SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Economic Analysis of Residential and Small-Business Energy Efficiency Improvements

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Foreword

For the past number of years, SEAI has been supporting householders and businesses to shift to more sustainable energy use. We provide advice, mentoring, training, standards development and financial supports to a broad range of energy users. These supports are delivering continuing financial savings through energy efficiency together with many important co-benefits. For example, improved insulation and more efficient heating supply are increasing comfort levels in our homes, and strategic energy management is increasing the competitiveness of our businesses. Further, the work undertaken to deliver these improvements is supporting jobs and providing environmental benefits through reduced emissions.

A key outcome of the Government programmes promoting energy efficiency and renewable energy is to develop new markets for sustainable energy goods and services, both within Ireland and potentially for application abroad. We have seen already strong development in Ireland of the markets for energy efficiency and renewable energy products and services; currently, more than 4,000 registered service providers are associated with the delivery of SEAI programmes to the residential and business sectors, representing a substantial increase over the last three to four years.

Evaluating our progress in achieving energy savings and deploying low and zero carbon energy sources is a key component of delivering sustainable energy policy. The analyses described in this paper form an important part of this evaluation and demonstrate the significant economic returns available from investments in energy efficiency in the residential and business sectors. Importantly, these investments both save money for the consumer, and reduce carbon emissions to the benefit of society as a whole.

Prof J Owen Lewis
Chief Executive
Sustainable Energy Authority of Ireland

Summary of main results

This report presents an economic evaluation of energy efficiency improvements made in the residential and small-business sectors via SEAI's Home Energy Saving (HES) scheme and Small and Medium Enterprise (SME) Programme. The results are based on best available data, including that collected by SEAI during programme delivery. The results illustrate the substantial savings available in the residential and business sectors through deployment of sustainable energy technologies and strategic energy management.

Key findings

Home Energy Saving (HES) scheme

The HES scheme provided financial support to households for energy efficiency upgrades to mid 2011 after which it was incorporated in to the recently launched Better Energy Homes scheme. Over 100,000 homes have been upgraded with a combination of improved insulation, high effiency boilers and heating controls through these schemes since 2009.

The scheme has a net benefit to society for all energy and CO_2 price scenarios, ranging from €106m (low CO_2 and energy prices) to €518m. In other words, the scheme saves society substantially more than it costs (in net present value terms). Every euro spent on the programme by SEAI delivers a net benefit of five euro to society, through energy, CO_2 and other pollutant savings.

Participating households are expected to save an average of €450 per annum on energy bills. The total investment on upgrades for improved energy efficiency is expected to be paid back in around eight years. CO_2 emissions reductions of approximately 1.5 tonnes per dwelling are achieved due to reduced consumption of fossil fuels, at a net benefit to society of between €92 and €118 per tonne abated.

Over 3,000 full time jobs in the construction and related sectors were supported by the scheme in 2010. Other potential co-benefits are also generated for participating households, including potential for improved comfort and health.

Small and Medium Enterprise (SME) Programme.

The SME Programme delivers assessments, advice, mentoring and training services to SMEs to help them reduce energy use and cut costs.

After all programme and investment costs are taken in to account, a net benefit to society increasing from €162 million in 2020 to €386 million in 2030 is estimated for the scheme when the lifetime of savings measures is included. Every euro spent by SEAI via the programme delivers a net benefit to society of €15 to 2020, and €33 to 2030.

The present value of CO_2 and other emissions abated is €40 million in 2020 and over €80 million in 2030. It is estimated that almost 1,800 kt of CO_2 (cumulative) will be abated to 2030 at a net benefit to society of around €200 per tonne.

Since 2007 the programme has supported over 1,470 companies employing the equivalent of approximately 130,000 full-time staff. Average business savings in the first year are 10%.

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Introduction and non-technical summary

The Sustainable Energy Authority of Ireland (SEAI) delivers a number of programmes on behalf of Government to achieve energy efficiency improvements and emissions reductions across the main energy using sectors of the Irish economy. This includes providing advice, mentoring and training, developing standards, and providing financial supports to a broad range of energy users.

Substantial benefits are being realised. Householders and businesses are saving money by reducing energy bills – often through measures with very short payback periods. In addition to continuing financial savings, many important co-benefits are available. These include improved comfort in homes, improved business competitiveness, support for employment in the energy and construction sectors, and environmental benefits through reduced emissions.

In developing sustainable energy policy, it is essential to assess the potential of different schemes, measure progress along the way, and consider the costs and benefits of a programme. The results provide a clear evidence base from which to make future policy decisions.

Cost Benefit Analysis (CBA) is a useful tool for assessing proposed and existing government policies. Consideration of direct costs and benefits together with so-called externalities – such as the societal costs associated with air pollution, for example – can provide valuable insights to enable programme prioritisation, and identification of the optimum choice from a social point of view. This is important because energy, environment and economy systems are highly entwined; changes in one part of the system can have important repercussions elsewhere. CBA attempts to explicitly capture these links, allowing the policymaker to explore trade-offs and knock-on effects in ways that private investment decision analysis does not generally permit. (Further detail on CBA methodology and application is provided in Box 1 on page 10.)

SEAI has developed a number of CBAs in key areas to support decision making in Ireland. The case studies presented in this report provide examples of the substantial savings available in the residential and business sectors through deployment of sustainable energy technologies and strategic energy management.

The analyses presented here provide an economic evaluation of energy efficiency upgrades made in the residential and small-business sectors via the following two SEAI programmes:

- ➔ the **Home Energy Saving (HES) scheme**
- ➔ the **Small and Medium Enterprise (SME) Programme.**

'Better Energy – The National Upgrade Programme', was launched by the Minister for Communications, Energy & Natural Resources on 11th May 2011 under the Government's Jobs Initiative. This new programme aims to deliver a major increase in the pace, scale and depth of sustainable energy investments in upgrading existing buildings and facilities.

'Better Energy Homes' has brought together the HES, Warmer Homes, and Greener Homes schemes to provide ongoing financial support to homeowners to implement upgrades for energy efficiency and renewable energy. The 'Better Energy Workplaces' scheme has provided financial support for implementing a wide range of qualifying sustainable energy upgrading projects in the, public, commercial, industrial and community sectors in 2011.

Key findings

The key findings for the policy measures analysed highlight the strong financial benefits to society that investments in improved energy efficiency bring. For both the HES scheme and the SME programme, measures delivered will save more than they cost over their lifetime – as indicated by a positive net present value (NPV).[1] These analyses take into account the costs and benefits of each programme and include monetary values for expected energy savings and CO_2 and other greenhouse gas (GHG) emissions reductions.

