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Focussed Policy Assessment:

SEAI Better Energy Homes 2009 -2015,

Sept 2017

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Executive Summary

This document undertakes a Focussed Policy Assessment (FPA) of SEAI's Better Energy Homes Scheme. This Assessment is taking place in the context of the 2015-2017 Value for Money Review round and as part of DCCAE's adherence to the Public Spending Code. The Better Energy Homes scheme provides grants to homeowners who invest in energy efficiency improvements. The Assessment examines the performances of the Better Energy Homes Scheme under the criteria of 'rationale' and 'impact'.

Under the **Rationale** metrics, the review concludes that the scheme's **objectives,** to support homeowners improve their energy performance, reduce energy use and greenhouse gas emissions, address **market failures** in the consumption/production of energy. They are also consistent with wider Government policy in the energy sector, which seek to 'deliver deeper energy efficiency upgrades… to put the residential sector on a realistic trajectory to a low carbon energy future'[1] . On that basis, there appears to be a firm rationale for corrective action.

Under the **Impact** metrics, it was found that, SEAI tracks **outputs** from its scheme and provides clear data in respect of measures installed, houses completed, money spent etc. Moving to **results** of this output, SEAI also estimates carbon abatement and energy efficiency improvements.

A high level costs benefit analysis estimated that, given certain assumptions on monetising these impacts, the scheme delivers a positive return on investment. This was bolstered by the risk profile associated with action and inaction, indicating the prudential nature of intervention.

In order to improve impact, it is recommended that a more direct link between expenditure and energy efficiency improvement, be explored. This could take the form of a grant related to BER improvement rather than specific measure per dwelling type. It is noted that such an approach has the potential negative unintended consequences such as gaming, efficiency/equity trade-offs which imply further work is needed.

In order to better understand the impacts of energy efficiency on security and health, it is also recommended that data on health impacts is collected and that improved metrics for measuring security of supply are developed.

[1] Ireland's Transition to a Low Carbon Energy Future 2015-2030
http://www.dccae.gov.ie/energy/SiteCollectionDocuments/Energy-Initiatives/Energy%20White%20Paper%20-%20Dec%202015.pdf

Introduction

This document undertakes a Focussed Policy Assessment (FPA) of SEAI's Better Energy Homes Scheme. This Assessment is taking place in the context of the 2015-2017 Value for Money Review round and as part of DCCAE's adherence to the Public Spending Code. Better Energy Homes is an SEAI programme which is available to all owners of homes built before 2006. The Better Energy Homes scheme provides grants to homeowners who invest in energy efficiency improvements in the following areas:

- Roof Insulation;
- Wall Insulation;
- Installation of a High Efficiency (> 90%) Gas or Oil fired Boiler;
- Heating Control Upgrades; and
- Solar panels.

The incentive is in the form of a cash grant. Grants are fixed, irrespective of home size, though where actual expenditure is lower than the grant value only the lower amount is paid. Grants are typically valued at equal to the value of 30% of the total cost of the measure. The programme commenced as a pilot in 2009 before a full launch in 2010. Following a decline in take-up, a re-launch in March 2015 amended the design of the scheme to improve attractiveness. The changes were as follows:

- The minimum grant requirement of €400 was removed.
- A new bonus of €300 was introduced on the third and €100 on fourth Energy Efficiency Measures – see Table 1, below.
- Revised grant amounts for Energy Efficiency Measures – see Table 1, below.

Table 1: Better Energy Homes Grants

Measure	Category	Sub-Category	Scheme 1 Mar 2009	Scheme 2 Jun 2010	Scheme 3 May 2011	Scheme 4 Dec 2011	Scheme 5 Mar 2015
Roof Wall	Attic Insulation		250	250	200	200	300
	Cavity Wall Insulation		400	400	320	250	300
	Internal Dry-Lining		2500	2500	2000	.	.
		Apartment or Mid-terrace House	.	.	.	900	1200
		Semi-detached or End of Terrace	.	.	.	1350	1800
		Detached House	.	.	.	1800	2400
	External Wall Insulation		4000	4000	4000	.	.
		Apartment or Mid-terrace House	.	.	.	1800	2250
		Semi-detached or End of Terrace	.	.	.	2700	3400
		Detached House	.	.	.	3600	4500
Boiler	High-efficiency boiler (oil or gas) upgrade with heating controls		700	700	560	560	700
	Heating Controls upgrade only		500	500	400	400	600
Solar	Solar Heating		.	.	800	800	1200
BER	Before & After Building Energy Rating		100	.	.	.	.
	Mandatory Before & After Building Energy Rating		.	100	80	50	50
Bonus	Bonus for 3rd measure		.	.	.	.	300
	Bonus for 4th measure		.	.	.	.	100

Source: Collins & Curtis[2]

The objectives of the scheme are to:

- Support homeowners in making intelligent choices to improve the energy performance of their home
- Reduce energy use, costs and greenhouse gas emissions
- Build market capacity and competence by driving contractor standards and quality
- Stimulating market innovation

In assessing the success of the scheme, the full range of Value for Money and Policy Reviews (VFMPRs) criteria prescribed by the Department of Public Expenditure and Reform are as follows:

- Rationale
- Efficiency
- Effectiveness
- Impact
- Continued Relevance[3]

[2] Collins & Curtis Collins & Curtis *Value for money in energy efficiency retrofits in Ireland: grant provider and grant recipients,* in Applied Economics, 2017

VFMPRs are complemented by Focussed Policy Assessments (FPAs) which are 'sharper and more narrowly focused assessments designed to answer specific issues of policy configuration and delivery'[4]. Typically, one or two of the VfM criteria, outlined above, are measured. In this instance, 'Rationale' and 'Impact' have been chosen as these combine a strong measure of the quantitative and qualitative performance of the scheme.

- Rationale - What is the justification for the policies underpinning the Programme? What is the underlying market failure which warrants Government intervention?

- Impact – What socio-economic changes can be attributed to the programme/scheme?

A key feature of VFMPRs and FPAs is a link to Programme Logic Models which illustrate inputs and outputs from a particular activity. The Model maps out the shape and logical "cause-effect" linkages (see table 2, below).

[3] http://publicspendingcode.per.gov.ie/reviewing-and-assessing-expenditure-programmes/
[4] http://publicspendingcode.per.gov.ie/reviewing-and-assessing-expenditure-programmes/

Table 2: FPA Criteria

Criteria	Link to Programme Logic Model
Rationale	Objectives
Impact	Outputs, Results, Outcomes

Rationale

As discussed, 'Rationale' relates to evaluation questions concerned with identifying programme objectives and examining their validity.

It is often assumed that a particular issue warrants government and that evaluation should focus on whether intervention has proven effective. Before examining this question, however, the first step is to interrogate the rationale for intervention. In economic terms, this may be placed in a market context. Why can a particular activity not be left to the market? **Where is the market failure** which justifies government intervention?

Examining SEAI literature[5], it is contented that a range of market failures are present which require government intervention. These include:

- Externalities
- Split incentives
- Access to capital
- Behaviour
- Lack of investment

It is worth examining each of these purported market failures in order to establish whether to rationale for government intervention is compelling.

