True value of an insulation and boiler upgrade under SEAI schemes based on actual fuel savings in comparison to the proposed new PAYS scheme.

Adrian Sheerin

BSc. Construction Economics and Management

Dublin Institute of Technology

2013

Abstract

With environmental issues being so important to the world today and international commitments under the Kyoto protocol growing more binding, the author critically assesses the impact deep retrofits on residences have on fuel use and green house gas emissions.

The author does this through Life Cycle Costing (LCC) on three options. Option 1 deep refit using Irelands Warmer Homes scheme, option do nothing (no deep retrofit) and option three deep retro fit using the incoming Pay As You Save scheme. The LCC also shows the Pay As You Save Scheme to be less financially beneficial than the current scheme.

The results show that there is very little financial value for the property owner in deep retro fits but other considerations like fuel poverty, energy security, physical comfort and environmental effects are highly influenced for the positive.

From the governments view point it is money well spent with reduced fossil fuel imports, induced local employment, a step closer to our Kyoto commitments, a lowering of the fuel poverty bill, social inclusion, and reducing the need to purchase carbon credits. It also enhances the countries green credentials.

The results of this work are that the move away from our current Warmer Homes schemes and onto the Pay As you Save Scheme must be treated with caution and must offer real value for it to be accepted by the public. The risk of an upset in the retro fit market and a drop off in customers is a real possibility.

Declaration

This dissertation is submitted in part fulfillment of the BSc. Construction Economics and Management (Quantity Surveying) Degree from Dublin Institute of Technology. It is the result of my own independent work and has never been submitted in part or in whole for any other coursework or dissertation.

All secondary sources of information have been acknowledged and a reference of all literature used has been provided.

Signed: --------------------------------

Adrian Sheerin

Date:--------------------------

Acknowledgements

I would like to thank my wife Jenny for her support during these college years and for helping me find the time to undertake this thesis.

I would also like to thank Graham Cherry and Sinead Leyne for allowing me to use their property as a case study and giving me access to their documentation.

Table of Contents

Contents

Abstract i

Declaration ii

Acknowledgements iii

Table of Contents iv

List of Figures vii

List of Tables viii

List of Graphs ix

List of Abbreviations x

Chapter 1 Introduction 1

1.1 Introduction 1

1.2Thesis objectives 1

1.3 Deep retro fit 1

1.4 Sustainable Energy Authority of Ireland (SEAI) schemes 2

1.5 Pay As You Save (PAYS) 2

Chapter 2 Literature review 3

2.1 Chapter Introduction 3

2.2 Kyoto Agreement - Global level 3

2.2.1 Introduction 3

2.2.2 History – How it came about 3

2.2.3 Effects of Climate Change 6

2.2.4 Signatures to the Kyoto Protocol (KP) 7

2.2.5 Cap and Trade 8

2.2.6 American Shale Gas Revolution 8

2.2.7 Energy Security 9

2.3 EU directives – European Level 10

2.3.1Introduction 10

2.3.2 2002 Energy performance of buildings 10

2.3.3 EU Emissions Trading Scheme (EU ETS) 10

2.3.4 2006 Energy End Use Efficiency and Energy services 11

2.3.5 2010 Energy performance of Buildings (recast) 11

2.4 Irish Government implementation Policy – National level 13

2.4.1 Introduction 13

2.4.2 Bills and Acts 13

2.4.3 Technical Guidance documents 13

2.4.3 Irelands Plans and Strategies 13

2.4.5 Ireland - National Climate Change Strategy 2007-2012 14

2.4.6 The National Action Plan for Social Inclusion 2007-2016 14

2.4.7 Delivering a Sustainable Energy Future for Ireland 2007-2020 14

2.4.8 Maximizing Ireland's Energy Efficiency – the National Energy Efficiency Action Plan, 2009–2020 14

2.4.9 Housing Energy Efficiency Grants 14

2.4.10The Home Energy Saving (HES) scheme (2007-2012). 14

2.4.11 The Warmer Homes Scheme 14

2.4.12 The Housing Aid for Older People Programme 15

2.4.13 Local Authority-owned Housing Improvement Works Programmes. 15

2.4.14 Irelands progress in meeting its Kyoto commitments 15

2.5 Sustainability 16

2.5.1 Sustainability in Construction 16

2.5.2 Cost of Sustainability 17

2.5.3 Conclusion 19

Chapter 3 – Research Methodology 20

3.1 Introduction 20

3.2 Documentary research 20

3.2.1 Primary Sources 20
3.2.2 Secondary Sources 20
3.2.3 Tertiary Sources 21
3.3 Quantitative Research – Analytical Case study 21
3.3.1 Introduction 21
3.3.2 Mathematical appraisal of data - Life Cycle Costing.................................... 21
3.3.3 Find the Net Present Value 23
3.4 Qualitative Research 24
3.5 Conclusion.. 24
Chapter 4 – Data Analysis and discussion 25
4.1 Introduction 25
4.2 Assumptions 27
4.3 Upfront cost of upgrade to property owner 28
4.4 Green deal operating figures 28
4.5 Loan rate calculator with and without grants received 30
4.6 Energy use calculations 31
4.7 Carbon emissions calculations 35
4.8 Results of the LCC 36
4.9 Energy poverty 46
4.10 Carbon and fuel savings from upgrade 48
4.11 Cost and return to exchequer.. 49
4.13 Interview with case study property owners 50
4.14 Industry take on PAYS set up process 52
Chapter 5 Conclusions and Recommendations 54
5.1 Thesis aims.. 54
5.2 Thesis objectives 54
5.3 Limitations of thesis 55
5.4 Conclusion.. 55

5.5 Recommendations..57
References...58
Electronic sources 59
Appendices..i
LCC Base/Real Cost Operations..ii
LCC Base/Real Cost Lifecycle iii
LCC Escalated Base Costs Operational v
LCC Escalated Base Cost Inputs Lifecycle vi
LCC Escalated Operational Costs in Present Value viii
Escalated Lifecycle Costs in Present Value ix
Thesis Proposal xi

List of Figures

Figure 1 Kyoto Timeline...4-5
Figure 2 Three pillars of sustainability........... 16
Figure 3 WLCC and LCC Differences...22
Figure 4 Carbon prices electronic trading system (ETS) trading.................................49