Home Energy Saving (HES) scheme

The HES scheme delivers energy efficiency upgrades to dwellings, including wall and roof insulation, high-efficiency boilers and heating controls.[2] Investments in household upgrades for energy efficiency made between 2008 and 2010 through the scheme are expected to be fully repaid through energy savings within around eight years; after this, a net saving to the economy accrues every year for the lifetime of the measures installed.

- ➔ Total scheme cost 2008–2010: €62.8 million
- ➔ NPV range estimate: €222 million to €285[3]
- ➔ Savings to the economy per tonne of carbon abated: €92 – €118.

Small and Medium Enterprise (SME) Programme

Energy assessments, advice and mentoring provided to SEAI's SME programme participants lead routinely to 10% energy savings in the first year of interaction. The value of energy, CO_2 and other pollutant savings significantly outweighs the cost of investments to achieve them, leading to a strong net return to participants and society over time.

- ➔ Total estimated scheme costs: €12 million
- ➔ NPV range estimate: €162 million (2020) to €386 million (2030)
- ➔ Savings to the economy per tonne of carbon abated: €200.

These results reflect the findings of a growing body of literature on the benefits of energy efficiency investments, including, for example, Ireland's Low Carbon Opportunity.[4] Energy efficiency investments are now widely regarded as the most cost-effective way to achieve carbon savings. This analysis suggests that a net financial saving per tonne of carbon abated is available to society via the investments made to improve energy efficiency; a result that flows from the lifetime reduction in energy costs of scheme participants.

SEAI continues to monitor the uptake of its programmes closely, together with changes in the markets for the goods and services it supports. It is not the Government's intention to directly grant-aid energy efficiency upgrades over the long term. Rather, the Government's role is to promote their benefits ahead of any broad scale market driven uptake, sufficient for Ireland to reap the full benefit of the financial gains available on the way to meeting our energy and emissions targets.[5] In certain cases, the Government's expenditure on its support programmes can be recouped, at least to some degree – for example, through increased corporation tax on company profits (flowing from energy savings), and on the basis of the value of emissions saved.

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1 NPV is defined as the present value of an investment's future net cash-flows minus the initial investment. It takes into account the time value of money by applying a discount rate to future cash-flows.

2 The HES scheme has since been incorporated into the Better Energy Homes scheme **http://www.seai.ie/Grants/Better_energy_homes/** This analysis considers upgrades delivered through the HES scheme only to the end of 2010.

3 The extreme NPV range of €106 million to €518 million represents low and high fuel price sensitivities.

4 **http://www.seai.ie/Publications/Low_Carbon_Opportunity_Study/Irelands_Low-Carbon_Opportunity.pdf**

5 The latest government initiative to shift towards a more complete market-based delivery system for upgrades is detailed in a public consultation on a National Retrofit Programme to encompass the residential, business and public sectors: **http://www.dcenr.gov.ie/Press+Releases/Public+Consultation+on+National+Retrofit+Programme+begins.html**

Cost Benefit Analysis (CBA)

CBA is a tool to aid consideration of a policy decision (from the public perspective) or an investment decision (from the private perspective). When a CBA is carried out from a public perspective, it is called a **Social Cost Benefit Analysis.**

CBA requires comparing the upfront investment needs with the monetised flows of costs and benefits over a period of time. To make a meaningful comparison of the initial investment with the flow of costs and benefits taking place in the future, these costs and benefits have to be discounted using an appropriate discount rate.[6] The final result of a CBA is a **net present value (NPV)**. A **negative NPV** means that costs exceed benefits, indicating that the policy or investment decision may not be viable without some further analysis of potential non-monetised benefits. Conversely, a **positive NPV** means that the costs are less than the benefits generated, and the initiative brings a financial advantage.

From a public perspective (e.g. government decisions), a CBA seeks to account also for those goods and services for which a market – and a price – does not exist. These are the so-called **negative and positive externalities** (e.g. energy security, air pollution, human health, global warming). When these externalities are 'internalised' it is possible to determine the socially optimal level of services and goods to be provided.

Conversely, private investors are commonly focused on the maximisation of profits. Therefore, the CBA performed for private investment decisions accounts only for those goods and services for which a market, and consequently a price, exists. This type of analysis aims to determine whether the net cash-flow generated by the upfront investment is positive or negative in present value terms.

A CBA can also be conducted from the Exchequer perspective. In this case, the analysis aims at identifying the degree to which public disbursement (i.e. the introduction of a subsidy mechanism) is compensated (or otherwise) by additional tax revenues.

As a consequence, the same policy option may have a positive NPV for the directly affected sectors (e.g. households, small and medium enterprises), while reducing the tax revenues for the Government or the Exchequer. Yet the aim of a social CBA is to assess whether the net costs for a specific sector of the economy are compensated for by the additional benefits generated for society as a whole.

The results of CBA do not provide the only basis for policy assessment and selection. These analyses need to be considered together with qualitative analysis of other costs and benefits not monetised in these calculations. In the context of energy policy, these might include potential job creation, improved business competitiveness, increased comfort and potential health improvements.

6 A discount rate of 4% consistent with current Department of Finance guidelines is applied. See: **http://www.finance.gov.ie/viewdoc.asp?DocID=5387**

The analyses presented are undertaken using the current government guidelines on cost-benefit analysis. The following sources of data and guidelines are considered:

- Up-to-date energy costs are used to calculate the value of energy savings based on SEAI fuel cost comparison sheets for the domestic and commercial sectors[7] and latest price projections developed as part of the SEAI forecasting process[8]
- The value of CO_2 savings is based on Department of Finance guidelines on incorporating CO_2 emissions into capital project appraisals (June, 2009)[9]
- The value of savings of other pollutant gases is based on the BeTa-MethodEx tool developed for the European Commission DG Research.[10]

While every attempt is made to model the expected future programme impacts as closely as possible, a number of factors could affect the assumptions made. To deal with this uncertainty, sensitivity analyses are conducted to investigate the impact of varying key assumptions such as fuel and carbon price over time – thus producing a range of possible outcomes.

The Energy Modelling Group (EMG) at SEAI is continuing to develop this type of analysis for other current and potential future government policies and measures. Future publications will provide in-depth analyses of proposed new initiatives such as the Government's National Retrofit Scheme. Further ex post assessments of government energy policy will be made, based on a range of monitoring and evaluation projects currently under way.

Feedback on the analyses presented in this document is welcome. You can contact the SEAI's Energy Modelling Group (EMG) directly at **emg@seai.ie**.

7 Available at **http://www.seai.ie/Publications/Statistics_Publications/Fuel_Cost_Comparison/**

8 See **http://www.seai.ie/Publications/Statistics_Publications/Energy_Modelling_Group/Energy_Forecasts_2010.html** for the latest forecast report.