[5] C.f. SEAI, The case for sustainable energy: A review and analysis of the economic and enterprise benefits (2012) http://www.seai.ie/Publications/Statistics_Publications/Energy_Modelling_Group_Publications/The_Case_for_Sustainable_Energy.pdf

- **Externalities:** It is well established that, in the long term, environmental damage caused by emissions of greenhouse gases will have a negative economic impact. The cost of this damage is negligible for the emitters but substantial for society. While attempts have been made to internalise these externalities (e.g. via the EU Emissions Trading System (ETS) and Irish carbon tax), it would appear that current prices are too low to induce the necessary investment in abatement.

- In addition to the environment externalities highlighted above, a further area exists in energy policy where the individually rational may diverge from what is collectively optimal. At a national level, increased efficiency improves **security of supply**: Ireland is heavily dependent on energy imports, often from areas that are subject to geo-political instability. Reduced energy consumption on the part of consumers reduces this dependence and ameliorates our vulnerability.

- **Information asymmetries:** The complex nature of how energy is measured and billed may deter homeowners investing in efficiency improvements. It may be unclear, to those wishing to invest, what benefits will be derived in terms of improved comfort and reduced expenditure[6].

- **Improved health outcomes:** The link between the quality of housing stock and health may provide another externality. While a strict libertarian might take the view that an individual's health outcomes are internalised within the market, this assumption breaks down in the presence of publicly funded healthcare. In addition, it may be argued that, as well as individuals, society more generally benefits from improved health outcomes[7].

- **Split-incentives:** This is where the economic benefits of reducing energy use or carbon emissions do not accrue to the party achieving the savings. For example, in the landlord/tenant relationship, an improvement to energy efficiency undertaken by the landlord may increase comfort for the tenant without any increase in rental value for the

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[6] C.f. ESRI Working Paper: *Identification of the information gap in residential energy efficiency: How information asymmetry can be mitigated to induce energy efficiency renovations*, April 2017

[7] Government's Healthy Ireland sets out a range of goals which are supported by Better Energy Homes http://health.gov.ie/healthy-ireland/

landlord. On the tenant's part, there is little incentive to increase energy efficiency if s/he has a relatively short tenure.

- **Lack of access to capital:** Inability to make desirable investments due to information deficits; where potential investors are unaware of the net benefits available through investing in energy efficiency. While traditional remedies may emphasise the role of the banking system, specialist knowledge of the field may imply a role for energy specialists.

- **Behavioural failures:** A number of studies show that people do not purchase energy in an economically rational fashion. Choices are based on force of habit rather than on cost. Thus, the inconvenience of clearing out an attic may deter investment in loft insulation despite the fact that the investment has a strong return[8].

- **Lack of investment** in research and development: It is well established that private markets will under-invest in R&D in new technologies because of uncertainty and an inability to fully realise the returns on such an investment. The history of the development of new technologies shows that, as deployment increases, costs decrease through learning and economies of scale. Until such economies of scale are reached, application of technologies (e.g. for deeper retrofit of our housing stock) is important for developing markets. While Ireland's scale may limit its potential to drive down costs, this is not to say there are no opportunities.

The above would suggest there may be a range of grounds for some form of intervention. The most straightforward may be to tackle each problem at its source. Returning to environmental externalities, the standard least cost response would be a 'Pigouvian tax' which internalises the cost imposed on society to the producer/consumer[9]. This tax gets its name from the economist who suggested that, where a market price is less than the social cost, the discrepancy should be covered by a tax. The commonly cited example is that of a laundry downwind from a smoking chimney. As the chimney owner does not face social the cost of his pollution, the level emissions will be sub-optimal.

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[8] http://neweconomists.org/files/Behaviour_and_Energy.pdf

[9] C.f. Baumol, William J. O*n Taxation and the Control of Externalities*, *The American Economic Review, Vol. 62, No. 3* (Jun., 1972), pp. 307-322

SEAI contends that such a policy will be insufficient as carbon pricing also suffers from market failures. It is suggested that behavioural factors and the nascent state of many of the relevant technologies and sectors require a more aggressive intervention.

There is a large body of evidence in support of this thesis. The Stern Review of UK climate policy states that the social cost of carbon is US$85/t$CO_2$, while the International Energy Agency estimates that a carbon price of US$45/tonne is required by 2020, with a further price rise to US$ 120/t CO_2 required by 2030, to reach global climate change targets. The difference between current carbon prices and these estimates represents a market failure in itself. Despite an expanding global carbon market, the EU-ETS carbon price applicable to large industrial emitters and power generation in Ireland decreased by 9% in 2011, to around €13/ tCO_2.

At the time of writing, the EU-ETS carbon price was approximately €5/ tCO_2 (May, 20176)[10]. Dealing with any remaining market barriers and failures through government intervention may complement the carbon pricing regime, thereby increasing the cost effectiveness of the carbon price signal.[11]

Energy efficiency is often cited as a cost effective means of addressing climate change. The International Energy Agency (IEA) considers energy efficiency to be the 'first fuel - a source of energy in its own right, in which they can invest ahead of other more complex or costly energy sources'[12].

Energy efficiency may also deliver co-benefits. Displacing imported fossil fuels may lead to increased local and rural employment. Such benefits may not deliver a net economic gain but they may deliver a positive distributional impact. Furthermore, reducing Ireland's reliance on imported fossil fuels increases our security of supply. This improves the resilience of the Irish economy to external shocks and is one of the pillars of national energy policy.[13]

While much of the discussion above has concentrated on least-cost, market-based mechanisms, this approach is not strictly adhered to by the European Commission which often has a variety of objectives (e.g. environmental sustainability, security of supply, competiveness, innovation) and a

[10] http://www.investing.com/commodities/carbon-emissions-historical-data
[11] http://www.seai.ie/Publications/Statistics_Publications/Energy_Modelling_Group_Publications/The_Case_for_Sustainable_Energy.pdf
[12] https://www.iea.org/newsroom/news/2016/october/energy-efficient-prosperity-the-first-fuel-of-economic-development.html
[13] DCCAE, *Ireland's Transition to a Low Carbon Energy Future 2015- 2030*, 2015 http://www.dccae.gov.ie/energy/SiteCollectionDocuments/Energy-Initiatives/Energy%20White%20Paper%20-%20Dec%202015.pdf

reliance on traditional command and control techniques (e.g. specification of standards, technologies etc.).

> *The current approach of using a combination of policies – setting national targets for emissions in the non-ETS sectors and then using an ETS scheme for other sectors – has proved inefficient.*
>
> *Moving EU policy away from targets for renewables makes sense as the current regime has proved an expensive way of reducing greenhouse gas emissions. It would have been better if more funding had been put into research to develop cheaper renewable technologies and less into subsidising the deployment of existing expensive technologies. For the future, if an appropriate regime is implemented at EU level to incentivise a reduction in greenhouse gas emissions, this regime should, on its own, provide appropriate incentives to deploy renewable technologies. Then the market will decide on the cost-minimising way of meeting the objective of reducing greenhouse gas emissions.*[14]

Rather than targeting carbon emissions and allowing the market to devise least cost means of abating them, European policy often imposes a range of targets, pertaining to renewables, efficiency, heat, transport etc.

