity walls, and 364,000 lofts by 2015, supporting 38,000–60,000 new jobs (DECC, 2012b). Yet progress towards delivering against this ambition has been slow particularly under The Green Deal, bringing into question the viability of this private loan-scheme mechanism in its current form. This has led to calls by some to make energy efficiency a national infrastructure priority, with the hope of attracting greater public investment to subsidise action[6].

2. On 2011 levels; baseline adjusted from the 2007 UK Carbon Plan 2010 scenarios. From the UK Energy Efficiency Strategy (DECC, 2012a).

3. Either for measures that are not considered cost-effective under the Green Deal, or to low income or vulnerable households.

4. These estimated savings must be larger than the cost of repayment; a requirement termed the "golden rule".

5. Recommendation to meet the fourth carbon budget (CCC, 2014).

6. As of October 2014, 351,518 cavity wall, 77,738 solid wall, and 216,502 loft insulation measures had been installed; around 97 % of these installed under ECO. DECC (2014); Green Deal and ECO monthly statistics: December 2014; [online]. Available from https://www.gov.uk/government/collections/green-deal-and-energy-company-obligation-eco-statistics.

What are the "multiple benefits" of energy efficiency, and what are they worth in the UK?

A growing body of research acknowledges that energy efficiency may have substantial social and economic value beyond its direct impact on energy consumption. Figure 1 provides an illustrative summary of some of the benefits most commonly attributed to energy efficiency interventions[7], including both the direct impact from reduction in energy consumption, as well as the non-energy impacts which we will discuss in more detail in this section. In the following section we analyse which of these are currently incorporated in the UK policy appraisal process, and those that are monetised in recent impact assessments have been highlighted in darker grey on Figure 1.

In the UK it is estimated that 10 % to 30 % of the predicted reduction in energy consumption achieved by greater energy efficiency may be offset by an increased demand for energy services; and a corresponding take-back of predicted energy savings[8]. The IEA (2014) point to the importance of understanding potential rebound effects across all of impact areas, and that whilst these are conventionally viewed negatively they may in fact have positive social welfare impacts. A householder is not just concerned with affordability of their energy use, but also with provision of warmth amongst other priorities, and so there are still palpable benefits that will not be observed if we focus solely on net change in energy consumption. The UK Government estimate 15 % of estimated energy savings through improved thermal efficiency to be taken as a proportional increase in energy for heating (DECC, 2012c); largely due to current under heating in many homes. However whilst the technical potential for energy savings may not be realised in practice, many non-energy related benefits on health and wellbeing from improved comfort, and their indirect social and public budgets impacts, may still be realised regardless of the energy saving.

Evidence of these impacts can be drawn from a multitude of programme evaluations and observations, ranging in size and in level of quantitative, qualitative or anecdotal insight. The IEA synthesise the research into five key priority benefit areas – macroeconomic development, public budgets, health and wellbeing, industrial productivity[9], and energy delivery. Reductions in demand can create supply-side "energy delivery" benefits, including reduced generation and delivery costs, which may increase quality and affordability of service to households. However our discussion focuses on the first three of these; we consider these are of greatest interest for the discussion of wider benefits in the domestic energy efficiency context.

MACROECONOMIC DEVELOPMENT

In the current climate of economic austerity, the overarching priority of many policies is that they deliver against key macroeconomic indicators – jobs and growth (GDP). These are also arguments supporting the case for making energy efficiency a national infrastructure priority. The UK Energy Efficiency