9 **http://www.finance.gov.ie/documents/guidelines/co$_2$capapprais.pdf**

10 **http://www.methodex.org/BeTa-Methodex%20v2.xls** (version 2 released in February 2007)

Evaluation of residential energy efficiency upgrades

1.1 Background

The following analysis considers the costs and benefits of residential energy efficiency upgrades undertaken via the Home Energy Saving (HES) scheme. The results demonstrate the substantial net lifetime savings available from retrofitting existing homes for improved energy efficiency.

The HES scheme provides grants to householders for retrofitting energy efficient technologies. It is open to owners of dwellings built before 2006. Its primary objective is to lower fuel bills for households through reduced energy consumption for home heating. Additional objectives are to reduce GHG and other air pollutant emissions. Technologies supported are roof/loft insulation, wall insulation (cavity, internal and external), and high efficiency boilers and heating controls.[11]

The HES scheme also aims to encourage the development of a market for energy efficient products and services in the residential sector, bringing benefits that will persist beyond the lifetime of the programme. Savings achieved through the scheme will contribute strongly towards the targets for energy efficiency as detailed in the National Energy Efficiency Action Plan (May 2009).[12]

This analysis is based on data collected from actual project roll-out. In this context the evaluation is considered ***ex post***; that is, based on past events.[13] The advantage of this type of analysis is that many of the variables in the calculation are based on actual data collected by SEAI during delivery of the scheme. This includes annualised data for:

- number and value of grants paid
- number of installed measures for each technology
- total cost of energy efficiency upgrades (public and private spend)
- dwelling types of participants
- assessment of non-grant programme costs.

Assumptions are made in terms of the energy, CO_2 and other pollutant savings per measure installed.[14] These are based on before-and-after Building Energy Rating (BER) data from the 2008 HES pilot and calibrated with extended BER modelling undertaken by SEAI. The budgetary allocation is based on actual grant spend in a given year. Upgrades made during the pilot phase in 2008 and the first two full years of the HES scheme rollout during 2009 and 2010 are taken into account.

11 A comprehensive description of the scheme and the online application facility is available at **http://www.seai.ie/Grants/Home_Energy_Saving_Scheme/**

12 Refer to Ireland's National Energy Efficiency Action Plan 2009–2020 for the contribution of individual actions towards targets.

13 This contrasts with ex ante (before the fact).

14 A future analysis will incorporate the results of an ongoing study to compare energy bills of scheme participants before and after efficiency upgrades.

Summary of the main results

- Positive NPV to society in all scenarios, ranging from €106m to €518m
- Total investment of upgrades paid back in around eight years through reduced energy bills
- Households in the programme expected to save an average of around €450 p.a. on energy bills
- CO_2 emissions reductions of approximately 1.5 tonnes per dwelling achieved due to reduced consumption of fossil fuels, at a net benefit to society of between €92 and €118 per tonne abated
- Over 3,000 jobs in the construction and related sectors supported in 2010
- Other potential co-benefits generated, including improved comfort and health.

1.2 Method and discussion

The table below sets out the costs of the scheme for the 2008 pilot and the full scheme rollout over 2009 and 2010. Grant spend represents an average of 35% of total installed costs for the measures supported. Almost €109 million of private funds were leveraged by the scheme to the end of 2010. Administration costs represent approximately 6% of total scheme expenditure and cover all overheads including grant processing, market capacity costs[15] and SEAI staffing costs.

Table 1: HES scheme cost summary

Year	SEAI grant spend (€m)	Private sector contribution (€m)	Total expenditure (€m)
2008 (pilot)	€1.4	€2.6	€4.0
2009	€16.2	€31.0	€47.2
2010	€45.2	€75.1	€120.3
Total	**€62.8**	**€108.7**	**€171.5**

1.3 Summary of CBA

The social CBA of the HES scheme provides an NPV for three scenarios:

- Scenario 1: Energy savings only
- Scenario 2: Energy and CO_2 savings
- Scenario 3: Energy, CO_2 and other pollutant gas savings.[16]

Two metrics of cost-effectiveness are considered:

Benefits to society per unit of energy saved equates the societal NPV of the scheme with the estimated cumulative *energy savings* over the lifetime of the technologies installed.

Benefits to society in € per tonne of CO_2 abated equates the societal NPV of the scheme with the estimated cumulative *CO_2 savings* over the lifetime of the technologies installed.

15 These are the costs incurred for quality assurance and training of assessors, installers, etc.

16 All costs and benefits are based on average annual energy prices (ex VAT).

1.3.1 Energy

Energy savings are estimated in terms of kWh/m^2 for each measure on the basis of data from the HES pilot scheme.[17] These estimates are refined by further modelling of typical dwelling types and upgrades using the Dwelling Energy Assessment Procedure (DEAP) software that is currently used to generate domestic BERs.

Table 2: Estimated savings per measure kWh

	Apartment	3-bed semi-detached	3/4 bed detached
Roof insulation	800	1,300	1,655
Cavity wall insulation	2,050	3,250	4,136
Dry-lining insulation	3,200	5,000	6,364
External insulation	3,750	5,900	7,509
Heating controls upgrade only	2,350	3,700	4,709
High Efficiency gas or oil boiler with heating controls and hot water cylinder upgrade	4,900	7,700	9,800

Total energy savings for each measure are then calculated for three dwelling types and sizes: two-bedroom apartments ($75m^2$), three-bedroom semi-detached houses ($110m^2$) and three/four-bedroom detached houses ($145m^2$). The mix of housing types upgraded is recorded by SEAI at the time of grant issue. The costs and benefits expected over the lifetime of the installed technologies are included in the analysis.[18]

Table 3: Installed measures per dwelling type 2009/2010 (before deadweight adjustment)

	Apartment	3-bed semi-detached	3/4 bed detached	% of total measures
Roof insulation	302	18,314	28,215	34.5%
Cavity wall insulation	206	15,569	26,349	31.0%
Dry-Lining insulation	271	2,060	1,670	2.9%
External Insulation	24	1,185	555	1.3%
Heating controls upgrade only	71	1,205	2,071	2.5%
High-efficiency gas boiler with heating controls and hot water cylinder upgrade	258	6,461	2,211	6.6%
High-efficiency oil boiler with heating controls and hot water cylinder upgrade	18	1,729	5,564	5.4%
Integral BER	164	6,620	6,379	9.7%
Before/after BER	256	3,623	4,444	6.1%

17 The HES pilot scheme was based on 1,500 properties in the counties of Clare, Limerick and Tipperary. Data were adjusted to reflect potential impacts on non-rural dwellings, given that the HES pilot targeted rural areas only.

18 Lifetimes used are those currently being considered for harmonisation under the EU Energy Services Directive: insulation 25–30 years, boilers 20 years. Second revision – Harmonised lifetimes of energy efficiency: Improvement measures of energy savings (European Commission, 2008, unpublished). These are considered conservative estimates of technology lifetime. Insulation technologies such as internal dry- lining and external wall insulation can provide energy savings for a period equivalent to a dwelling's useful lifetime i.e. greater than 50 years.