Under the European Union's energy and climate policies, Ireland has an extremely challenging, legally binding, target to reduce emissions in the non-ETS sector by 2020, along with a non-binding target to improve the energy efficiency of the economy. Given the limited options in reducing our emissions in non-ETS sectors such as agriculture, energy efficiency may be the optimal method of reaching these challenging targets. Within energy efficiency the two most important measures are renovating buildings, so that they require less energy to heat and light, and changing consumer behaviour to prioritise energy saving.

The buildings sector has been consistently identified as a major potential source of cost effective energy efficiency improvements at international level by bodies such as the IEA[15]. Based on the latest NEEAP, total savings from the buildings (excluding public sector buildings) to end of 2016 are

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[14] ESRI *Irish Energy Policy: An Analysis of Current Issues* https://www.esri.ie/publications/irish-energy-policy-an-analysis-of-current-issues/ (2014)

[15] C.f. IEA, *Transition to Sustainable Buildings, 2013*
IEA *Energy Technology Perspectives 2015, 2015*

estimated as 5,578 GWh. It is anticipated that with current policies and measures (at current programme expenditure levels), this could increase to 7,482 GWh by 2020. Despite these gains, it is anticipated (as per the latest National Energy Action Plan[16]) that Ireland's 20% efficiency target will not be met in 2020.

While such a 'command and control' approach to policy may not be favoured by economists, it is the policy which is in place. Within this framework, improving energy efficiency through improved efficiency in our housing stock is an effective means of meeting our targets.

Conclusion

Summarising the motivation underpinning the scheme, it is helpful to return to the Programme Logic Model which identifies 'objectives' as an indicator in assessing Rationale.

The scheme's **objectives**, to support homeowners to improve the energy performance of their homes, reduce energy use and greenhouse gas emissions, address **market failures** in the consumption/production of energy. They are also consistent with wider Government policy in the energy sector, which seeks to 'deliver deeper energy efficiency upgrades… to put the residential sector on a realistic trajectory to a low carbon energy future'[17] . On that basis, there appears to be a firm **rationale** for corrective action.

It is noted that wider Government policy is supportive of the Better Energy Homes Scheme. The Energy White Paper[18] includes a commitment to ensure that, 'by 2030, the Better Energy Programme delivers the number of deeper energy efficiency upgrades required to put the residential sector on a realistic trajectory to a low carbon energy future, maximising the 9,400GWh of energy saving potential that has been identified post 2020'. In addition, the Department of Communications, Climate Action and Environment is currently conducting a 'Warmth and Wellbeing' pilot which aims to make homes warmer and healthier by providing extensive energy efficiency upgrades to people in energy poverty who are living with chronic respiratory conditions[19].

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[16] National Energy Efficiency Action Plan for Ireland, 2017-2020
http://www.dccae.gov.ie/documents/NEEAP%204.pdf
[17] http://www.dccae.gov.ie/energy/SiteCollectionDocuments/Energy-Initiatives/Energy%20White%20Paper%20-%20Dec%202015.pdf
[18] http://www.dccae.gov.ie/energy/SiteCollectionDocuments/Energy-Initiatives/Energy%20White%20Paper%20-%20Dec%202015.pdf
[19] http://www.dccae.gov.ie/energy/en-ie/Energy-Efficiency/Pages/Warmth-and-Wellbeing-pilot-scheme.aspx

It should be noted, that the presence of market failure, noted above, is a necessary, not a sufficient condition for intervention. It is not a given that government action will not also be subject to failures (e.g. principal – agent problem)[20]. For this reason, any appraisal must move beyond an examination of rationale to evaluating the impacts of intervention.

[20] C.f. An Analysis of the Principal-Agent Problem Sanford J. Grossman and Oliver D. Hart Econometrica Vol. 51, No. 1 (Jan., 1983), pp. 7-45 http://www.jstor.org/stable/1912246

Impact

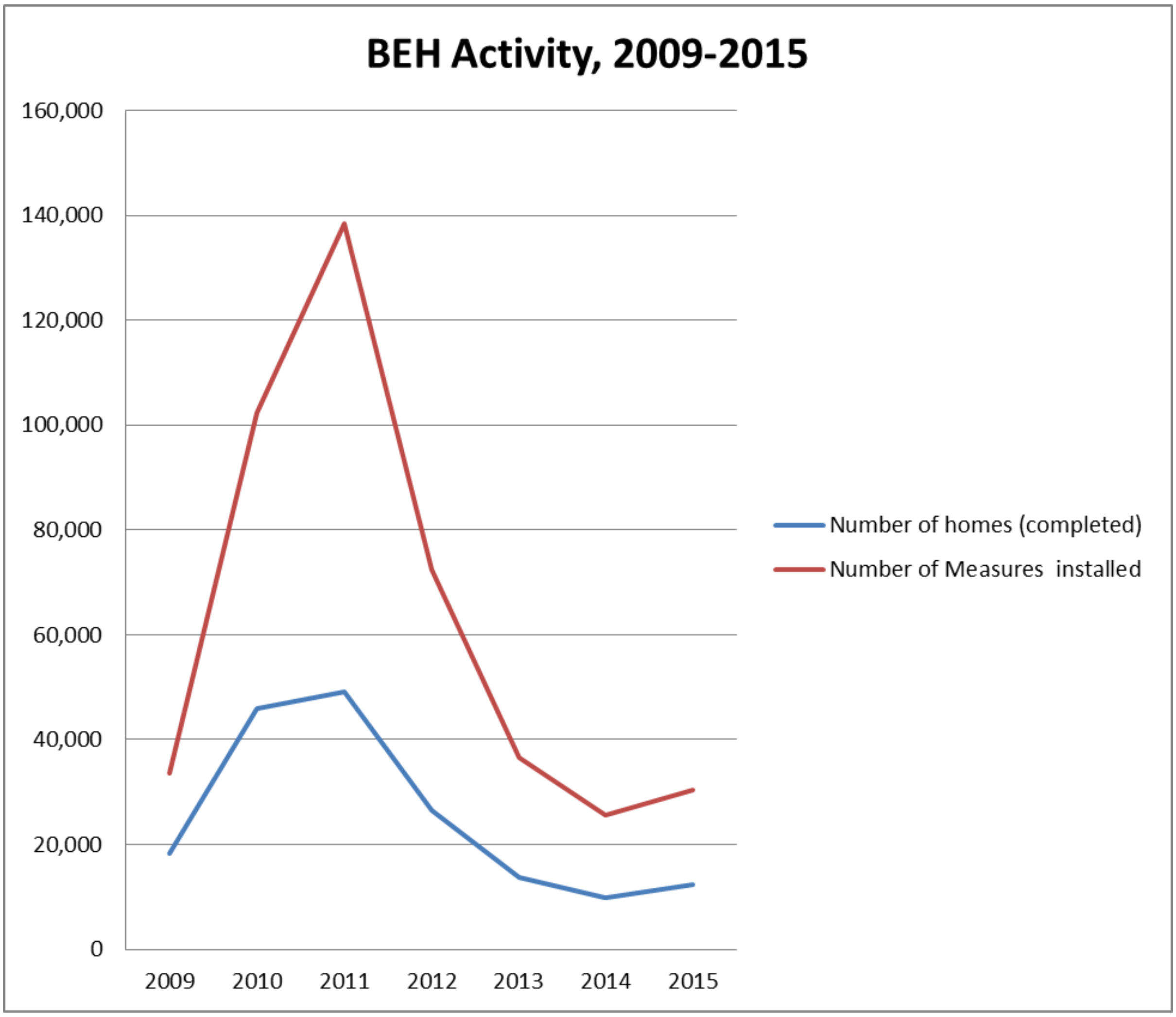
Department of Public Expenditure and Reform guidance suggests impact evaluation should focus on wider socio-economic effects (including the medium to long term impacts on target beneficiaries), the contribution of the programme to overall policy implementation and the influence on and of other policy frameworks[21].