List of Tables

Table 1 Energy savings 18

Table 2 Assumptions. The author has provided a list of assumptions upon which the LCC is based on. 26

Table 3 Gas price outlook 27

Table 4 Installation cost of deep retrofit to customer 28

Table 5 Britains Greendeal interest rate for solid wall insulation. 28

Table 6 Fixed rate loan calculator with no grants received. 30

Table 7 Fixed rate loan calculator if grants where received. 30

Table 8 Opportunity cost of investing savings in deep retrofit upgrade. 31

Table 9 Energy use breakdown before and after upgrade. 32

Table 10 Difference in gas usage averaged over three years before and after retrofit. 33

Table 11 Average gas usage before upgrade applied to a utility suppliers 2010 bill format. 34

Table 12 Average gas usage after upgrade applied to a utility suppliers 2010 bill format. 34

Table 13 Applying before and after upgrade gas usage to carbon emissions. 35

Table 14 Results of LCC on options one to three. 36

Table 15 LCC figures of option one without opportunity cost. 37

Table 16 Comparisons of Base Costs in the three options. 38

Table 17 Comparisons of Escalated Costs in the three options. 39

Table 18 Comparisons of Escalated Costs in Present Value. 40

Table 19 Energy poverty rates by accommodation (Department of Communications, Energy and Natural Resources, 2011) 46

Table 20 Carbon emissions saved when 1972-1978 units upgraded to case study standard 48

Table 21 Financial savings when 1972-1978 units upgraded to case study standard 48

Table 22 Cost of grants to exchequer to up grade units built in the 1972-1978 period. 49

List of Graphs

Graph 1Accumulated service costs 41
Graph 2Accumulated escalated service costs. 41
Graph 3 Escalated service costs accumulated in present value...................................42
Graph 4 Accumulated lifecycle costs...43
Graph 5 Accumulated escalated lifecycle costs. 43
Graph 6 Lifecycle costs accumulated in their present value.......................................44
Graph 7 Accumulated service and lifecycle costs...45
Graph 8 Escalated service and lifecycle costs...45
Graph 9 Escalated service and lifecycle costs in their present value. 46

List of Abbreviations

European Union (EU)

World Meteorological Organisation (WMO)

World Climate Conference (WCC)

United Nations Environment Programme (UNEP)

International Council for Science (ICSU)

Intergovernmental Panel on Climate Change (IPCC)

UN Framework Convention on Climate Change (UNFCCC).

Climate Change Detection Project (CCDP)

Conferences of the Parties (COP)

International Energy Association (IEA)

Energy Performance Certificate (EPC)

LCC Life Cycle Costing (LCC)

Pay As You Save (PAYS)

Sustainable Energy Authority Ireland (SEAI)

Building Energy Rating (BER)

Electronic Trading System (ETS)

National Treasury Management Agency (NTMA)

Chapter 1 Introduction

1.1 Introduction

The working title of this thesis is 'True value of an insulation and boiler upgrade under SEAI schemes based on actual fuel savings in comparison to the proposed new PAYS scheme.' The authors' interest in this topic stems from an interest in the environment combined with an interest in value for money. As with any prospect of purchasing a product it is always good to understand what your buying and at what cost. In this thesis the author answers these questions through the thesis objectives.

1.2Thesis objectives

- To assess the property upgrades undertaken and how they contribute to fuel savings.
- To critically appraise the true financial savings or cost to the property owners as owner occupiers of upgrading the property using SEAI grants.
- To compare what the financial difference would be if they used the PAYS system instead of SEAI grants.
- To find out the true cost to government of providing both schemes to the property owner after costs are offset against EU level fines.

Answering these objectives and using actual fuel consumption readings not estimates adds vital information to the discussion on financing energy efficient retro fits and their value for money.

1.3 Deep retro fit

When a property receives a boiler and insulation upgrade it is referred to as a deep retrofit. The building regulations are constantly changing and the energy efficiency standards of buildings has heightened over the years. The aim of a deep retro fit is to take a building constructed to an earlier standard and increase its energy efficiency closer to today's standard. So where an older boiler has an efficiency rate of 70 percent an upgrade will bring it up to 90 percent efficiency.

According to the Technical Guidance Documents (2013) insulation is measured in conjunction with the element as a whole so the thermal resistance and thickness of the rendering, insulation and block work are combined with the internal surface resistance

and the external surface resistance to give the total resistance of the wall. This resistance is given in terms of the heat loss through one square meter of element at a one degree Celsius difference in temperature between its internal and external face. This is referred to as its U-value. The lower the U-value the higher the thermal resistance of that element. An upgrade in insulation involves adding a layer of insulation to the element to increase its resistance to heat transfer.

Both the boiler upgrade and the insulation upgrade result in less fuel being needed to achieve the same thermal comfort.

1.4 Sustainable Energy Authority of Ireland (SEAI) schemes

The SEAI was set up to by the Irish government to work towards meeting their commitments under European directives and the Kyoto protocol. As part of their remit the SEAI set up schemes to encourage energy efficient upgrades in the residential sector.

1.5 Pay As You Save (PAYS)

The PAYS systems objective is to make energy efficient upgrades at a minimum, cost neutral. Under European Union (EU) directives each member country should have a PAYS system up and running by the end of 2013. A PAYS system is already up and running in Britain called The Green Deal. The main points stated in The Green Deal 'A Summary of the Governments Proposal' (2010) are;

- Make finance available to customers to upgrade their properties to be more energy efficient.
- Allow customers to pay for energy efficient retro fits through their energy bill.
- Tie the dept to the property not the individual.
- Use a golden rule were the upgrade costs must be at least cost neutral.

Chapter 2 Literature review

2.1 Chapter Introduction

The aim of this literature review is to show the origins of human concern about climate change, and the International, European and National response to it. Part of the national response has been to encourage energy efficient upgrades. The benefits of sustainable construction are also explored.