The value of the energy saved (€ per kWh) is estimated on the basis of average fuel prices for 2008, 2009 and 2010 for the domestic sector, as recorded by the Energy Policy Statistical Support Unit (EPSSU) of SEAI.[19] An average value per kWh saved is calculated on the basis of an assumed fuel mix for savings of 95% heating fuels (45% gas, 45% oil and 5% solid fuel) and 5% electricity, resulting from the technologies supported (i.e. insulation, high-efficiency boilers and heating controls).

For the headline scenario, an average per annum energy price growth rate of 3.07% is assumed for all fuels over the scheme's lifetime. This is consistent with current working assumptions being used for all government analysis of this type.

Adjustment to expected savings

Improved comfort

While the installation of energy efficient technologies will enable householders to save on their energy bills, it is likely that in some instances some of the benefits will be absorbed by increased internal temperatures. Energy savings are modelled within DEAP as described above using conservative assumptions to take into account this 'comfort take-up' expected in some households. [20]

Deadweight and Spill-over Effects

It is possible that, as well as stimulating additional take-up, the HES scheme includes some households that would have taken measures without the scheme being in place (deadweight). At the same time, scheme participants might carry out more work than originally decided as a result of information received via the scheme (spill-over). The direct measurement of these effects is very complex and often results in a range of possible adjustment factors.

In line with an evaluation of the UK Energy Efficiency Commitment (EEC), an 18% deadweight adjustment has been included to reduce benefits (energy and CO_2 savings) attributed to the HES scheme.[21] No upwards adjustment is made to savings estimates for potential spill-over effects.

19 http://www.seai.ie/Publications/Statistics_Publications/Fuel_Cost_Comparison/

20 Work is underway to determine the level of comfort take-up observed in HES participant households. This will be informed by a billing analysis currently under development by SEAI.

21 'Report to Defra: Evaluation of the Energy Efficiency Commitment 2002-2005', Eoin Lees, 2006. 18% based on average deadweight estimates of technologies covered under both the EEC and HES schemes.

1.3.2 CO_2 and other emissions

An additional benefit from the HES scheme is a reduction in carbon emissions. Energy savings (adjusted for comfort take-up and deadweight) are converted into carbon savings, using emission factors for CO_2 weighted for the different fuels saved.[22]

A reduction in energy use also results in a reduction in other emissions associated with fuel combustion, namely NOx, SOx, VOCs and particulate matter.[23] The BeTa-MethodEx tool, developed for the European Commission, is used to provide the damage costs (to core health and crops) of each pollutant gas in Ireland.[24] An average of the low and high CAFE/WHO damage costs from this tool is applied.[25] As with carbon savings, the energy savings (after adjustment for comfort take-up and deadweight) are used to calculate the reduction in other pollutants.

Sensitivity analysis

Sensitivity analysis was conducted on two key variables, as indicated in Table 4. Assumptions for the low- and high-cost estimates are indicated. The headline values correspond to the assumptions used in the principal CBA outcome.

Table 4: Assumptions used in the sensitivity analysis

Variable	Headline	Low	High
CO_2 price per tonne	Market price (as issued by Dept. of Finance[26])	Market price minus 10%	Market price plus 100%
Energy price growth rate (2011 onwards)	3.07%	0%	6.14%

Table 5 indicates current market prices identified in the Department of Finance guidelines on incorporating CO_2 emissions into capital project appraisals.

22 As per Energy in Ireland – 2010 Report, EPSSU. 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 electricity generation.

23 Average emission factors for gas, oil and solid fuel for these emissions are based on Environmental Protection Agency Ireland (unpublished) data. The emission factors for electricity are derived from European Environment Agency data for Ireland, to determine total emissions, and SEAI data for the total electricity generated. See: http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=1058 and http://www.SEAI.ie/Publications/Statistics_Publications/Energy_in_Ireland/Energy_in_Ireland_1990-2007.html

24 The BeTa-MethodEx tool (v2 released in February 2007) was developed for the European Commission DG Research: http://www.methodex.org/BeTa-Methodex%20v2.xls

25 CAFÉ (Clean Air For Europe) and WHO (World Health Organisation).

26 http://www.finance.gov.ie/documents/guidelines/co$_2$capapprais.pdf (June, 2009)

Table 5: Market price of CO_2 assumptions used to monetise carbon savings

Year	Price €/t
2009	13.24
2010	13.91
2011	14.61
2012	15.59
2013	16.76
2014	17.93
2015 onwards	39.00

Source: Department of Finance

1.4 Results

1.4.1 NPV

Table 6 summarises the NPV of the HES scheme under the three scenarios. Under all scenarios, the NPV is positive, suggesting that the costs of the measures installed are more than outweighed by the benefits.

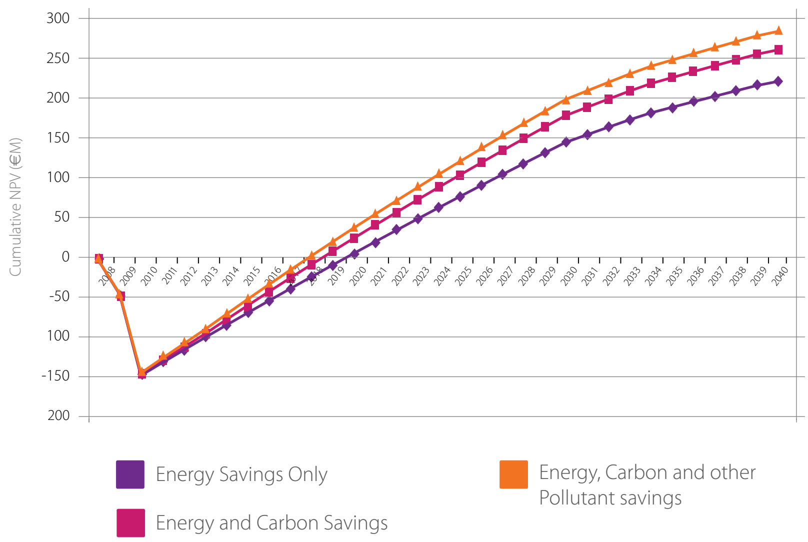
Table 6: Overview of the CBA results (including sensitivity analysis)

	Headline	Low	High
Societal NPV savings (€m) over lifetime of technologies installed			
Scenario 1: Energy savings only	**€222**	€106	€415
Scenario 2: Energy and CO_2 savings	**€262**	€142	€495
Scenario 3: Energy, CO_2 and other pollutant savings	**€285**	€166	€518

The NPV is still positive (€106 million) using the low sensitivity parameters and taking into account energy savings only. Substantial additional savings of up to €518 million are estimated on the assumptions of high energy price and high CO_2 price, as detailed above.