7. Based on the multiple benefits identified by the IEA (2014), considered for relevance in the UK context.

8. Estimate of direct rebound effects (Sorrell, 2007).

9. Not considered relevant for the discussion of domestic energy efficiency in this paper.

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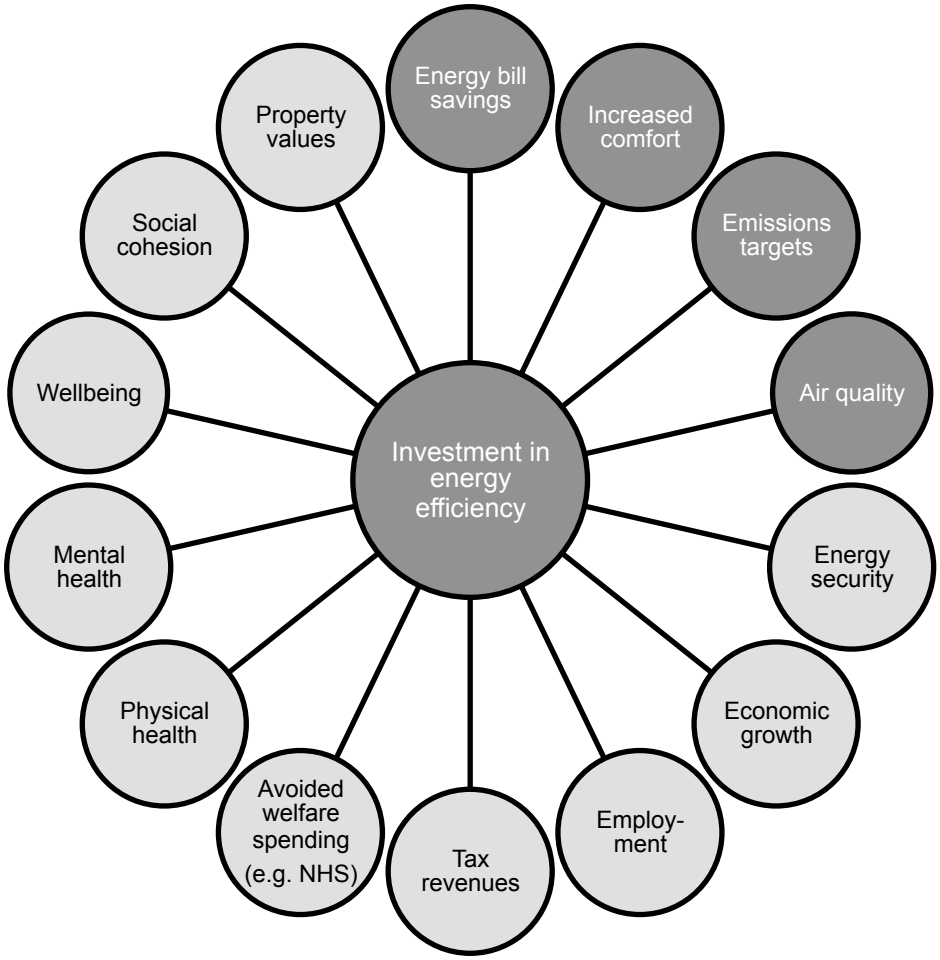

Figure 1. The "multiple benefits" of energy efficiency investment in the UK.

Strategy (2012) identifies investment in energy efficiency as key to supporting long term growth in the UK – and the sector has been estimated by Government to be worth more than €25.6 billion[10], supporting 136,000 jobs (BIS, 2013). Evaluation of UK energy efficiency policy between 2000 and 2007 has estimated that these policies contributed additional annual economic growth (GDP) of 0.1 percent over that period, resulting in roughly 270,000 additional jobs in 2010 due to the cumulative impact of higher growth (Barker et al, 2007). Analysis on behalf of the Energy Bill Revolution[11] has estimated the macroeconomic growth benefits of an energy efficiency investment scenario as €3.20 in increased GDP per €1 invested[12] (Cambridge Econometrics & Verco, 2014).

Based on recommendation from Construction Skills (a government advisory body), DECC assume that for every €1.4 million investment in the delivery of domestic energy efficiency 32.6 jobs are created[13]. Due to the nature of the jobs created (assessment, installation), a large number of jobs are likely to be located close to where measures are put into homes, thereby benefitting local economies; although the longevity and of these roles should be considered.

The IEA differentiates two processes underpinning macroeconomic outcomes: those effects resulting from increased *investment* in targeted sectors, and those resulting from the *cost reduction* made possible by delivering energy efficiency – that is to reduce the marginal cost of providing a given service or utility. The benefit of bill savings to consumers manifests itself as an increased portion of household budget made available for other areas of spending. These spending effects have been estimated to amount to the majority of the macroeconomic impact[14], and may also have secondary benefits where they enable increased spending in other key household budget areas, for example on nutrition. Spending on energy efficiency has also been suggested to increase property asset values. Hedonic analysis of EPC rating and property price undertaken by DECC (2013a)

10. All monetary values converted from GBP using a factor of €1.42: £1. HM Revenue & Customs (2015); HMRC exchange rates for 2015: monthly; [online]. Available from https://www.gov.uk/government/publications/hmrc-exchange-rates-for-2015-monthly.

11. A campaign alliance calling for more ambitious home energy efficiency action; including the designation of energy efficiency as a UK national infrastructure priority.

12. Under their proposed scenario, this is equivalent to a growth in GDP of 0.6 % by 2030 – in line with the IEA estimated range of GDP growth rates associated with energy efficiency of 0.25 % to 1.1 % (IEA, 2014).