The first step in assessing impact from the Better Energy Homes Scheme is to analyse the output. Figure 1, below, illustrates levels of activity, as measured by homes completed and measures installed. The highest level of activity took place in 2011 with approx 140,000 measures installed across approx 50,000 homes. Following this period, there was a sharp decline to approx 25,000 measures across approx 10,000 homes, in 2014. Despite a slight lag, this likely corresponds with developments in the wider economy[22] which underwent significant turbulence between 2009-2015. On average two or more measures were installed across each home over the period.

[21] C.f. Draft Value for Money Review (VFMR) and Focussed Policy Assessment (FPA) Guidelines, received from DPER, Sept 2016. See also: https://www.tcd.ie/Economics/assets/pdf/MScEPS/Economic%20Evaluation/EvaluationWeek2attachmentMCollins.pdf

[22] In terms of annual percentage change in national income, 2011 represented a nadir of the financial crisis with Δ-4%GNP http://www.cso.ie/multiquicktables/quickTables.aspx?id=n1502

Figure 1: Better Energy Homes Activity, 2009-2015[23]

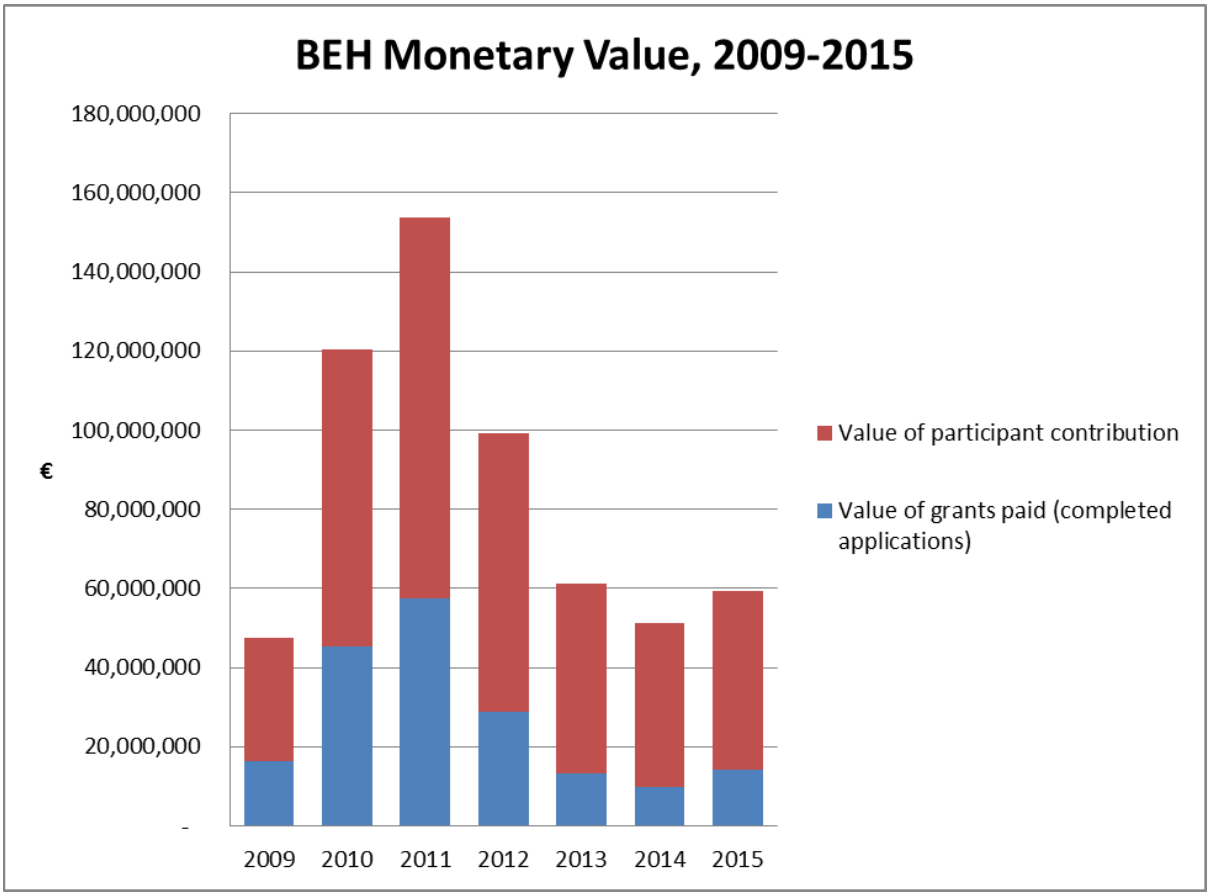


Unsurprisingly, the contraction in activity undertaken is mirrored by a decline in expenditure both in terms of grants paid out and householder contributions (see Figure 2, below).

In recent years, as the economy has improved, there may be some evidence of supply constraints entering the market. In 2009, the average cost (homeowner + grant) per measure was €1,415. By 2015, this had increased by 40% to €2,008. This aggregated figure may conceal compositional differences, however, particularly since the re-launch in 2015 which included more expensive measures (see Introduction, above). As such, it would be inappropriate to place undue emphasis on this increase.

[23] By way of context, the 2006 Census recorded 1,469,521 private households in the State: http://www.cso.ie/en/media/csoie/releasespublications/documents/statisticalyearbook/2007/Chapter_21_Housing_and_Househ...pdf

Figure 2: Better Energy Homes Monetary Value, 2009-2015



The data in Figure 2 give an indication of efficiency, by illustrating the level of output achieved for a given level of input. Efficiency, in terms of construction activity, is not our primary concern, however. As outlined above, the rationale for State intervention is not to support levels of activity in the construction sector[24]. Rather, it is to tackle market failures arising in energy production/consumption. On that basis, evidence of impacts in relation to health outcomes, energy security of supply and carbon abatement is required. The following section explores literature around the wider impacts associated with energy efficiency measures.