As can be seen in Figure 1 below, energy savings are expected to pay back the total cost of initial investments between 2008 and 2010 in around eight years' time. At this point, net benefits start accruing to society. The period to 2042 is taken to incorporate savings over the lifetime of the technologies installed.

Figure 1: NPV per annum for lifetime of technologies installed



1.4.2 Cost effectiveness

Table 7 provides an overview of two cost-effectiveness metrics considered. These demonstrate how the HES scheme delivers significant savings, primarily because the value of the energy saved from the installation of efficiency measures more than outweighs the cost of installation.

Table 7: Cost-effectiveness metrics – headline scenario

Indicator	Result
Cumulative energy savings after comfort take-up and deadweight (GWh)	9,363
Benefit (saving) to the economy per unit of energy saved (€ per kWh)	
Scenario 1 – Energy savings only	€0.024
Scenario 2 – Energy and carbon	€0.028
Scenario 3 – Energy, carbon and other pollutant gases	€0.030
CO_2 savings (Mt)	2.40
Benefit (saving) to the economy per tonne of CO_2 abated (€ per tonne CO_2)	
Scenario 1 – Energy savings only	€92
Scenario 2 – Energy and carbon	€109
Scenario 3 – Energy, carbon and other pollutant gases	€119

There is a financial benefit per tonne of CO_2 emissions saved – that is, in the long run the programme saves both money and carbon. These results are consistent with a recent analysis of the costs and benefits of reducing Ireland's GHG emissions, which suggest a negative cost (or net benefit) to society per tonne of CO_2 abated for residential retrofit measures, among others.[27]

1.4.3 Exchequer analysis

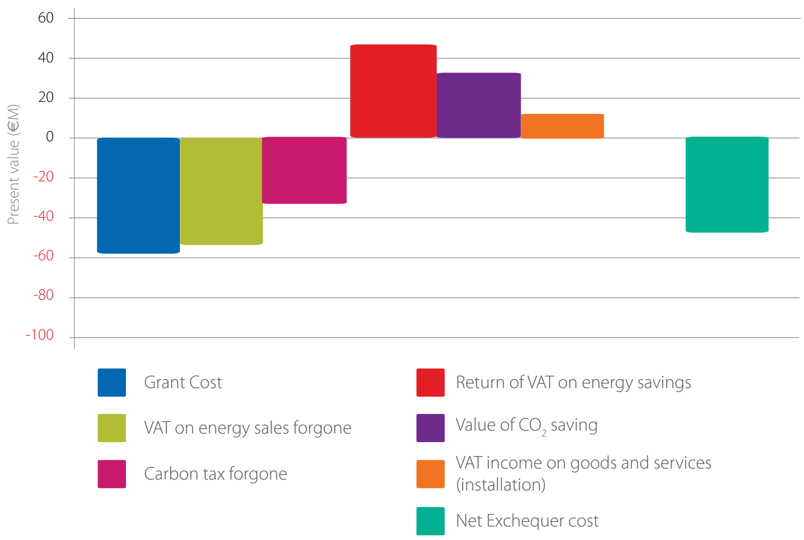
The Exchequer analysis includes the following costs and benefits (Table 8):

Table 8: Estimated Exchequer costs and benefits

Costs	Benefits
Grant expenditure	VAT income on installations (after deadweight adjustment) at 13.5%
Scheme administration costs	Value of CO_2 savings
VAT on energy sales forgone at 13.5%	Eventual VAT income based on expenditure of increased disposable income from savings
Carbon tax forgone as result of energy savings	

The cost of subsidies for the three years of the programme to the end of 2010 is €56.6 million (discounted) or 40% of the total Exchequer cost of the scheme. Other costs flow from VAT and carbon tax lost due to the reduction in energy use of scheme participants. Inflows to the Exchequer include the value of CO_2 savings on the basis of avoided need to purchase carbon credits (37% of benefits) and eventual inflow of VAT (50% of benefits) based on an estimated 70% return of participants' financial savings to the economy.[28] VAT on works undertaken (after the deadweight adjustment) makes a further modest contribution to the Exchequer.

Figure 2: Exchequer flows – HES scheme



27 Refer to the SEAI publication ***Ireland's Low-Carbon Opportunity*** (July, 2009) for detail.

28 It is assumed that a portion of the value of energy savings (30%) does not return to the economy. This would include items such as savings, and money spent outside the country. The lower VAT rate of 13.5% is used to ensure a conservative estimate of returns.

The overall cost to the Exchequer is to be expected from a programme of this nature. As can be seen above, it is compensated for by the value of CO_2 savings, the return of VAT through expenditure of increased disposable income as a result of energy savings, and the inflow of VAT on installations. On the basis of this spend, over €96 million was leveraged from the private sector for the investments in energy efficiency upgrades. A range of other benefits are available to the Irish economy from the programme, as described below. If quantified in monetary terms, these would potentially further reduce the cost to the Exchequer.

Co-benefits

In addition to the benefits monetised in this analysis, a number of co-benefits are associated with the programme. These include:

- ➔ support for jobs in supply, installation, project management of improvements, and related fields
- ➔ improved householder comfort
- ➔ health benefits through improved household internal living environment.

The additional spend on labour induced by the scheme supports jobs in the construction industry. SEAI estimates that 60% of total expenditure on installations is on labour.[29] For 2010, this is estimated at over €72 million, which when considered in relation to the average industrial wage in Ireland, is sufficient to directly support over 2,000 full-time jobs.[30] When indirect jobs in related fields are included, this rises to over 3,000 jobs supported in 2010.[31]

While the additional comfort felt by homeowners participating in the scheme was subtracted in the CBA in order to estimate the value of energy saved, this benefit accrues to the householder also. A recent survey of participants in the scheme highlighted this as the first tangible impact felt by householders following an upgrade.[32] Potential improvements to health flowing from improved internal climate are also available to participants in the scheme. Work continues to assess these potential benefits in more detail.

29 Based on programme experience.

30 The average industrial wage for the first three-quarters of 2010 was €35,740 (http://www.cso.ie).

31 Conservative multiplier of 1.4 to estimate direct plus indirect job support. Source: Annual Construction Industry Review 2009, DKM Consultants (October, 2010). Other examples include: Scottish government construction projects (1.8); construction-related activities detailed in the environmental impact statement for metro-North (average 1.5).