13. Direct and indirect jobs as a result of investment in the housing repair and maintenance sector. Janssen and Staniaszek (2012) estimate that investing €1 million will create 19 new direct jobs.

14. A study in Canada estimated this to be as much as 88 % to 91 % of impact on gross product that occurs over the lifetime of the energy efficiency measures (Howland et al, 2009).

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find a positive relationship between energy rating and price per square metre for some house types, with properties in Band C estimated to sell for 10 % more than those in Band G. However whilst the analysis employs a large sample (>300,000 property transactions), it is difficult to account for all price-influencing property attributes[15].

PUBLIC SPENDING

The public budgets impact of energy efficiency relate to the effect on the public balance sheet of action, considering: the revenues from tax (sales, excise, emissions trading, carbon); the costs of implementing, administering, enforcing and paying for schemes (financial incentives and subsidies); changes in unemployment and social welfare spending (including health services); and impact on public investment in energy supply infrastructure.

General perception is that there is a heavy financial burden on the Government through delivering these programmes. And it is important to recognise that up-front subsidy of increasingly expensive *high-hanging-fruit*[16] insulation measures (for example hard-to-treat cavity or solid wall insulation) does represent a substantial financial investment. However more comprehensive analyses have found that when the tax revenue and net public spending impacts are considered across multiple areas, these can make energy efficiency a potentially self-financing public investment. Modelling of a nationwide retrofit scenario on behalf of the Energy Bill Revolution estimates that, in discounted present value over 30 years, positive impacts on the economy would generate around €1.27 in increased tax revenue for every €1 invested[17]. Even for insulation measures with high up-front costs, for example solid wall insulation, the delivery costs of subsidy and lost VAT due to reduced energy consumption have been estimated to be largely offset by increased tax receipts in other areas and avoided unemployment and welfare spending (Rosenow et al, 2014).

One areas of public spending potentially impacted by investment in energy efficiency is the National Health Service (NHS). An indirect result of improved health in a population is a reduction in the demand for health services. The total cost to the NHS of cold homes has been estimated to be around €1.94 billion per year (Age UK, 2012), and evaluation on the warm homes scheme in Northern Ireland (2001–2008) estimated that for every €1 spent on reducing exposure to cold in homes 42 cents was recouped by the NHS in avoided health costs (Liddell, 2008).

HEALTH AND WELLBEING

There are also a number of non-energy benefits from living in healthy and safe conditions that directly impact the health and mental wellbeing of occupants, and indirectly their ability to participate and contribute to society. The health and mental wellbeing impacts of living in cold temperatures has received considerable recent policy attention in the UK, particularly in relation to its impact amongst the fuel poor. In particular there may be higher health risk from exposure to cold amongst the elderly, young children, and those with a long term illness or disability (Hills, 2011).

Poor energy efficiency has been empirically found to be associated with lower indoor temperatures during the winter (BRE, 2013), and a strong body of evidence links living in low temperatures to an increased morbidity rate, and a higher risk of mortality (Marmot et al, 2011). In 2013/14 there were an estimated 18,200 excess winter deaths[18] in the UK, and there has been shown to be a greater risk in colder housing[19]. Exposure to cold has been associated with increased risk of respiratory and circulatory conditions, cardiovascular problems, and arthritic and rheumatic illnesses; and can exacerbate existing health conditions, including common flu and cold, and allergies. Improvements to household condition may improve general safety, and hand strength and dexterity also improve with higher temperatures, both reducing injury from accidents.

Physical health is a key factor in determining mental health and wellbeing outcomes, although these are also influenced by other aspects of achieving and affording comfortable warmth in the home. Cold living conditions can cause chronic thermal discomfort and generate stress and anxiety due to physical complaints. Lack of affordable warmth can generate stress related to high bills, fear of falling into debt, and a sense of lacking control – all potential drivers of further negative mental health outcomes, such as depression. Warm Front found that self-reported states of depression and anxiety fell by 48 % following installation of measures (Green & Gilbertson, 2008).

Aside from the benefits to physical and mental health a number of wider benefits relating to household and community wellbeing have been observed. Avoidance of physical (particularly respiratory health in children) and mental stresses through energy efficiency retrofit has been linked to decreased absenteeism from school by children and from work by adults; with potential impacts on academic performance, labour productivity and earning power. The ability to affordably heat a larger area of the home effectively increases the space available to a family, and may reduce tensions arising from space restrictions, and provide more private and comfortable spaces for activities like homework. Better nutrition has also been observed: by making fuel bills more affordable a "heat or eat" situation can be avoided. Interventions can improve pride in the home – remove mould, make temperatures more comfortable – enabling residents to avoid (sometimes self-imposed) social isolation. Retrofit schemes may also support community wide social outcomes, for example evaluations studies have linked them with lowering crime, improving social cohesion, and stimulating local economies[20].