2.2 Kyoto Agreement - Global level

2.2.1 Introduction

The Kyoto protocol came about as a result of international concern over climate change and its effect on the planet. It has been formulated and advanced over the years to try to impose binding targets on participating nations to reduce their greenhouse gas emissions which lead to global warming. In this regard it has had some success in that nations, both signatories and non signatories are making efforts to reduce these emissions. The future of binding agreements on reducing emissions lies in Cap and Trade within Emissions Trading Schemes (ETS). There are several of these schemes worldwide with the European scheme being the largest. While there are criticisms of Kyoto from small island nations and environmentalists for not going far enough and from industry and some industrial nations for going too far, it is the best we have and has had a huge impact in keeping climate change on the global agenda.

2.2.2 History – How it came about

The following time line is based on two sources, the first coming from an interview with WMO secretary-general Michael Jarraud titled 'Anticipating Climate Impacts on Life and Livelihoods' in April 2009, Michael Jarraud puts forward the contribution of the World Meteorological Organisation (WMO) in bringing climate change, its causes and implications to the world's attention. (http://www.unspecial.org/UNS683/t22.html)

The second coming from the UNFCC webpage (essential background), the information provided overlaps the history provided by Michael Jarraud in the years 1979-1990 and continues the history into the International response to Climate Change. (http://unfccc.int/essential_background/items/6031.php)

Figure 1 Kyoto Timeline

1960	The World Meteorological Organization (WMO) sets up a working group on climate change.
1973	WMO aware of effects climate change (CC) has on humans
1976	WMO links carbon dioxide with global warming
1979	WMO organizes the first World Climate Conference. Highlights impacts of climate change on future generations
1985	WMO, United Nations Environment Programme (UNEP) and the International Council for Science (ICSU) make a statement that temperature rise in early 21st century highest in history of mankind.
1988	The Intergovernmental Panel on Climate Change (IPCC) is set up.
1990	Second World Climate Conference is held. Work on setting up of the United Nations (UN) framework Convention on CC begins.(UNFCCC)
1990	IPCC calls for a global CC treaty.
1991	First meeting of the Intergovernmental Negotiating Committee (INC) takes place.
1992	The INC adopts the UNFCCC and it is opened for signature.
1993	The WMO begins issuing annual CC statements through the Climate Change Detection Project (CCDP).
1994	The UNFCCC enters into force.
1995	The First Conference of the Parties (COP) takes place in Berlin.

1996 The Secretariat of the UNFCCC is set up to support action under the convention.

1997 The Kyoto Protocol is formally adopted.

2001 The IPCC releases it third assessment report. The Bonn and Marrakesh Accords are adopted, these provide an implementation plan for the Kyoto Protocol.

2005 The Kyoto Protocol (KP) comes into force and negotiations for the next stage commence.

2007 The IPCC releases its fourth report.

2009 The COP draft the Copenhagen Accord and the parties make nonbinding pledges to reduce emissions or use mitigating action on emissions.

2010 The Cancun Agreements are drafted and largely accepted by the COP's, with a two degree temperature rise limit and with a time line. To be reviewed in 2015 with the option of reducing the temperature rise goal to1.5 degrees.

2011 Durban Platform for Enhanced action adopted by the COP. Focuses on creating legally enforceable agreements by 2015 to achieve a 1.5-2 degree maximum rise in temperature.

2012 The Meeting of the Parties of the KP adopts the Doha Agreement setting out binding emission reductions for signatories to the KP. This has not come into force yet.

2.2.3 Effects of Climate Change

There is a lot of focus on climate change but how exactly is it going to affect us and the planet, according to Perman, et al., (2003) will be in;

Africa - Higher sea levels effecting populated areas in low-lying areas, Lack of drinking water, negative effect on farming, more non-productive land.

Asia – Lack of fresh water, flooding in coastal areas and river basins, spread of disease due to floods and droughts.

Australia and New Zealand – Significant loss of biodiversity especially in Queensland's wet tropics and the Great Barrier Reef, Lack of fresh water, in some areas a decline in agricultural and forestry production.

Europe – in Northern Europe gains due to milder climate, but in Southern Europe temperatures becoming too high, leading to drought. Coastal erosion and flooding, inland flooding, extensive species loss of up to 60 percent in some areas, health risks due to heat waves and wildfires.

Latin America – Loss of tropical forests, changing vegetation from semi-arid to arid, species extinction, food scarcity leading to hunger, lack of fresh water.

North America – wetter winters and drier summers leading to flooding and droughts, changes in crop growth patterns, health implications due to heat waves.

The author goes on to say that 'it is quite possible that average temperatures will eventually increase by more than 6 degrees Celsius.' (Perman, et al., 2003, p. 319)

Options available are to 1; increase the capacity of sinks that sequester carbon dioxide and other greenhouse gases from the atmosphere; 2 decrease emissions of greenhouse gases below business as usual (thereby reducing GHG inflows to the atmosphere). (Perman, et al., 2003, p. 319)

2.2.4 Signatures to the Kyoto Protocol (KP)

> *'Currently, there are 195 Parties (194 States and 1 regional economic integration organization) to the United Nations Framework Convention on Climate Change'.* (http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php)

The EU signed up to the KP on 1 June 2002 (Bothe & Rehbinder, 2005) and Ireland signed the Kyoto Agreement on 29 Apr 1998 ratifying it on 31 May 2002.

The developed nations having more duties than developing nations due to the fact they have contributed more to the rise in greenhouse gases in the atmosphere, and are also better positioned to shoulder realigning their economies towards fewer emissions.

America is one of the largest contributors of green house gases in the world contributing 25 percent of the worlds greenhouse gas emissions (Yamin, 2006) but has not signed up to the KP for the following reason outlined in the Senate of the United States on July 25 1997;

> *'Whereas the Senate strongly believes that the proposals under negotiation, because of the disparity of treatment between Annex I Parties and Developing Countries and the level of required emission reductions, could result in serious harm to the United States economy, including significant job loss, trade disadvantages, increased energy and consumer costs, or any combination thereof; ' In referring to annex 1 Parties it is referring to a list of developed nations which are assigned greater responsibilities under the KP'.*

Despite not having signed up to the Kyoto Protocol, America is still on target to meet its 17 percent reduction in greenhouse gases by 2020 under the pledge and review approach. (Stavins, 2012) Robert Stavins is a Harvard Professor in Environmental Economics and works on behalf of the Harvard Project on Climate Change to promote co-operation between nations on climate change.