32 Bringing Energy Home: Understanding how people think about energy in their homes, SEAI (September 2010).

Evaluation of energy savings in the Small and Medium Enterprise (SME) sector

2.1 Background

SEAI's Small and Medium Enterprise (SME) Programme delivers assessments, advice, mentoring and training services to SMEs to help them reduce energy use and cut costs. The focus of the programme is on encouraging a structured approach to energy management and on demonstrating the benefits that can be achieved.[33] SEAI has found that participants who examine their energy use for the first time are likely to find it quite easy to cut costs by 10% by taking simple and quick steps, such as replacing lighting or raising awareness of energy use among employees by providing information or basic training.

It is well established that many investments in energy efficiency improvements[34] save more than they cost as a result of reduced energy usage.[35] It is also evident that many such investments are not being taken by SMEs despite the opportunity for good (often short-term) economic returns. Many reasons exist for this lack of action: time constraints, financial barriers, lack of knowledge, inadequate human resources, etc.

Improvements in SMEs' energy efficiency not only save money, but also help to reduce dependence on imported fossil fuels, while reducing GHG emissions. These savings have the potential to raise SME competitiveness, and thus benefit employment and growth. The analysis here considers the programme costs, including government and private sector expenditure linked to the programme; and the value of benefits, including energy, CO_2 and other pollutant savings. Data are also provided on the level of employment in the companies supported by the programme and the average energy bill of participating companies.

Summary of the main results

- Positive NPV to society of €162 million in 2020 and €386 million in 2030
- Present value of CO_2 and other emissions abated of €40 million in 2020 and over €80 million in 2030, at a net benefit to society of around €200 per tonne
- Since 2007 the programme has supported over 1,470 companies employing the equivalent of approximately 130,000 full-time staff
- The cost to the business of saving one kWh is 1.8c to 2020 and 0.7c to 2030. By comparison, the average cost of a kWh of purchased energy to the clients is 8.2c.

2.2 Method and discussion

Since the programme began in 2007, SEAI has supported over 1,470 companies. Data are collected on each company at the outset of the programme, including business type (sub-sector), energy spend, and number of employees. Further site-specific data – concerning energy savings achieved during the three months of programme participation and the expected 12-monthly savings measures – are captured by energy advisors.

33 For more details about the SME programme and how it operates, see: http://www.seai.ie/Your_Business/SEAIs_services_for_SMEs/

34 Examples of such measures in the SME sector include lighting upgrades and control systems, efficient heating and cooling sources, improved thermal insulation, and behavioural change measures – see Ireland's Low-Carbon Opportunity (July, 2009) for detail.

35 Ibid

The average energy bill of companies currently participating in the programme is around €80,000 per year.[36] This average figure is declining as smaller companies enter the scheme over time.[37] Energy savings per company are multiplied by the number of companies assumed to participate in each future year of the programme. For the purpose of the analysis, it is assumed that current programme funding will remain intact until 2020.[38] It is also assumed (conservatively) that this funding enables the programme to engage with 450 new companies each year, up to 2020.

Energy and CO_2 savings benefits extending beyond 2020 have been included to account for measures installed before 2020 that will still be providing companies with energy savings after 2020. An average lifetime of 12 years is assumed for the combination of technologies installed and measures taken, including behavioural change leading to energy savings.[39]

Consistent with the current EU norms for such calculations, the duration of the savings has been established on the basis of the range of technologies or measures that SME programme participants have implemented, or been recommended to implement.

The average lifetime assumption across electricity, thermal and fleet energy savings is 12 years.[40] It is recognised that not all savings measures will last this long, on the basis that some companies may close within this timeframe. An average annual decline in savings of 8% has been incorporated to simulate this effect.[41]

Although SEAI, through programme design, has sought to eliminate the potential for deadweight, this analysis assumes a conservative deadweight factor of 20%. Given the existing barriers for SMEs in independently introducing energy efficiency measures and the observation that companies are not currently prioritising energy efficiency investments, it is considered unlikely that action will occur in the absence of direct supports. Analysis of client evaluations undertaken in the early stages of the programme indicated that few companies reported that the programme ***'told us what we already knew'*** or listed opportunities that the company was already planning to take. The common characteristic for this group was an energy bill of over €400,000. To manage this deadweight, all companies with an energy bill of over €350,000 at registration are contacted to ensure that they are directed to the appropriate SEAI programme – for example, the Large Industry Energy Network programme. In a number of instances, data captured relate to a site that is a member of a multi-site organisation, such as a retail food outlet or facility management company. A multiplier effect, in the form of a rollout of energy savings initiatives beyond the site participating in the programme was reported as a benefit of the scheme. This multiplier effect has not been quantified in this analysis.

36 This figure excludes some larger energy users that participated in the programme in 2007 and 2008, as these are now being channelled to alternative SEAI programmes, such as EnergyMAP and the LIEN/Energy Agreements programmes.

37 The current rate of decline of energy spend per company is 5% per year. In addition, as SEAI currently directs larger firms which apply to the programme to more appropriate SEAI programmes, the average total energy use of participants is expected to decrease over time at the rate of 5% per year, as incorporated in the analysis.

38 Current funding is set at €1.2 million per year. This is a working assumption; future programme funding is subject to the Government budgetary process – programme costs might eventually accrue to energy suppliers and/or the private sector via the National Retrofit Scheme. The programme scope and aims are under continuing review.

39 Based on SME and public sector programme data and compatible with EU harmonised lifetimes for energy savings estimates, in accordance with the Energy End-Use Efficiency and Energy Services Directive 2006/32/EC.

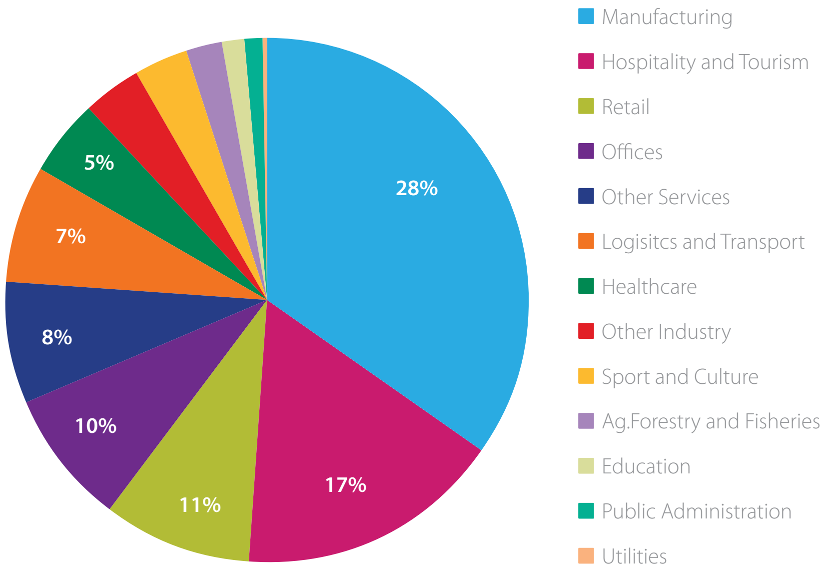
40 Weighted average value

41 Representing an estimation of the current failure rate of Irish SMEs, calculated from figures contained in Small Business Failure in Ireland, Fitzpatrick Associates (June 2001), and updated on the basis of discussions with Forfás and the Central Statistics Office (CSO).