15. Homes with better energy efficiency may also be favourable in other aspects, for example: quality of bathroom or kitchen, general condition.

16. The term "low hanging fruit" is used to describe those actions that are easiest and so typically undertaken first.

17. Split across income tax revenue (43 %), VAT (28 %), social security contributions (23 %), and corporation tax (6 %) (Cambridge Econometrics & Verco, 2014).

18. Excess Winter Deaths (EWD) calculated by the ONS as the difference between the number of deaths during December to March, as compared to the average number of deaths during the preceding August to November and following April to July.

19. Wilkinson et al (2001) find significant associations between EWD and the age, thermal efficiency and temperature of a property. The Marmot Review team (2011) estimate that 21.5 % of all EWDs can be attributed to low temperatures in the coldest quarter of housing; over and above what would be expected.

20. See for example the Nottingham City Homes, Secure Warm Modern Programme – The impact of improving your home; [online]. Available from: http://www.nottinghamcityhomes.org.uk/improving_your_home/impact_study/.

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Although there is wide acceptance that improved energy efficiency can have positive health outcomes, observing and quantifying the magnitude of these can be difficult. Warm Front (2000–2013) was a grant programme, set up as the Government's primary scheme for tackling fuel poverty, with particular focus on addressing the health risks of cold homes. Whilst evaluation of this programme confirmed that energy efficiency measures did lead to improved internal temperatures, observation of changes in physical health outcomes proved difficult (Green & Gilbertson, 2008). Meta-analysis of studies has found that energy efficiency intervention leads to a modest but significant improvement in health (Maidment et al, 2014). An evaluation of the mental health outcomes of the Kirklees retrofit programme in the north of England, estimated that the benefits to the mental and physical health of occupants recouped a benefit-cost ratio to the project of 0.2:1; with mental health accounting for around half of this impact (Liddell et al, 2011). Observation of less direct impacts such as nutritional spending and family cohesion are even more difficult to empirically justify, and the evidence for these is often anecdotal and from the evaluation of smaller, localised schemes. These outcomes are the result of complex relationships in an individual's life that may lead to negative, as well as positive, unintended consequences (Shrubshole et al, 2014).

Empirical evaluation of retrofit projects is complex and expensive, requiring time and expertise that are unlikely to be available to all schemes. A supporting approach to understanding the impact of energy efficiency on health is to estimate the impact of an intervention using a model. As part of their Fuel Poverty Strategic Framework (2013b) DECC have commissioned the HIDEEM model[21]. This aims to quantify and monetise the health impacts associated with the changing indoor conditions (temperature, air quality, mould growth) brought about by energy efficiency, including heart and circulatory disease, cancers and strokes, as well as respiratory illness and common mental health disorders. Using evidence on exposure rates and incidence of health outcomes as inputs, the model monetises health impacts through Quality Adjusted Life Years[22]; a well-established approach to the economic appraisal of health impacts. HIDEEM estimates the present value of the health benefits achieved from cavity wall insulation for a typical home is estimated to be €1,379[23]. Indicating that when evaluated long-term, the health benefits of a measure may more than contribute towards repaying the up-front investment; estimated to be €700 for a straightforward cavity wall insulation installation[24]. Whilst models have an important role to play in providing an affordable estimation of impacts, they are nonetheless only as accurate as the empirical evidence observations on which they are developed and held accountable.

Whilst the discussion presented in this paper focuses on benefits and the arguments *for* increased investment in energy efficiency, it is crucial to be aware that there are also potential negative unintended consequences of action. Wilkinson et al (2009) find that the way in which energy efficiency measures in UK housing are delivered can influence not only the magnitude of the health impacts, but also the direction. Identified risks include increased build-up of harmful toxic particles in the home from a reduction in air permeability, and potential summer over-heating resultant from increased thermal retention.

How far does current policy go to recognise this value?

We have established that a range of non-energy social and economic benefits have been linked to energy efficiency and that some of these can be quantified and monetised, with a UK evidence base to support this. However, recognition of these benefits alone will not necessarily deliver against their potential. That requires a supportive policy framework that internalizes these values and supports stakeholders to make socially, and privately, optimizing decisions.