Canada has pulled out of the KP on 15 December 2011 with Peter Kent the Environment Minister stating the protocol "*does not represent a way forward for Canada"* and the country would face crippling fines for failing to meet its targets. (http://www.bbc.co.uk/news/world-us-canada-16151310)

2.2.5 Cap and Trade

Bothe and Rehbinder, (2005) describe Emission Trading as trading in the rights to emit emissions, in this case greenhouse gases. A target is set by the regulator and each source has to keep under this target, if the source succeeds it can sell the rights for the emissions not used or keep them for another year. If it exceeds its target it must buy extra allowances on the open market to make up the differences. This results in a monetary incentive to save on emissions and a monetary disincentive to over shoot your allowances. It also gives a financial comparison for investments in cleaner technology.

There are several Cap and trade or Emissions Trading Schemes (ETS) in operation worldwide, the largest in operation being the EU ETS. The purpose of these ETS is to limit the number of green house gas emissions by allocating emission quotas that are reduced over time to match the targets signed up to under the KP. There has been a large variance in the price of these since they have been traded due to an initial over allocation and due to a worldwide recession resulting in a drop in the manufacture of goods.

A fear is that Europe with a cap and Trade will not be competitive with Nations outside the Cap and Trade but according to Tietenberg (2013) '*Should leakage become a problem it can be controlled to some extent by border adjustment mechanisms such as import tariffs or requiring importers to buy carbon allowances'*.

2.2.6 American Shale Gas Revolution

America, although it has not signed up to the KP looks set to reach its targets in part due to the revolution in shale gas, resulting in an increase in gas fired electricity generating stations and a reduction in coal electricity generating stations. *'Carbon emissions decline as electric generators substitute this now abundant gas for coal'* (Tietenberg, 2013)

Europe may end up increasing its gas powered stations and decreasing its coal fired ones to lower its emissions but this would leave Europe importing more gas from Russia at a risk to its energy security. (Tietenberg, 2013)

2.2.7 Energy Security

Another advantage to reducing the emissions of greenhouse gases and reducing the use of fossil fuels is sustainable Energy Security as expressed by Maria Van Der Hoven executive director of the International Energy Agency (IEA) (Hoven, 2012)

> *Since the International Energy Agency was founded 38 years ago, its mandate has expanded beyond the initial focus on oil security. The IEA champions a broader form of energy security, its core concern, not just by guaranteeing oil reserves and other safeguards against supply disruptions but by working to reduce dependency on oil overall and oil imports in particular. From climate concerns to geopolitical risk, the best ways to build a secure and reliable future are to improve efficiency and to shift to a sustainable low-carbon energy system.*

In the Green Paper – 'Towards a European strategy for the security of energy supply'. The commission puts forward that 40 percent of the EU's gas comes from Russia and 45 percent of oil imports originate in the Middle East. This dependence on imports for our energy needs poses risks to our Energy Security and if no action is taken our dependence will keep increasing and with it our risks. It proposes exploring new and renewable energy sources as well as considering the nuclear option. It also puts forward taxes on fossil fuels to discourage their use.

(http://eurlex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&lg=en&type_doc=COMfinal&an_doc=2000&nu_doc=769)

2.3 EU directives – European Level

2.3.1Introduction

Having signed up to the Kyoto Protocol on the first June 2002 the EU then set about enacting legislation to be implemented by its members. Among these are the

- 2002 Energy performance of buildings
- 2005 greenhouse gas emissions trading
- 2006 Energy End Use Efficiency and Energy services
- 2010 Energy performance of Buildings (recast)

The EU in consultation with its members set emission reduction targets in the form of Cap and Trade for some industries and national targets for emissions not covered under Cap and Trade. If members exceed these targets they would have to buy Carbon credits on the open market to cover the difference.

2.3.2 2002 Energy performance of buildings

Reducing energy consumption and eliminating wastage are among the main goals of the European Union. EU support for improving energy efficiency will prove decisive for competitiveness, security of supply and for meeting the commitments on climate change made under the Kyoto protocol. There is significant potential for reducing consumption with cost-effective measures. With 40 percent of our energy consumed in buildings, the EU has introduced legislation to ensure that they consume less energy. (CA-EPBD, 2010)

A key part of this legislation is the Energy Performance of Buildings Directive (Directive 2002/91/EC,EPBD), first published in 2002, which required all EU countries to enhance their building regulations and to introduce energy certification schemes for buildings. All countries were also required to have inspections of boilers and air-conditioners. (CA-EPBD, 2010)

2.3.3 EU Emissions Trading Scheme (EU ETS)

In this report from Macken (2011) titled 'The EU Emissions Trading Scheme' the author highlights that the EU ETS is the cornerstone of the EU's policy to combat climate change. It also shows how in the first year of trading the price per CO2tonne rose to 30 Euro before collapsing to 1 cent per ton in the second year due to an over

allocation of emission credits to most EU countries. This in effect meant there was no cap on emissions. This occurred in the initial phase of trading or first phase (05-07) and lessons learned where applied to the second phase (2009-2012) with a reduction in the cap by 6.5 percent resulting in credits rising in value to around 16.50Euro/tone. They are currently trading on the 25 July 2013 at 4.39Euro/tone. (http://www.pointcarbon.com/news/1.2481847)

We are now in the third phase (2012-2020) and there is an annual declining emissions cap, which will reduce by 21 percent by 2020 or 1.74 percent annually. This is the phase where our emissions are reduced in line with our Kyoto commitments. There is also a progressive shift to auctioning allowances instead of allocating them. (Macken, 2011)

2.3.4 2006 Energy End Use Efficiency and Energy services

(http://europa.eu/legislation_summaries/energy/energy_efficiency/l27057_en.htm) This webpage provides a summary of the act. The main points being to promote efficiencies through national targets for reductions in greenhouse gas emissions, address the energy market composition to encourage incentives for the efficient end use of energy and encourage the setting up and promotion of the trade of energy services in energy saving programmes. A system of energy audits to identify areas of increasing efficiencies must be available to all energy end users including certification of the audit. Energy bills must provide a breakdown of energy use and all costs included in the bill so the customer is fully informed.

The act also addresses the public sector and the promotion of energy efficiencies in their operations.