[24] Though the labour market impact of the scheme was highlighted in the Action Plans for Jobs process c.f. https://www.djei.ie/en/What-We-Do/Jobs-Workplace-and-Skills/Action-Plan-for-Jobs/

Energy Efficiency and Health Related Research

As outlined above, externalities in relation to human health may be present if housing stock is correlated to spending on healthcare. Recent research has illustrated the relationship between adequate heating levels and human health. Living in a cold and damp home has proven links with increased incidence of respiratory diseases, circulatory diseases, excess winter mortality and even poor mental health and general wellbeing.

Dr. Anne O'Farrell and Dr. Davida De La Harpe from the Health Intelligence Unit, HSE recently conducted a study to determine whether the excess in winter mortality and inpatient hospital emergency admissions among the elderly is continuing in recent years 2005-2010. They also set out to describe the causes of death and reasons for hospital in-patient admissions among the elderly in winter months versus summer months.

The method involved assessing the following:

- Persons aged ≥65 years who died in Ireland in winter months (i.e.Nov-Jan) versus summer months (i.e. May-Jul). This data was extracted from the CSO for years 2005-2009.
- Patients aged ≥65 years who were admitted to acute hospitals as emergency admissions during winter months versus summer months. This data was extracted from HIPE database.

Below is a summary list of the results of the study:

- There is an average of 650 excess deaths per year in elderly people during winter compared to summer.
- 1,223 excess deaths in elderly people due to respiratory diseases in winter versus summer months over the 5 year study period.
- 1,770 excess deaths in elderly people due to circulatory diseases in winter versus summer months over the 5 year study period.

A British Medical Journal article *'Effect of insulating existing houses on health inequality: cluster randomised study in the community*[25]*'* published in 2007 found that "insulating houses led to a significantly warmer, drier indoor environment and resulted in improved self-rated health, self-reported wheezing, days off school and work, and visits to general practitioners as well as a trend for fewer hospital admissions for respiratory conditions."

An article published by the Lancet, in 1997, asserts: *'Cold exposure and winter mortality from ischaemic heart disease, cerebrovascular disease, respiratory disease, and all causes in warm and cold regions of*

[25] http://www.bmj.com/content/334/7591/460

Europe' found that "mortality increased to a greater extent with given fall of temperature in regions with warm winters, in populations with cooler homes, and among people who wore fewer clothes and were less active outdoors[26]."

Results from a programme, entitled Warm Up New Zealand: Heat Smart Scheme, may be informative. This was a Government funded programme that began in 2009 and provided funding for insulation, retrofits and clean, efficient heating grants for New Zealand households. It involved a $340m investment.

In 2010 a cost benefit analysis of the Warm Up New Zealand project found the following:

- The present value of the health benefits spread over the duration of those benefits (30 years for insulation and 10 years for clean heat) was estimated to be $1,263m
- Patients with circulatory conditions who took part in the programme showed a significant improvement in mortality rates[27].

In light of the evidence above, it would seem highly likely that the improvement in housing stock, through the Better Energy Homes scheme, has led to improved health outcomes. Given the timescales and data involved, however, it has not been possible to establish this causal link. SEAI data is available, however, on energy efficiency improvements. This demonstrates that Better Energy Homes expenditure has led to efficiency improvements of GWh cumulatively over the period covered.

Energy Efficiency and Security of Supply

Increased energy security is a commonly cited economy-wide benefit of energy conservation and efficiency, and warrants mention in the context of macroeconomic benefits. Energy security is defined by the IEA as "the uninterrupted physical availability of energy at a price which is affordable, while respecting environmental concerns."[28]

The IEA model of short-term security and those presented by others (Cherp and Jewell, 2011; Scheepers et al., 2007) consider three aspects of energy security: robustness (adequacy and reliability of resources and infrastructure); sovereignty (the degree of exposure to threats from

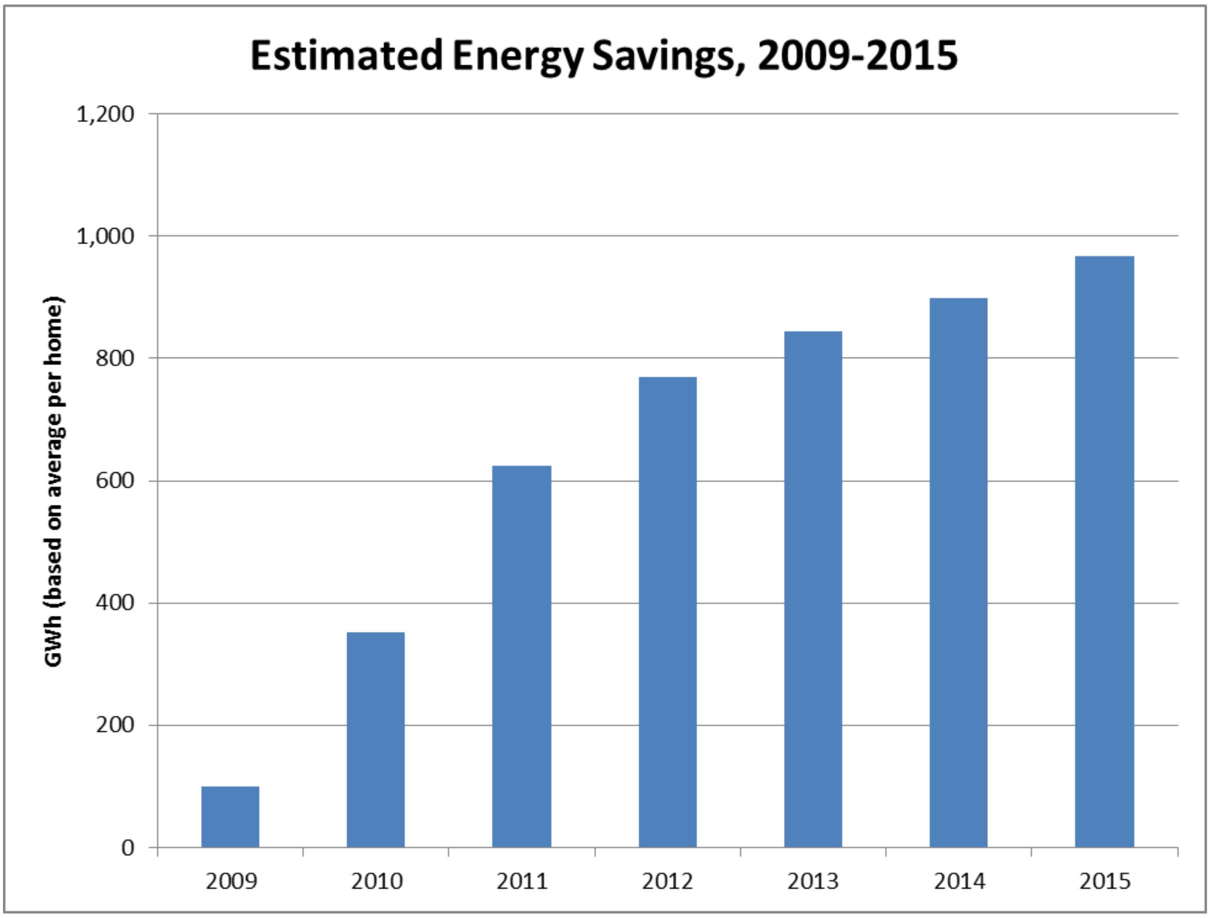
[26] http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(96)12338-2/abstract
[27] http://www.healthyhousing.org.nz/wp-content/uploads/2012/05/NZIF_CBA_report-Final-Revised-0612.pdf
[28] https://www.iea.org/publications/freepublications/publication/moses_paper.pdf

foreign actors); and resilience (ability to respond to diverse disruptions). Energy efficiency models tend to calculate energy imports as an output and therefore focus on sovereignty and resilience.