In order to understand how these values are reflected in UK policy we consider three recent policy initiatives – the Green Deal and ECO (2012), changes to Part L (the energy efficiency requirements) of Building Regulations[25] in England and Wales, and the consultation on new regulations setting minimum energy efficiency standards for the Private Rented Sector (PRS). These are complex policies and critical evaluation of all aspects of their design and progress would require a larger discussion. Instead, here we focus specifically on how policy makers used the evidence base on wider impacts in the design and appraisal of each of these policies. We look at the regulatory impact assessments that appraise the net societal impact, before considering how the designed structures of the interventions frame these impacts.

Regulatory impact assessment is a standard part of the UK policy making process[26]. By examining the evidence-base, the aim is to justify the need for policy action, to understand the key objectives, and to appraise the effectiveness of different policy options in delivering a cost-effective response. The identification and comparison of value is central. Table 1 summarizes the range of impacts evaluated in three recent UK policy impact assessments, and the extent to which they are recognised. Where they have been included in the appraisal, estimates of quantity and monetary value are presented here. In the case of these policy proposals the analytical approach is to assess the likely impact on uptake of measures as a result of the intervention, assess the social impacts, and estimate the distributional impacts on individual stakeholders; comparing these against a counterfactual under which no new intervention is undertaken.

Each of these policy actions is part of the UK's energy efficiency strategy to reduce carbon emissions from the domestic building stock, although they are of different scale and each addresses particular aspects within this overarching objective.

21. HIDEEM – Health Impact of Domestic Energy Efficiency Measures (HIDEEM) model, developed for DECC by the UCL Energy Institute and the Complex Built Environment Systems Group of the Bartlett School of Graduate Studies, in collaboration with the London School of Hygiene and Tropical Medicine.

22. QALYs – a measure of health that adjusts life expectancy in years to reflect quality of life.

23. Assumes that cavity wall insulation has a lifetime of 42 years, health benefits continue to accrue for 5 years beyond this since it typically takes a number of years for the health impacts of an action to be realized.

24. Estimate for an easy-to-treat cavity wall insulation.

25. Part L (Conservation of fuel and power) are the part of UK Building Regulations that relate to the energy efficiency requirements of a building.

26. The standard set of guidance for all policy, programme and project appraisal in the UK is the HM Treasury Green Book (2011).

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Table 1. Impacts identified in recent UK energy efficiency policy initiatives.[1]

	Area of impact	Green Deal / ECO June 2012	Part L Building Regulations August 2013	PRS Minimum EE Standards[2] July 2014
BENEFITS	Energy savings	€21,331 million	€1,661 million	€582 million
	Increased comfort	€4,910 million	mention	€155 million
	Carbon reductions[4]	€8,173 million	€455 million	€125 million
	Air quality	€2,041 million		€10 million
	Energy security	mention	mention	mention
	Sustainability	mention	no mention	no mention
	Fuel poverty	*125,000–250,000 households*	*no mention*	*mention*
	Economic growth	mention	no mention	mention
	Employment	38–60,000 jobs	no mention	8,400 jobs
	Asset values	no mention	mention	mention
	Tax revenues	no mention	mention	no mention
	Welfare spending	no mention	no mention	mention
	Physical health	mention	mention	*€36 million*[5]
	Mental wellbeing	mention	no mention	
COSTS[8]	Installation	€14,404 million	€1,571 million[6]	€329 million
	Additional[7]	€4,936 million	-	€33 million
	Assessment	€1,728 million	-	€16 million
	Finance	€2,166 million	-	€205 million
	Business cost	€1,345 million	-	-
	Administration	€57 million	mention	-
	Transition	-	€7 million	-
	Understanding regs	-	-	€23 million
	Unintended health	mention	mention	mention
	Net Present Value	€11,820 million	€539 million	€269 million
	Benefit-Cost Ratio	1.5:1	1.3:1	1.5:1

[1] Quantified values are central estimates.

[2] These estimates are for the preferred Option 1 proposal, domestic CBA.

[3] There is no quantification of this since comfort take is not assumed relevant in the new homes model.

[4] Lifetime non-traded carbon savings, and lifetime EU allowance savings.

[5] A UK policy objective that encompasses a range of other impacts described elsewhere.

[6] An estimate of health impacts from HIDEEM was included as an indication of impact, but was not counted in headline total quantification of benefits from the policy, see main body for further discussion.

[7] The additional capital costs of compliance with regulations.

[8] These hidden and overlooked costs to participants; sometimes termed "hassle" costs.

[9] The classification of costs varies between each assessment.