Sub-sector profile and employment data

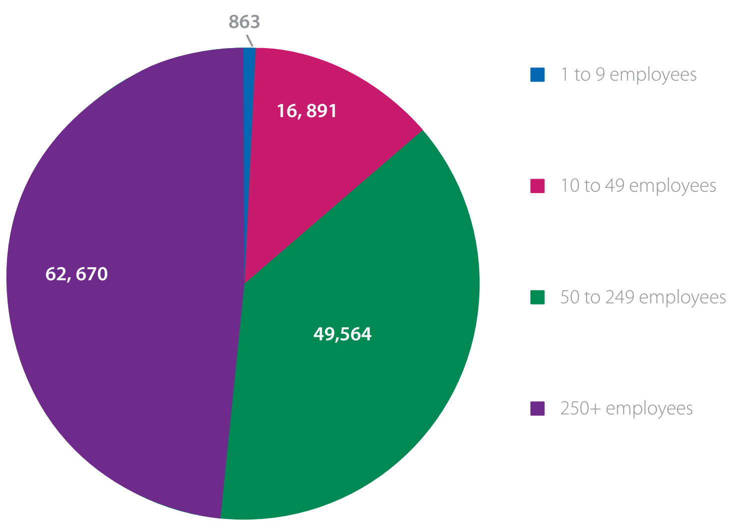
Advice and mentoring has been provided to a broad range of sub-sectors within the commercial SME sector. These include manufacturing, hospitality and tourism, retail, offices, logistics and transport, etc.

Figure 3: Percentage of total participant companies to date by sub-sector



Analysis of data on employees per company indicates that the majority of SMEs in the programme (46%) employ between 10 and 49 employees. A further 34% of companies employ between 50 and 250 people. The average number of employees per company is 88 (full-time equivalents). In total, businesses employing 130,000 full-time equivalents (FTEs) have been supported by the programme.

Figure 4: Total of approximately 130,000 FTEs supported since programme inception



The 577 participants that registered for the programme in 2009 employed a total of almost 31,000 full-time equivalents. The minimum number of employees was one and the maximum 750, with an average of 54; indicating a reduction in the average number of employees per company since the programme began. Approximately 70% of the companies had fewer than 50 employees; only 3% had over 250.

2.3 Summary of CBA

2.3.1 Energy, CO_2 and other pollutants savings

Data collected for each company in the programme provide a breakdown of energy use by energy type. Energy savings are captured by mode (i.e. electricity, thermal or fleet). This enables CO_2 to be accurately calculated on the basis of current emissions factors for each unit of energy saved.

Table 9: CO_2 saved

	2009	2010	2015	2020	2030
Cumulative energy savings, final (GWh)	58	154	1,060	2,450	5,340
Cumulative energy savings, PEE[42] (GWh)	89	240	1,720	3,990	8,730
Cumulative CO_2 saved (kilotonnes)	19.5	51.8	357	822	1,790

The value of energy savings is based on the 2009 price per kWh for each energy type and the amount of energy savings contributed by that fuel type.[43]

The value of CO_2 savings has been calculated with reference to current Department of Finance guidelines for the cost of carbon.[44]

A summary value of the energy, CO_2 and other emissions saved is set out in Table 10.

Table 10: Summary value of the energy, CO_2 and other emissions saved

	2009	2010	2015	2020	2030
Cumulative value of energy saved (€m)	€5	€13	€93	€233	€576
Cumulative value of CO_2 saved (€m)	€0	€1	€7	€26	€63
Cumulative value of other emissions saved (€m)	€1	€2	€12	€29	€71
Cumulative total (€m)	€6	€15	€112	€287	€710
Cumulative discounted total at 4% (€m)	€6	€15	€97	€219	€443

42 Primary Energy Equivalent

43 The prices increased by the rate of inflation.

44 Guidance note on incorporating CO_2 emissions into capital project appraisals, Department of Finance (June 2009).

2.3.2 Programme costs

Given that the programme began in 2007, set-up costs have already been incurred. The budget in 2010 was set at €1.2 million; this level of budget is assumed to continue between now and 2020 for the purpose of this analysis. About one-sixth of the budget is allocated to administrative and staffing costs of €0.2 million per year. The remainder (€1m) is allocated to the provision of information and support to SMEs. This category captures the main programme cost, which includes the cost of energy advisors' site visits, assessment and mentoring supports.

2.3.3 Other benefits

- Since 2007, the programme has supported over 1,470 companies employing about 130,000 full-time equivalent staff
- Data collected from companies participating in the programme indicate a 12-month saving rate of 10.3%
- The abatement cost per tonne of CO_2 in the period to 2020 is minus €198 per tonne, and minus €216 per tonne in 2030 – in other words, as an abatement measure, the programme saves more money than it costs
- The cost to the business of saving one kWh is 1.8c to 2020 and 0.7c to 2030. By comparison, the average cost of a kWh of purchased energy to the clients is 8.2c
- A reduction in energy use also results in a reduction of the following emissions associated with fuel combustion: oxides of nitrogen (NOx), oxides of sulphur (SOx), non-methane volatile organic compounds (NMVOC) and particulates ($PM_{2.5}$). In this case, the following figures (Table 11) were used for the cost per tonne of emissions (and inflated appropriately in future years).

Table 11: Cost per tonne of emissions saved for pollutant gases other than CO_2

	NO_x	SO_x	NMVOC	$PM_{2.5}$	Total
Price per tonne	€7,400	€9,400	€1,340	€28,500	-
g/kWh energy demand	0.534	0.597	0.018	0.022	-
Cost per GWh Energy	**€3,949**	**€5,616**	**€24**	**€639**	**€10,227**

Prices per tonne are based on the BeTa-MethodEx tool developed for the European Commission which is used to provide the damage costs (to core health and crops) of each pollutant gas in Ireland.[45]

2.4 Results

2.4.1 Social CBA

This programme delivers a positive NPV to society as a whole. The social CBA provides a positive NPV of €162 million over the period up to 2020, and €386 million to 2030, demonstrating a substantial return to society even after the costs of achieving the savings are taken into account. In other words, savings in energy, CO_2 and other pollutants have a higher social value than the investment cost required to achieve the energy savings.

The NPV is assessed by summing the value of energy, CO_2 and other pollutant savings (benefits) minus the costs to achieve those savings (public and private expenditure), as outlined in Table 12.