Many studies modelling energy efficiency measures include energy security as a key rationale for investing in energy efficiency. However, there are few examples where more analysis is carried out. It is simply assumed that any reduction in energy demand will improve a country's energy security. While this is true generally, analysis needs to be undertaken in each case to understand which energy fuels are likely to be saved through energy efficiency measures, as energy security is likely to improve mainly when non-domestic energy sources are affected.[29]

Figure 3, below, illustrates estimated energy savings arising from BEH measures implemented. The trend is continually positive representign the cumulative nature of the savings achieved (i.e. savings in 2009 are achieved again in 2010 and added to savings in that year).

Figure 3: Better Energy Homes, Energy Savings



[29] https://www.iea.org/publications/freepublications/publication/Captur_the_MultiplBenef_ofEnergyEficiency.pdf

Carbon savings

As well as energy savings, an additional benefit of improved energy efficiency is a reduction in carbon emissions. In order to measure these, energy savings (after comfort take up) are converted into carbon savings, using an emission factor for CO_2 in tonnes per GWh PEE[30]. Emission factors are calculated based on a fuel mix of 95% heating fuels (45% gas, 45% oil and 5% peat) and 5% electricity. The emission factor for electricity during the project lifetime is adjusted to take into account the change in fuel mix used in electricity generation (i.e. greater uptake in renewables), and efficiency improvements in the plant used for electricity generation.

Two options are available to monetise the carbon savings: the market price for carbon, and the Shadow Price of Carbon (SPC[31]). Market prices for carbon (both spot and future) in the EU Emissions Trading Scheme are readily available.

To date, the UK is the only country to have developed a methodology for estimating the SPC. The Department for Environment, Food and Rural Affairs (Defra) UK estimated the SPC as £26 per tonne CO_2 in 2008 prices[32], with the SPC in future years subject to an annual 2% increase on the 2008 price[33]. This estimate is not country-specific, but is effectively a global estimate of the damage costs of one extra tonne of CO_2 under assumptions on the trajectory needed to stabilise atmospheric concentrations at 550ppm.

Figure 4, below illustrates the CO_2 saving estimated between 2009-2015. As with energy savings (see Figure 3, above), the trend is monotonic representing the cumulative nature of the savings.

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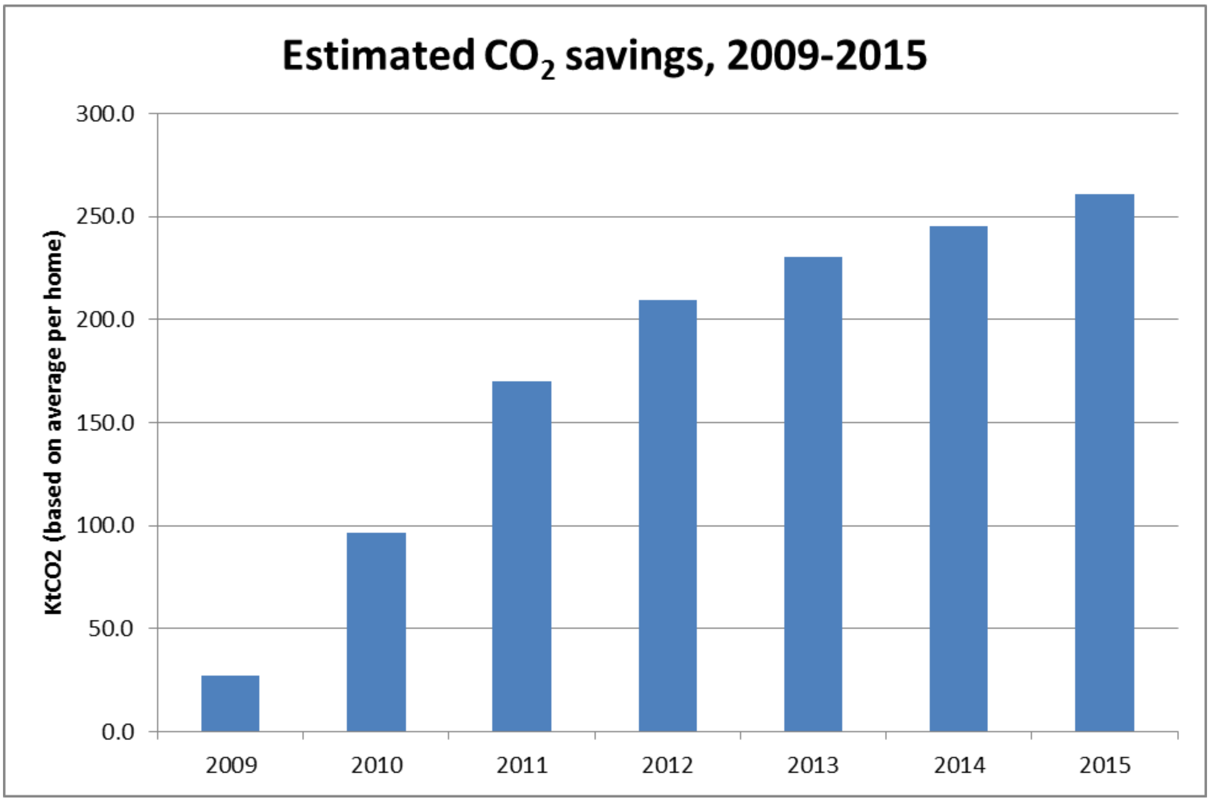
[30] Emission factors have been calculated by the Ireland Energy Policy Statistical Support Unit (EPSSU).

[31] http://www.defra.gov.uk/ENVIRONMENT/climatechange/research/carboncost/

[32] Equivalent to €32.68 based on an exchange rate of £1 to €1.26 (average exchange rate in 2008). http://www.ecb.int/stats/exchange/eurofxref/html/eurofxref-graph-gbp.en.html

[33] The 2% increase reflects the fact that the concentration of CO_2 in the atmosphere is rising annually before stabilisation at the target of 550ppm $C0_2e$. It is not an inflationary adjustment.