2.3.5 2010 Energy performance of Buildings (recast)

This directive builds upon the 2002 legislation to further reduce the energy use and greenhouse gas emissions from buildings with a target date of 2020 for all new builds to be nearly zero energy buildings. It also promotes the advancement of renewable energy sources. The directive also seeks to harmonize methodologies for certification of buildings energy use across the EU member states and this Energy Performance Certificate (EPC) is provided by the building owner, when a building, whether domestic

or non-domestic is being sold or rented. The directive covers regular inspection and performance of air conditioning units and boilers.

The directive addresses Public buildings and stipulates all public buildings over 1000m2 must display an EPC. Public authorities must lead the drive in energy efficiency in buildings by only buying or renting near zero energy buildings by 2018 two years ahead of everyone else. They must also strive to upgrade their existing building stock to be more energy efficient.

Member states shall also introduce effective penalties for non-compliance and keep the Commission notified on policies and enforcement. (CA-EPBD, 2013)

2.4 Irish Government implementation Policy – National level

2.4.1 Introduction

After being accepted internationally and in the European Union it now has to be implemented nationally. This section shows how this is being done.

2.4.2 Bills and Acts

As Ireland is a member of the EU and has signed up to the Kyoto Protocol it has introduced measures to comply with our commitments to both institutions. Among the measures introduced are;

- 2002 Sustainable Energy Act (Set up the SEI now known as the SEAI to advance our energy efficiency and low carbon goals)
- 2004 Greenhouse Gas Emissions Trading (This ties in with EU legislation allowing for greenhouse gas emissions allowance trading)
- 2004 Kyoto Protocol Flexible Mechanisms Regulations (Ties in with Irelands and the EU's commitments under the Kyoto Protocol in regards to Joint Implementation or Clean Development Mechanisms respectively provided for under Article 6 and 12 of the Kyoto Protocol.)
- 2006 Carbon Fund Bill (Designates the National Treasury Management Agency (NTMA) to set up a carbon fund to buy carbon credits as needed)
- 2006 Energy Performance of Buildings (Authorizes the SEAI as the authority on Building Energy Rating (BER) Certificates in Ireland)
- 2012 Energy Performance of Buildings (Builds on the 2006 Act and makes it mandatory for any building for sale or rent to have a BER certificate)

2.4.3 Technical Guidance documents

Technical Guidance documents from the Department of the Environment, Community and local government are the blue prints for complying with building regulations in Ireland and it is through these that energy efficiency in buildings has been improved in line with EU Directives.

2.4.3 Irelands Plans and Strategies

There have been numerous strategies and plans introduced to outline Irelands goals in regards to energy policy some of these are;

2.4.5 Ireland - National Climate Change Strategy 2007-2012

This outlines how Ireland plans to cut its greenhouse emissions in line with its EU and Kyoto commitments. It contains a chapter titled 'Residential' which deals with energy efficiencies in the residential area.

2.4.6 The National Action Plan for Social Inclusion 2007-2016

This action plan under 'innovative measures' deals with fuel poverty and how sustainability and energy efficiency are vital for dealing with fuel poverty.

2.4.7 Delivering a Sustainable Energy Future for Ireland 2007-2020

This white paper deals with Ireland's energy security and states that Ireland currently imports 90 percent of its energy supply and forecasts a growth of 600 percent in renewable energy up to 2020.

2.4.8 Maximizing Ireland's Energy Efficiency – the National Energy Efficiency Action Plan, 2009–2020

This builds upon 'Delivering a Sustainable Energy Future for Ireland 2007-2020' and sets out policies to reduce energy use by 9 percent by 2016 and 20 percent by 2020.

2.4.9 Housing Energy Efficiency Grants

In line with Irelands international commitments and its domestic commitments to encourage energy efficiency in residential buildings, and reduce fuel poverty the Irish Government has set up through the Sustainable Energy Authority of Ireland (SEAI) and Local Authorities a number of initiatives to provide grants to householders to upgrade their houses to be more energy efficient such as;

2.4.10The Home Energy Saving (HES) scheme (2007-2012).

This scheme initially made €100 million available and further allocations where made over its life time. It provided grants of between 21 and 40 percent for upgrading attic and wall insulation, installing high efficiency boilers and controls, and low emissivity double glazing although the double glazing was later removed from the scheme due to a lack of cost effectiveness. This scheme has been extended and is now referred to as the Better Energy Homes Scheme.

2.4.11 The Warmer Homes Scheme

This scheme was aimed at low income housing and was provided at minimum cost to the householder. It provided attic insulation, draught proofing, lagging jackets, low

energy light bulbs, cavity wall insulation and energy advice. This scheme is now called 'The Better Energy Warmer Homes scheme'.

2.4.12 The Housing Aid for Older People Programme

This scheme is aimed at the over sixties in private owned units and provides finance for energy efficiency upgrades.

2.4.13 Local Authority-owned Housing Improvement Works Programmes.

This scheme is aimed at the over sixties in local authority owned housing and provides finance for energy efficiency upgrades. (DECLG., 2011)

2.4.14 Irelands progress in meeting its Kyoto commitments

In 2007 Irelands National Climate change Strategy predicted Ireland would have a deficit on our Kyoto targets, but due to the economic upheaval since 2008 Irelands emissions have reduced and Ireland is currently on target to meet our Kyoto commitments. However emissions in transport and agriculture are projected to grow and by 2016 Ireland will be breaching its targets again.

The two areas of emissions Ireland must deliver on are those covered under the ETS and those under non-ETS. The ETS emissions are covered under the Cap and Trade with EU wide agreement on annual reductions up to 2020 and a move to auctioning credits instead of allocations. The non-ETS emissions are covered under the EU Commissions Climate and Energy Package under which Ireland is committed to reduce non-ETS emissions by 20 percent, by 2020, on 2005 levels. This reduction is set out in annual targets up to 2020. The areas covered under the non-ETS are agriculture, transport, residential and waste sectors. Under residential, savings are projected to be up to 24 percent, if these measures are fully utilized;

- Better Energy Homes (residential retrofit)
- 2011 Building Regulations (insulation standards)
- Residential renewable energy requirements (2008 and 2011 Building Regulations)

(Environmental Protection Agency, 2013)

2.5 Sustainability

2.5.1 Sustainability in Construction

Sustainability in construction comprises of these three pillars, Social, Environmental and Economic. For a project to be considered sustainable it must address these three pillars. With proper planning, satisfying these three pillars can become economically advantageous to the client. The three pillars are clearly illustrated by the Venn diagram model shown below, which is taken from Addis and Talbot (2001).