As is consistent with this goal the headline focus is on the energy and carbon emission savings, and in each case the monetised estimates of these dominate in terms of their net benefit. Across all three appraisals, costs, both to public budgets as well as to businesses and households, are clearly differentiated; although definitions of these vary slightly. Primarily the assessments look to provide an evaluation of the cost effectiveness of delivering emissions reductions. Beyond this, however, no other benefits are included in the net benefit-cost calculations of any of the appraisals. Whilst both the Green Deal & ECO and PRS appraisals identify an impact on employment and point, particularly in the case of the Green Deal, to increased investment, the impact of this on GDP is not quantified. There is no substantive discussion of impact on tax revenues[27] or on spend-

27. Although, as transfer payments, we would not expect taxes to be included in the NPV calculations.

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ing impacts across other Government departments – although the PRS appraisal does refer to a reduction in the use of NHS services as a potential outcome of improved health.

As introduced there has been considerable UK policy interest in quantifying and monetising the health impacts of energy efficiency; primarily driven by the importance of addressing fuel poverty as a central objective of DECC. The PRS makes the first use of the HIDEEM model to provide an indication of the likely impact on health. However, whilst they are monetised, the health impacts of energy efficiency measures are not included in the primary benefit-cost calculations. The reasoning behind this is to avoid double counting with "comfort take". Since this increase in energy consumption is assumed to capture the market value that a householder places on being warmer, this may include a consideration of thermal health. It is unclear however whether individuals have the necessary information (on future health risk), or the cognitive capacity, to factor in long-term health benefits when increasing temperatures, or simply enjoy the immediate warmth. In fact all three policies make reference to the potential negative health consequences of poorly, or inappropriately, insulated homes; such as overheating and inadequate ventilation. In this context it seems unlikely that households have consistent, personally relevant information with which to rationally choose action on the basis of health. Nonetheless, the fact that there is a quantification of health benefits shows that, even over the 2 years separating these policies, there has been progress towards the recognition of health impacts in government decision making.

The overall lack of evaluation of wider benefits in these impact assessments does not necessarily indicate that these are not valuable or valued, and indeed many of these are mentioned in the supporting narrative. At a headline level these appraisals focus on DECC's priority: the cost-effective reduction of carbon emissions; with a secondary consideration to distributional impact on fuel poverty. In many ways any wider impacts, such as reduced unemployment benefits or public health spending, lies outside of DECC's remit, and there are not currently clear incentives for ministries to collaborate to share these. Whilst this crossover of departmental aims remains challenging at a national level, there is some emerging evidence from local schemes that collaborative projects can unlock net cost savings for a number of public bodies investing in the same programme. For example the Warm Homes Oldham Scheme funded by Oldham Clinical Commissioning Group[28], Oldham Council and Oldham Housing Investment Partnership has found positive early impacts across financial, health and social measures[29]. However, to-date, these pilot schemes have been very small scale with a focus on households with existing poor health issues, and so are some way from providing a robust, representative template that can be used to evaluate the cost-effectiveness of schemes delivered in this way.

The design of the Green Deal implies that up-front cost is the greatest barrier to the adoption of energy efficiency measures, and that access to capital that spreads these costs over time addresses this. It focuses the decision to take up energy efficiency on its financial merits – do the estimated monetary savings on a household's energy bill[30] outweigh the cost of repayments financed through the loan. However wider benefits, such as health, are not captured in this transaction.

How could policy go further to recognise this value?

One reason why the inclusion of multiple benefits in UK policy appraisal is not more advanced is that there remain uncertainties within the evidence base that make reliable quantification and monetisation difficult; even when theoretically these may appear clear. A good example of this comes from considering the evidence for health and wellbeing benefits. Whilst there is strong epidemiological evidence linking exposure to cold and damp with negative health outcomes, a number of confounding factors may make the observation of these challenging, particularly in *ex-post* programme evaluations. Thomson et al (2013) reviews studies assessing health change following housing improvements, finding that extreme variation in methodological approach and context make quantitative synthesis of results very difficult. There are also a number of reasons why health outcomes may be difficult to observe, or less extensive than expected, following improvements in warmth. These include factors such as: coping mechanisms amongst householders in cold homes; difficulty in controlling for the influence of external temperatures or the outbreak of illnesses, such as influenza; that long-term health outcomes cannot be observed over short follow-up periods; and that samples sizes are too small to observe full range of outcomes and generate statistically valid results. All of this is notwithstanding that health outcomes are by generally subjective; particularly if/when they rely on self-reported assessments of health.