Figure 4: Better Energy Homes, CO_2 savings



Other air pollutant gas savings

A reduction in energy use also results in a reduction in other gases associated with fuel combustion, namely NOx, SOx, VOCs and Particulate Matter. The Be-Ta-Method-Ex[34] tool, developed for the European Commission, is used to provide the damage costs (to core health and crops) of each pollutant gas in Ireland. An average of the low and high CAFÉ/WHO[35] damage costs from this tool is applied. Average emission factors for gas, oil and solid fuel for these gases are based on Environmental Protection Agency Ireland (unpublished) data. The emission factors for electricity are derived using European Environment Agency data for Ireland to determine total emissions and SEAI data for the total electricity generated[36]. As with carbon savings, energy savings (after adjustment for comfort take-up) can be used to calculate these savings.

[34] The Be-Ta-Method-Ex tool (v2 released in February 2007) was developed for the European Commission DG Research http://www.methodex.org/BeTa-Methodex%20v2.xls
[35] CAFÉ (Clean Air For Europe) and WHO (World Health Organization)
[36] http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=1058 and http://www.sei.ie/Publications/Statistics_Publications/Energy_in_Ireland/Energy_in_Ireland_1990-2007.html

High level cost-benefit analysis

Figure 5: Better Energy Homes Impact w.r.t. Energy Savings & CO_2 Abatement

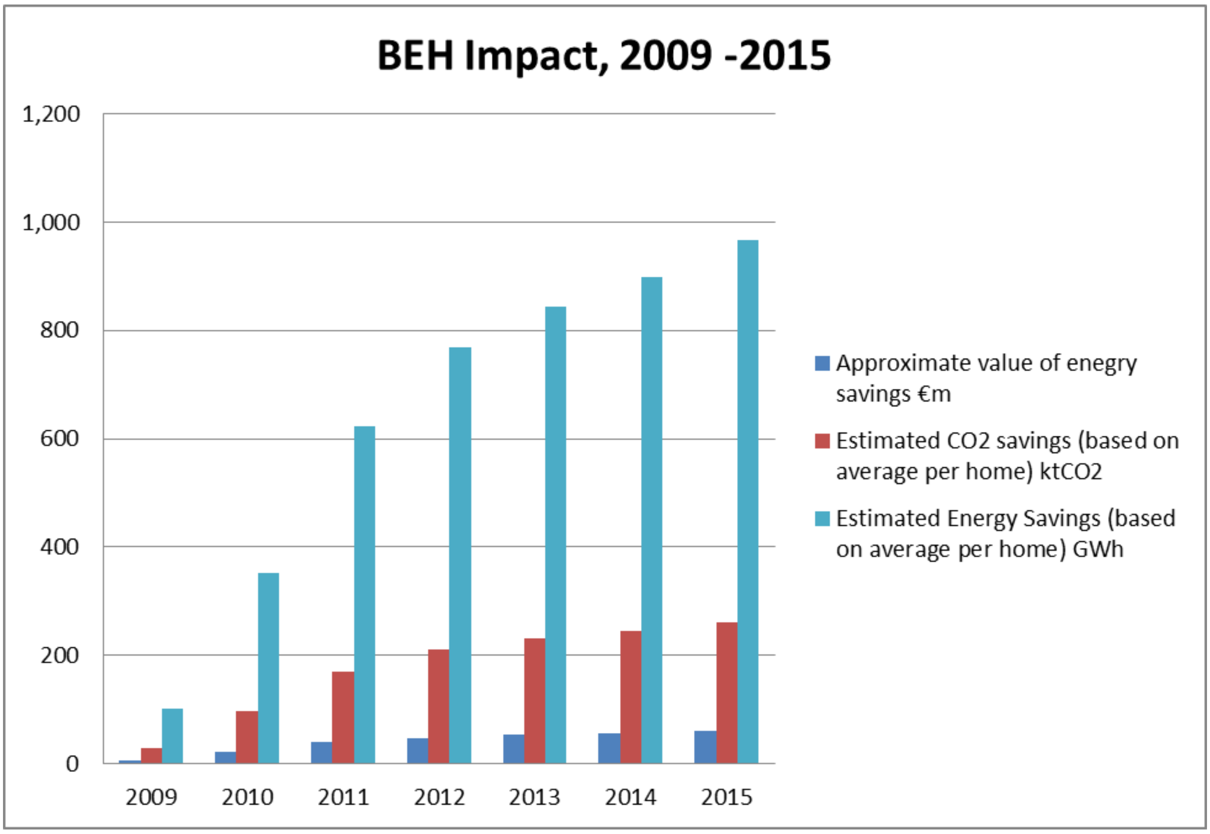


Figure 5, above, measures each three of the outputs arising from the BEH scheme. The Y axis, however, does not display constant units: efficiency and carbon abatement are measured in GWh and $KtCO_2$ respectively, while energy savings are measured in €. In order to evaluate the composite benefits, it is necessary to convert these into a common unit. This can be done by calculating a monetary value for the externalities associated with energy savings and CO_2 abatement.

The fact that costs tend to be paid up front, while benefits are derived over time, adds a small degree of additional complexity to the calculation of net benefits. For this reason, a discount rate is applied: 'The discount rate is used to convert costs and benefits to present values to reflect the principle of time preference.'[37]

A high-level cost benefit analysis is undertaken below. As outlined above, established methodologies are in place for undertaking this calculation in respect of CO_2. An indicative value of €20 per tonne of CO_2 abated is applied. This is in line with Ireland's carbon tax. Fuel savings area also incorporated in

[37] http://publicspendingcode.per.gov.ie/wp-content/uploads/2012/09/The-VFm-Code-except-D-03-Print-Version.pdf

line with SEAI estimates. It is important to note that, while health and security of supply benefits have been discussed qualitatively, they are not included in the quantitative analysis below[38]. Based on the assumptions applied, the CBA indicators of net present value, benefit to cost ratio and internal rate of return are all significantly positive (see table 3, below).

Table 3: CBA Summary Results

CBA Indicators	
PVC	562,154,173
PVB	785,740,525
NPV	223,586,352
BCR	1.40
IRR	10%

In performing a sensitivity analysis, based on the above assumptions, a reduction in benefits by 30% would eliminate these net positive benefits. On the upside, increasing benefits to incorporate health and security of supply benefits would deliver a significantly stronger return on investment.

It should be noted that some uncertainty may be present over Ireland's future efficiency targets. It is important to emphasise, however, that the risks associated with climate change are asymmetric. To expand upon this point it is helpful to define, what are known in statistics as, type I and II errors. A Type I error is the incorrect rejection of a true null hypothesis (false positive). A type II error is the failure to reject a false null hypothesis (false negative). The cost to Ireland (or the globe) of investing in technologies which mitigate a problem which fails to materialise, is likely to be significantly less than the cost of failing to mitigate a problem which materialises. As such, we may conclude that, in the presence of uncertainty, a Type I error is preferable to a Type II error. Hence, interventions, such the Better Energy Homes Scheme may be said to be prudent.

While the results above present a net positive, the aggregated data conceals differing levels of performance for different measures. In its review of SEAI retrofits, the ESRI found: 'retrofits including solid wall insulation or solar collection units provide a much lower net benefit and are more costly to the grant provider'[39].