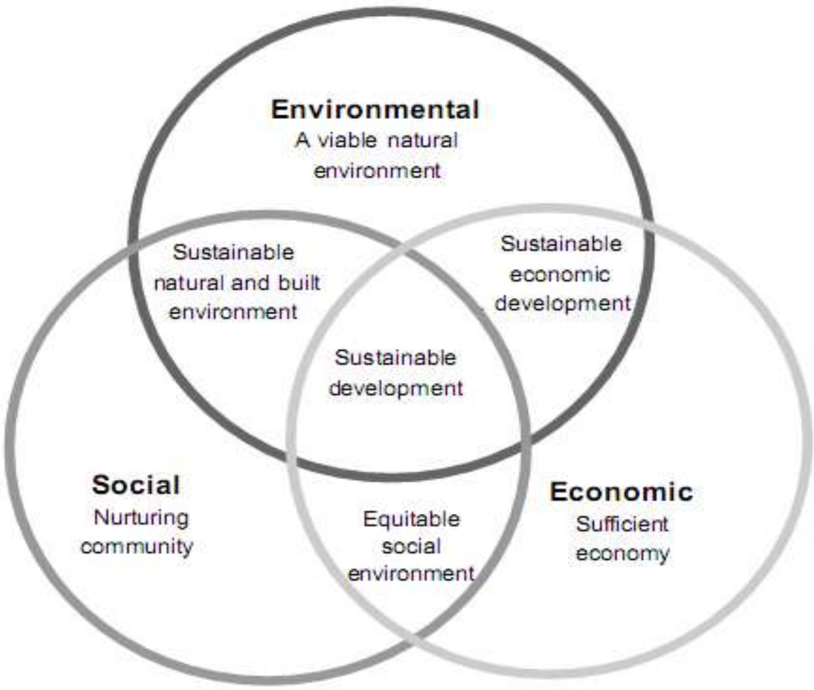


Figure 0-2 Three pillars of sustainability

Government policy is also encouraging sustainability through legislation and the Technical guidance document part L. This document is limiting the Co2 emissions from new buildings, on a phased basis, up to 2020 and beyond as part of Irelands commitments under the Kyoto Protocol and the European emissions directive.

Government carbon taxes and water rates are incentivizing firms to look at alternative construction methods. As highlighted by Halliday (2008) '*Fabric not services'* meaning at design stage the energy efficiency and functionality of the building should be designed into the fabric of the building not into the services of the building.

From the need to design buildings to be constructed and run in a sustainable manner several sources of advice and certification have come forward as Addis and Talbot (2001) explain, there is a need for the guidance they offer because *'There is a growing*

realization and acceptance throughout our society that there is a need for a more responsible approach to the environment'. This reason is developed further by BRE Trust and Cyril Sweet (2005) when they say '*It is often said that the costs of today's lifestyles are such that future generations will pay a high price through reduced environmental quality and living standards'*. This next quote from CIBSE (2007) goes much further and puts forward the idea that the survival of future generations is at threat when they describe sustainability as being '*here to stay unless we cynically compromise the quality of life of future generations —some would say even the possibility of future generations'*. All these authors are stressing the importance of sustainability for the present generations and also for future generations in terms of health and well being, and one author even suggests the threat to human survival. Therefore the need for sustainable development as a spoke of overall sustainability is obvious especially since the process of construction along with the running and maintenance of the finished product uses up so many finite and environmentally damaging resources.

2.5.2 Cost of Sustainability

Another very important reason for sustainable development is that from a commercial view it makes sense. There has been a fear that sustainability while being ideologically sound would cost too much in the present. This way of thinking is acknowledged by BRE Trust and Cyril Sweet (2005) when they say *'One of the principal barriers to the wider adoption of more sustainable design and construction solutions is the perception that they incur substantial additional costs.'* This statement gets to the heart of the reason why sustainable construction hasn't been the norm and the report it's taken from goes on to show why it should be the norm. This report titled 'Putting a Price on Sustainability' gives four examples of different buildings with different functions and shows how through using sustainable construction, savings in energy and water usage can be made over the lifespan of the building.

The following table (1) based on figures from this report clearly shows huge long term savings can be obtained from minimum inputs. The two most striking are the two office scenarios where the savings on energy and water usage are substantial, with the larger air–conditioned office having savings of up to 26 percent on energy usage, which if calculated over the BREEM period of 60 years gives a saving of 15.6 years of energy. This large reduction in the buildings energy use gives a considerable competitive advantage especially in a future of predicted energy price rises, as well as considerably reducing damaging emissions into the atmosphere.

	Good Rating	Very Good	Excellent	Energy savings up to	Water savings up to
Ecohomes	0.3 – 0.9%	1.3 – 3.1%	4.2 – 6.9%	6%	40%
Naturally ventilated office	0.3 – 0.4%	0.4 – 2%	2.5 – 3.4%	17%	71%
Air-conditioned office	0 – 0.2%	0.1 – 5.7%	3.3 – 7%	26%	55%
PFI-procured health centre	Standard	0%	0.6 – 1.9%	3%	10%

Table 1 Energy savings

These savings are made possible by having sustainability in mind from the inception of the project. This is backed up by CIBSE (2007) when they say '*Integrating sustainable solutions from the start may save considerable time, effort and money later on'*. It is also reaffirmed by BRE Global LTD (2011) in this quote ' *Appointing a BREEAM assessor or accredited professional early in the project will help in achieving the target rating without undue impacts on the flexibility of design decisions, budgets and potential solutions'*. The importance of the design phase is also stressed by Addis and Talbot (2001) when they say '*Energy efficient designs can substantially reduce life time costs, making the purchase or lease of property a more attractive and affordable option'*. The obvious financial benefit of using sustainable construction methods is received from the major life cycle cost benefits but other benefits also include market differentiation where your product has a unique selling/leasing point, attracting sustainable investors and improved living/working conditions. (Addis & Talbot, 2001)

When the client has decided to develop in a sustainable fashion he/she needs to know that the projects sustainability is being delivered to a certain standard, i.e. how does the client know if he/she is getting what they asked for? The answer to this is an independent certification from a recognized body. BREEM is one such body; it is run by BRE Global LTD which is a trading subsidiary of BRE Trust who refers to BREEM as being '*the world's leading environmental assessment method for buildings*.' (BRE Global LTD, 2011) It is worth noting that two sources for this literature review are written by or co-written by the BRE Trust and that all the other authors refer to BREEM in their writings. On residential units a BER cert classifies the energy efficiency of the building and must be supplied by the property owner free of charge to any party interested in the sale or lease of the property.