45 An average of the low and high damage costs from this tool is applied. The BeTa-MethodEx tool (v2 released in February 2007): **http://www.methodex.org/BeTa-Methodex v2.xls**

Table 12: NPV – value of savings minus costs

	PV to 2020	PV to 2030
Present Value (PV) of SEAI spend (€m)	€12	€12
PV of energy saved (€m)	€178	€359
PV of CO_2 saved (€m)	€19	€39
PV of other emissions saved (€m)	€22	€45
PV of private (SME) investment (€m)	€45	€45
Societal NPV (€m)	**€162**	**€386**
€ saved per € of SEAI spend	**€15**	**€33**
Benefit to the economy per tonne of CO_2 abated (€)	**€198**	**€216**

It is also evident from the table that the net programme cost is negative, because the value of carbon savings is greater than the programme cost.

The net private sector cost is also negative, because the value of energy savings is greater than the private (SME) investment costs.

Thirdly, it is worth noting that the carbon savings accruing to the emissions trading sector exceed those accruing to the Exchequer by 55%, and are more than double the entire SME programme budget. Overall, the programme saves carbon emissions with a value that is 3.25 times the programme budget.

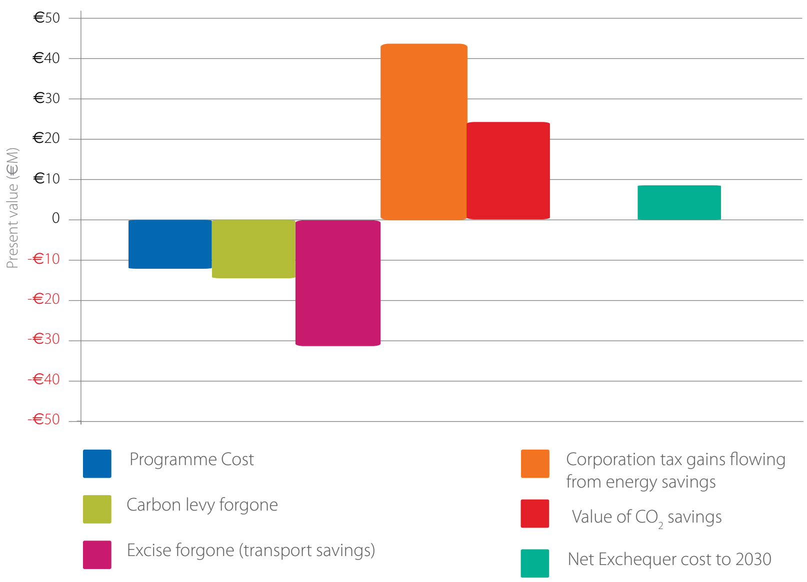
2.4.2 Exchequer analysis

The Exchequer cash-flow analysis considers the programme cost, flows of VAT on fuels, corporation tax on company profits, fuel excise duty forgone, and the value of carbon saved to the Exchequer.

The SME programme cost, at €12 million discounted, accounts for 15% of total Exchequer cost; the remainder is the tax impact.

The tax impact to 2030 breaks down as follows: excise duty losses of €31 million, carbon levy losses of €14.7 million, offset by corporation tax gains of €43 million and carbon savings of €23.6 million.

Figure 5: Exchequer flows – SME programme



Taken together, the programme cost and net tax impact result in a net Exchequer loss in 2020 of almost €2 million, however when lifetime savings are taken into account the result is a gain of €8.8 million (i.e. to 2030).[46]

2.4.3 Present value to the private sector

The level of private sector investment is a function of the new, annual energy savings and the assumed payback period of energy efficient technologies or management practices deployed.[47] For the purpose of this analysis, the same value is also taken to include behavioural change methods introduced to participants through the advice and mentoring programme.

A management overhead of 10% of the capital cost has been included in the calculation. This covers the additional staffing and consulting costs required to implement some projects deployed by SMEs. Further work will be required in the future to refine this figure.

46 There are two underlying assumptions in this analysis. First, it is assumed that the energy saved goes to the bottom line for the company in question, hence resulting in increased corporation tax. This may not be wholly accurate – energy savings may end up being shared between the client and customers. Second, the manner in which any energy efficiency equipment is financed and depreciated could significantly affect companies' bottom lines, hence affecting corporation tax calculations. The current assumption is that debt is not used (which is favourable to the corporation tax calculation) and that depreciation occurs over one year, as per the accelerated capital allowances programme (which is neutral to the undiscounted corporation tax calculation and unfavourable to the discounted corporation tax calculation).

47 By way of example, if new energy savings of €1 million are made in a given year, and the average payback period is 1.5 years, then an investment of €1.5 million is required to deliver the necessary savings.

Table 13: Savings and investments

	2009	2010	2015	2020	2030
New annual savings (€m)	€4.8	€3.1	€2.3	€2.4	-
Payback period (years)	1.5	1.5	1.5	1.5	
Private-sector investment (€m)	€7.1	€4.7	€3.5	€3.6	-
Private-sector investment incl. management costs (€m)	€7.8	€5.2	€3.8	€3.9	-
Cumulative private-sector investment incl. management costs (€m)	€8	€13	€34	€54	€54
Cumulative private-sector investment incl. management costs, discounted (€m)	€8	€13	€31	€45	€45

2.4.4 Sensitivity analysis

The overall programme costs and benefits are driven by five main factors:

- the percentage energy saved per company
- savings directly attributable to the programme after deadweight and other adjustments such as company closure rates, etc
- the payback period used by the programme participants
- the number of new companies per year
- the cost per unit of energy.

The impact of two of these – percentage energy saved per company and the cost of energy – is examined below.

The impact of a 50% increase and 50% decrease in each of these variables was considered against four outputs: the energy saved to 2020, social NPV to 2020, the cost of carbon in 2020, and the Exchequer net impact.

The results are as one might expect: increasing the amount of energy saved per firm affects to a similar extent the total energy saved, the social NPV and the Exchequer impact. The cost of CO_2 falls from minus €198 per tonne to minus €203 per tonne and remains negative for a 50% decrease in the energy saved per firm, hence reflecting a saving.

Increasing the value of each kWh saved increases the cumulative value of the energy saved to 2020, improves the social NPV (as the expenditure on more expensive energy is avoided).

Increases in energy prices are also likely to boost the level of energy efficiency investment that companies will undertake. For example, for the analysis presented here it is assumed that a company will invest in projects with an average payback of 1.5 years. This implies that, to get a saving of €1,000 on energy bills, a company will invest €1,500. Should energy prices rise by 50%, the value of savings from the same measures would be €1,500, indicating a payback period of one year on the original investment. Hence, as energy prices rise, further investment options become available within the 1.5 year payback limit imposed in this analysis. For simplicity, this impact has not been incorporated in this sensitivity analysis.

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