[38] It should also be noted that results will differ from those incorporated in the 2017 Estimates process due to differences in methodology (e.g. the incorporation of the shadow price of public funds, real TDR of 5%, simplified assumptions in relation to constant 2009 prices, exclusion of health benefits, exchequer cashflow impacts).

[39] Collins & Curtis Collins & Curtis *Value for money in energy efficiency retrofits in Ireland: grant provider and grant recipients,* in Applied Economics, 2017

In order to address this issue and improve value for money more generally, it is helpful to provide a direct link between incentives and desired outcomes. The ESRI recommends examining 'the potential to award grant aid based on the energy efficiency improvement gained'[40]. This recommendation is supported. It should be noted, however, that such an approach could have unintended consequences. These could include increased transaction costs, manipulation of BER results, urban – rural differentials resulting from differences in housing stock and ownership. For this reason, more work is needed before a stronger recommendation can be made.

Conclusion

SEAI tracks **outputs** from its scheme and provides clear data of measures installed, houses completed, money spent etc. Moving beyond this to examine **results**, estimates were also provided in respect of carbon abated and energy efficiency improvements.

The literature cited above, in respect of benefits associated with increased security of supply, improved health outcomes and reduced carbon emissions, provides qualitative evidence in support of Better Energy Homes' **outcomes**. This evidence is bolstered by the high-level quantitative analysis (summarised in Table 3, above) which suggested that, given certain assumptions, **impacts** would deliver a positive return on the intervention. Furthermore, the risk profile associated with action and inaction supports intervention.

In order to improve impact, it is recommended that a more direct link between expenditure and energy efficiency improvement, be explored. It is noted that such an approach has the potential negative unintended consequences which imply further work is needed.

To better understand energy efficiency interventions in relation to security of supply and health outcomes, it is also recommended that data on health impacts is collected and that improved metrics for measuring security of supply are developed.

[40] Collins & Curtis Collins & Curtis *Value for money in energy efficiency retrofits in Ireland: grant provider and grant recipients,* in Applied Economics, 2017

Conclusions/Recommendations

The Focussed Policy Assessment examined the performance of SEAI's Better Energy Homes Scheme under the criteria of 'Rationale' and 'Impact'.

Under the Rationale metrics, the review concludes that the scheme's **objectives**, to support homeowners improve the energy performance, reduce energy use and greenhouse gas emissions, address clear **market failures** in the consumption/production of energy. They are also consistent with wider Government policy in the energy sector, which 'seek to deliver deeper energy efficiency upgrades… to put the residential sector on a realistic trajectory to a low carbon energy future'[41] . This would appear to provide a firm **rationale** for government intervention.

It was noted that this rationale represents a necessary, not a sufficient, condition for intervention. *A priori*, it is not possible to determine that government failure will not be as great, or greater than, market failure. For this reason, it is critical to examine impacts.

Under the Impact metrics, it was found that, SEAI tracks **outputs** from its scheme and provides clear data in respect of measures installed, houses completed, money spent etc. As to the **results** of these outputs, SEAI also estimates carbon abatement and energy efficiency improvements.

A high level costs benefit analysis estimated that, given certain assumptions on monetising externalities (in the form of carbon abated), these **impacts** generate a positive return on investment. This was bolstered by the risk profile associated with action and inaction, indicating the prudential nature of intervention.

In order to improve impact, it is recommended that a more direct link between expenditure and energy efficiency improvement, be explored. This could take the form of a grant related to BER improvement rather than specific measure per dwelling type. It is noted that such an approach has the potential negative unintended consequences which imply further work is needed.

In order to better understand energy efficiency interventions in relation to security and health **outcomes**, it is also recommended that data on health impacts is collected and that improved metrics for measuring security of supply are developed.

[41] http://www.dccae.gov.ie/energy/SiteCollectionDocuments/Energy-Initiatives/Energy%20White%20Paper%20-%20Dec%202015.pdf

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http://neweconomists.org/files/Behaviour_and_Energy.pdf

Appendix – CBA Calculations[42]

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Costs																											
Exchequer	16,254,779	45,207,885	57,596,324	28,949,749	13,158,770	9,914,693	14,326,468																				
SPPF Exchequer	21,131,213	58,770,251	74,875,221	37,634,674	17,106,401	12,889,100	18,624,408																				
Householder	31,125,320	75,066,262	96,127,897	70,191,109	48,084,188	41,262,624	45,071,925																				
Total Costs (current)	52,256,533	133,836,513	171,003,118	107,825,783	65,190,589	54,151,725	63,696,333																				
CPI Index	1.0000	0.9900	1.0157	1.0330	1.0382	1.0402	1.0371																				
Costs (2009)	52,256,533	135,188,396	168,353,238	104,380,437	62,793,593	52,056,504	61,416,064																				
Benefits																											
CO2	546,090	1,924,470	3,401,550	4,194,330	4,605,630	4,903,440	5,213,440	5,213,440	5,213,440	5,213,440	5,213,440	5,213,440	5,213,440	5,213,440	5,213,440	5,213,440	5,213,440	5,213,440	5,213,440	5,213,440	5,213,440	4,667,350	3,288,970	1,811,890	1,019,110	607,810	310,000
Health benefits	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
€ savings	6,000,000	22,000,000	38,999,530	45,928,334	52,857,138	56,284,596	60,544,596	60,544,596	60,544,596	60,544,596	60,544,596	60,544,596	60,544,596	60,544,596	60,544,596	60,544,596	60,544,596	60,544,596	60,544,596	60,544,596	60,544,596	54,544,596	38,544,596	21,545,066	14,616,262	7,687,458	4,260,000
Additional Benefits	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Benefits (Current)	6,546,090	23,924,470	42,401,080	50,122,664	57,462,768	61,188,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	59,211,946	41,833,566	23,356,956	15,635,372	8,295,268	4,570,000
Total Benefits (2009)	6,546,090	24,166,131	41,744,029	48,521,100	55,349,916	58,820,569	63,403,960	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	59,211,946	41,833,566	23,356,956	15,635,372	8,295,268	4,570,000
Net Benefits	-45,710,443	-111,022,265	-126,609,209	-55,859,337	-7,443,677	6,764,065	1,987,896	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	65,758,036	59,211,946	41,833,566	23,356,956	15,635,372	8,295,268	4,570,000
NPV	-45,710,443	-105,735,491	-114,838,285	-48,253,396	-6,123,931	5,299,822	1,483,398	46,733,008	44,507,627	42,388,216	40,369,730	38,447,362	36,616,535	34,872,890	33,212,277	31,630,740	30,124,514	28,690,013	27,323,822	26,022,688	24,783,512	21,253,676	14,300,799	7,604,355	4,848,027	2,449,616	1,285,270

[42] This high level CBA makes a number of simplifying assumptions: Health and security of supply benefits are not included nor are exchequer impacts to VAT, Corporation Tax etc. Constant real (2009) fuel prices are also assumed.