2.5.3 Conclusion

Expenditure on incorporating sustainability and energy efficiency into the building design and fabric is offset by the savings made over the lifespan of the building in reduced running costs. Other benefits associated with sustainable construction are an improved living and working environment and a market differentiation for your product (sale and lease value). There is also less of a risk factor from pollution. The appointment of a credited professional to certify installation of energy efficient upgrades is also essential for proof you are in receipt of what you paid for, energy efficient sustainable construction.

These benefits are based only on the cost or benefit to you from a financial viewpoint, the benefit of securing you and your descendant’s future must also be appreciated.

Chapter 3 – Research Methodology

3.1 Introduction

The purpose of this chapter is to guide the reader through the methods used in this thesis, to answer the thesis question and why these methods were chosen. The main bulk of information was gathered from quantitative methods, by use of field work in the form of a case study. The reason for this is a large part of the thesis is related to hard numerical data and a mathematically analytical approach is the most suited for this. Some qualitative information was gathered to give the reader a personal account of the process; this has been done through interview. The Research Methods in Education handbook expresses the authors intention when it states '*Quantitative and qualitative methods can work well together'* explaining that '*quantitative methods can show, by before and after tests, that change has occurred '* and that '*qualitative methods reveal in detail just how change occurred in day-to-day activities'* (Anon., 2003) So in this thesis the author has strived to prove that change has occurred and quantified this change. The author has also strived to reflect how this change has influenced the case studies households' day to day running.

3.2 Documentary research

3.2.1 Primary Sources

Primary sources are those found closest to your subject. This may take the form of interviews with people who were present at the event i.e. historical event, to accessing letters, journals and reports directly from the event. In this thesis the primary sources used were an interview with the property owners, of the property used in the case study, and receipts for goods from suppliers.

3.2.2 Secondary Sources

These are published papers, articles and books already written on the subject. In this thesis these include statutory instruments, International agreements, EU directives, Irish government reports, industry reports and books on the subject.

3.2.3 Tertiary Sources

Examples of tertiary sources are encyclopedias, newspapers and magazines - places providing general information but with a reputation for accuracy. The author used a Harvard College magazine interview with Robert Stavins a Harvard Professor in Environmental Economics who works on behalf of the Harvard Project on Climate Change to promote co-operation between nations on climate change. The author also used various web resources such as the UNFCC web site.

3.3 Quantitative Research – Analytical Case study

3.3.1 Introduction

Quantitative researchers collect facts and study the relationship of one set of facts to another. They measure, using scientific techniques that are likely to produce quantified and, if possible, generalizable conclusions. (Bell, 2005, pp. 7-8)

In this thesis raw data supplied from the case studies energy supply companies was gathered and broken down into their component parts. Data from invoices for work done on a deep retrofit were also gathered. This data was then run through a Life Cycle Cost (LCC) analysis on a before and after (deep retrofit) basis to give comparative figures to ascertain the highest value scenario.

3.3.2 Mathematical appraisal of data - Life Cycle Costing

Life cycle costing and whole life cycle costing are the two methods used to evaluate the true full cost of a project. Whole life cycle costing takes into account all of the contributors to life cycle costing as well as other financial income and expenditure. Figure 3 taken from BSi (2008) shows the differences between the two. Whole life cycle unlike LCC includes incomings and outgoings from running the business from the property. The environmental cost is also included in this diagram. Different authors include or omit this in their calculations.

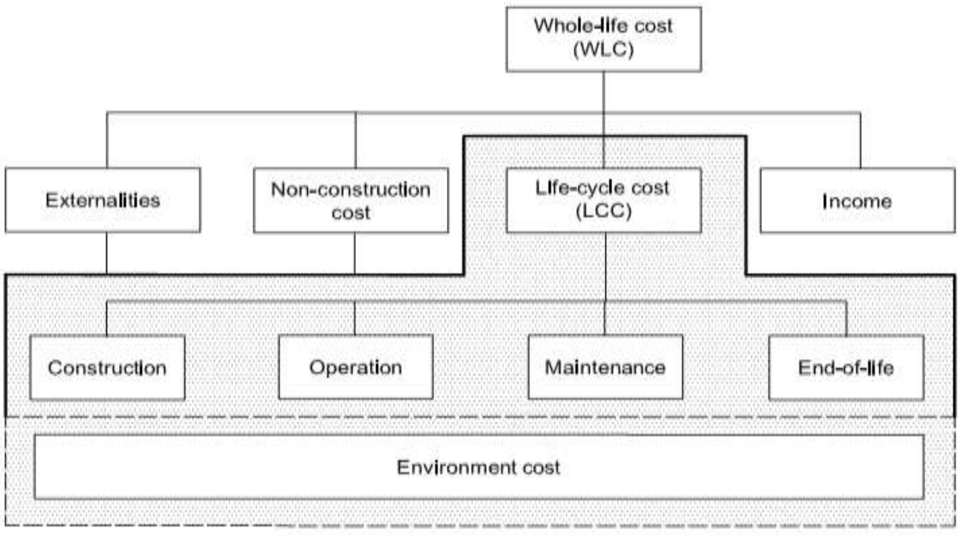


Figure 3 WLCC and LCC Differences

From using the diagram above it is clear that in this thesis Whole Life Cycle Costing is not applicable in a residential scenario, only LCC is applicable to the case study undertaken in this thesis as no income will be generated from the property.