The observation of lower than expected health benefits from schemes might also be explained not by inadequacies in measurement, but by the reality that they are simply less prevalent than expected or even negated by unintended negative impacts; and a number of studies have found a net negative health impact following energy efficiency schemes (Maidment et al, 2014). It is important that evaluations research focuses as diligently on understanding the causes of these health risks, as on positive outcomes. A better understanding of these may enable more effective regulatory action and guidance for industry. In addition to reducing the risk of unintended health risks, the setting of minimum parameters would likely also provide greater guarantee of energy savings, overcoming some of the observed performance gap from energy efficiency measures (DECC, 2012c).

One approach to overcoming some of these challenges has been to focus on mental health outcomes. Mental wellbeing outcomes manifest themselves over shorter timeframes than physical health, which can make them more straightforward to observe within the limitations of scheme evaluations than physical outcomes; for example in the evaluation of Warm Front. And alternative approaches to measuring progress and growth within society predicated on personal wellbeing have also been gaining traction. There are a number of conditions

28. Regional organisations that commission and deliver NHS services.

29. Warm Homes Oldham evaluation: interim report (2014); [online]. Available from: http://www.oldham.gov.uk/warm_homes_oldham.

30. Modelled using the Government's Standard Assessment Procedure (SAP). An "in-use" reduction factor is applied to account for observed underperformance in situ against modelled estimates, however comfort take is not included.

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in which direct measures of subjective (self-reported) wellbeing may prove preferable to the traditional measure of GDP (O'Donnell et al, 2014). Whether these approaches are can be accepted by Treasury as part of the central benefit-cost decision making framework remains unclear, yet they may provide a useful supplementary metric in support of monetary measures. The Office for National Statistics (ONS) now routinely collects data on national wellbeing[31], including as part of the English Housing Survey. However reporting of these measures has been limited and, despite these gains in recognition, until these measures are used and referenced in official decision making it is unclear to what extent that can be influential.

Health and wellbeing impacts are not the only impacts that need to be viewed for their value as a long-term investment. Other variables, for example tax rates, and energy prices, are short-term and may generate uncertainty that makes public investment difficult. For example, whilst the scenario modelled by Cambridge Econometrics highlights that the positive economic impact of their proposed programme generates enough additional revenue to more than pay for the investment in the long run[32], over the first parliamentary term[33] the net impact on the government balance sheet would be negative. Although subsequent terms would see the additional revenues begin to outweigh the front-loaded investment costs this may still be a politically unpopular[34] position.

Leading from this, the second key question that should be asked of the evidence base for wider benefits is whether a stronger set of economically structured arguments are *all* that is required to make investment in energy efficiency more attractive. As demonstrated by the steps taken to incorporate health impacts in the central economic appraisal for energy efficiency activities, it is feasible that many if not all of these arguments could reach a point where they can be expressed within this framework; particularly as models becomes more complex. One barrier to this is that current departmental impact assessments do not provide incentive for policymakers to consider all areas of impact – only those areas relevant to their policy objectives. The appraisals analysed in this paper focus on the numbers of measures installed, the estimated impact of these on energy consumption and carbon emissions, and to a lesser but growing extent on health and fuel poverty outcomes, but not on macroeconomic or public budgets impacts despite these being identified in the wider literature as amongst the largest.

Allowing a focus on evaluating narrow outputs of schemes, such as the number of measures installed, rather than the outcomes resulting from this action, seems unlikely to achieve the most cost-effective outcomes. An example of this would be the vast numbers of low-cost energy efficient light bulbs distributed under historical supplier obligation schemes in the UK. Able initially to focus solely on supporting energy cuts energy suppliers acted rationally in providing the measures with the lowest marginal cost. However this was at the expense of measures with larger up-front cost but higher long-term value, even more so under a multiple-benefits approach.

Calls to make energy efficiency an infrastructure priority may hold the key to opening up this appraisal process to consider these impacts more fully. When impacts on growth and public budgets are appraised, the estimated returns of energy efficiency investment fall into the category of "high" value for money[35]; with an benefit-cost ratio of 2.27:1[36]. Moreover were this analysis expanded to include wider impacts, for example on health spending through reduced morbidity from cold homes, this value proposition would be further strengthened in support of energy efficiency investment. When we compare this against other infrastructure investments that the UK government is planning to make this appears to represent high value for money. For example HS2[37] has been estimated as having a benefit-cost ratio of only 1.4:1 for the initial London to West Midlands proposals, towards the lower end of the medium value for money category.

Investment in energy efficiency will always require a considerable, visible up-front delivery cost, whereas the benefits are accrued more gradually and are dispersed as a wide range of both private and public outcomes. These benefits may be less visible and measurable and so are more difficult for particular policies actions and policy makers to take direct credit for. An outcome of improved understanding and evidencing of the impacts of energy efficiency may be a growth in political acceptability and support; also vital in support of economic credentials. In terms of its attractiveness as an investment, energy efficiency may be handicapped in this respect when compared to investments with clearer, very visible outcomes – even if the total present value of these is not as great when considered in a multiple benefits approach[38]. In early 2014 Government announced cuts to the energy supplier obligation element of current policy, ECO[39]; despite it delivering the large majority of progress against current retrofit targets. Action to cut ECO took place amidst media pressure to take action on energy bills, and Government responded to reduce the cost of this policy on household energy bills.

Whilst building a strong monetary case is important for Treasury, other narratives may be necessary. This is both to convince politician, civil servants and other political actors, but also to engage households to take interest as adopters of measures and as voters with political influence. Monetary arguments are necessary, but they may not be compelling to all stakeholders. The Green Deal treats a householder as a decision maker, who is able to make a rational decision to invest, or not invest, based on an evaluation of the costs and benefits. However whilst the structure of the Green Deal should appear to guarantee a net

31. Measures include happiness, life satisfaction, worthwhileness, and anxiety.

32. They estimate a net impact on the Government balance sheet of €23.8 billion by 2030.

33. Parliamentary representatives in the UK are elected for fixed five-year terms.

34. Or even impossible?

35. Department for Transport's Transport Analysis Guidance (TAG) for appraising transport infrastructure investments describes a "high" value for money investment to return monetised benefit-cost ratio impacts of between 2:1 and 4:1.

36. This ratio includes net/discounted benefits of: consumer spending, government balances, increases in company profit, consumer energy savings, and carbon emissions reductions.

37. A proposed high speed railway project linking London with areas in the Midlands and North of England.

38. It is beyond the scope of this paper to compare the social return on investment of different types of infrastructure project, however it would be interesting to consider this in future analysis.

39. The Carbon Emissions Reduction Obligation (CERO) element was cut by 33 % (to March 2015).

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financial gain and make action rational, uptake has been lower than expected. If the multiple benefits approach is to prove successful in demonstrating the *real* value of investment in energy efficiency, then we also need to consider how it can be used to capture and communicate value to householders as well as at a policy level. Over-reliance on a private payback narrative, may also fail to harness the strength of social norms that can be highly influential over an individual's decision making.

Concluding comments

There is a mounting case that energy efficiency has high value for money as a public investment, with a range of benefits to individual households and to wider society. However it is less clear how this evidence can best be exploited to achieve retrofit action at the rate that is required to meet energy efficiency and carbon targets.

In the current economic climate, there is clear necessity to maximise cost-effectiveness of action and a more complete and nuanced understanding of the impacts of energy efficiency can support this. A stronger appreciation of the multiple benefits and particularly their distributional impact on different groups may empower policy makers to make better use of existing budgets that they have available to them; for example in changing the targets of supplier obligations (Howard, 2014). However we should also be cautious not to rely on these arguments as the silver bullet that will unlock greater investment. Under ongoing austerity, Governments are likely to be hugely restricted in their ability to sanction public spending, and it is important to consider where else these insights can be valuable.

The UK has a strongly evidence-led policy appraisal framework which at a departmental level focuses action on cost-effectively meeting central objectives. However as we have seen with our analysis of the impact assessments undertaken for recent policy actions, these structures may not allow for the full multiple benefits case to be made. If energy efficiency can deliver against employment and health spending objectives, then further collaborative action needs to be taken to ensure that this value is reflected in decision making. Evaluation of local co-funded projects between health service providers and housing providers may provide the template and evidence needed to justify this way of thinking more widely.

Finally, the multiple benefits approach points to the potential for new narratives that speak engagingly and with relevance to different stakeholders. Whilst the economic case will always be needed for treasury, the emergence of some alternative measures of utility such as the Wellbeing approach do highlight that there may be a growing recognition of complementary tools for appraisal. Given that current policy places a strong onus on householder participation, it should also be considered how these arguments can be made most compellingly to the public. The UK energy efficiency strategy reflects that energy efficiency is not "salient" for many consumers – and that beyond reducing energy costs, the benefits are not well understood. Taking communication beyond energy bills savings to involve the health, comfort and lifestyle benefits, for example the potential impact of investment on property value, may be an effective way of overcoming the hassle costs and inertia that have limited public enthusiasm and direct private investment in energy efficiency to date.

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