LCC is described by BSi (2008) as '*a valuable technique that is used for predicting and assessing the cost performance of constructed assets'*. This prediction and assessment can be a quick mental arithmetic or it can be an in depth investigation as described by BCIS-BSi (2008) when they state, that life cycle costing is a *'methodology for the systematic economic evaluation of life cycle costs over a period of analysis, as defined in the agreed scope'*.

The author also states '*Long-term costs over the life of the asset are more reliable indicators of value for money than the initial construction costs.'* This quote is referring to the maintenance and running costs of the building adding up to more than the initial construction costs, so a little extra spent at the construction stage can be cost neutral, or positive over the life of the building. The author advises that costs should be estimated from first principles and only to use historical cost information as a check because historical data is based on an industry that was focused on the lowest price not best value. (BCIS-BSi, 2008)

3.3.3 Find the Net Present Value

When doing life cycle costing, a value must be given for ongoing costs, such as annual running costs, annual maintenance costs and lifecycle maintenance costs, such as painting and boiler replacement.

Since the exact cost of these in the future is not known we must make assumptions as accurately as possible. To do this we apply an escalation rate which may be based on average interest rates over the last twenty years or with energy costs a different figure may be used to allow for higher rates of price inflation and carbon tax inflation.

Many different items in a costing exercise may have different rates applied to them. These rates are applied in an escalation formula with the relevant number of years and today's cost of the item, giving a value for that item in the future. That future value is then brought back to its present value. This is done by applying a discount rate based on what return that money could receive if invested elsewhere or how much it would cost if borrowed.

A discount rate is how much a set sum in the future is worth today. The rates used in the private sector should represent the opportunity cost of investing the capital, which as stated by BCIS-BSi (2008) might be: the interest cost of a loan for the investment; the interest lost on reduction of cash on deposit; returns lost on investment elsewhere (e.g. in bonds or equities); the risk and uncertainty of the proposed investment; the actual return achieved on capital investment in the business or the required investor's rate of return in a business involving the constructed asset. When these two formulas, the escalation formula and the discount formula are applied together it gives the net present value for that future cost.

These calculations are done for all costs associated with the project to give us a figure for the entire project. This figure can then be compared to alternative solutions to discover the most financially advantageous solution. Due to the complexity, and the number of these calculations, it is best done using a computer program. The Office of Government Commerce (2003) recommends that even though there is specialist software to run whole life costing scenarios, they are limited in what they can do and that it is better to adapt an Excel spreadsheet to meet the specific task needs.

3.4 Qualitative Research

Researchers adopting a qualitative perspective are more concerned to understand individual's perceptions of the world. They seek insight rather than statistical analysis. (Bell, 2005, pp. 7-8)

In this thesis an interview with the homeowners of the case study property was carried out to get their personal insight on the process of getting the deep retro fit done and how their experience in the property has changed. This was done through an unstructured interview with open questions to allow them the opportunity to bring the interview in a new direction and provide information the questions didn't cover.

An interview with Kevin Middleton of Airtricity was proposed to be carried out to ascertain how the development of PAYS came about from a personal level but unfortunately Kevin has emigrated to New Zealand. Ann Finneran also from Airtricity has provided some information by email but due to ongoing discussions within industry about PAYS felt an interview at this stage would be inappropriate.

3.5 Conclusion

This chapter has set out what methodologies were used in this thesis and why the author chose these methodologies. It also shows why some types were used more robustly than others, due to their relevance to the topic being investigated in this thesis. An in-depth look at LCC was carried out because of its strong relevance in producing quantitative findings for analysis, upon which this thesis is based.

Chapter 4 – Data Analysis and discussion

4.1 Introduction

In this chapter the author uses the quantitative and qualitative methods discussed in chapter three and extrapolates as much information as possible from them. An LCC is conducted on three scenarios;

Option 1: Deep retro with opportunity cost. This uses the finance option and grants, the property owners used to upgrade their property.

Option 2: Do nothing. In this scenario the property owners don't upgrade their property and continue to pay higher fuel bills.

Option 3: Deep retro fit with PAYS. In this scenario the property owners have undertaken the upgrade using the incoming PAYS system.

To run an LCC all cost inputs must be quantified so the author has provided a list of assumptions upon which the LCC is based, some assumptions are taken from reports such as future gas price trends, inflation rates and carbon tax projections.

Information obtained from the interview with the property owners is used to give the opportunity cost, based on where they would put money on deposit and at what interest rate. Other information was taken from supplier receipts.

A thirty year timeframe is used since the NSAI certify the external insulation for this period and an LCC is run within this timeframe.

The results of this LCC and the interviews provide the basis for the conclusions and recommendations in chapter five.

Assumptions
Boiler replaced in 2010 as per life cycle to a 90% efficient boiler from a 70% efficient boiler so heating bills have been adjusted to reflect this. Allowing a 22% reduction in gas charges for new boiler. **70/90=78 100-78=22** Boiler serviced ever 2yrs. It is initially serviced at the end of the first year. Radiators have a given lifespan of 20yrs but on inspection the radiators are in perfect order so allowing a lifespan of 25yrs on this project. (CIBSE) Current radiators and pipe work fitted in 1995. Insulation is weber.therm XM (PM018) NSAI certificate No. 09/0338. The assessment indicates that the system should remain effective for at least 30 years, providing that it is designed, installed and maintained in accordance with this certificate. Weber gives a ten year guarantee with this product. Manufacturer gives painting lifecycle at 19 years. External walls painted in 2001 (15yrs cycle) as per Crown ultra smooth masonry paint brochure and Dulux trade weathershield brochure. Radiators were never painted are in good condition so repainting not needed. House built in 1975. Money on deposit held in KBC bank - Standard demand deposit account 1.5% gross/AER. Discount rate used is the return the client can get on their deposits 1.5%. The boiler had to be changed for all options due to its 15 year life cycle. The opportunity cost relates to the cost of the external insulation only. VAT is a cost to the client. Escalation rate based on ECB inflation target close to but below 2% Using 2% inflation rate in this project. The property owner is using savings along with grants to finance the project.

Table 2 Assumptions. The author has provided a list of assumptions upon which the LCC is based on.

Escalation Rate Gas	
IEA World Energy Outlook 2009 page 660 http://www.worldenergyoutlook.org/media/weowebsite/2009/WEO2009.pdf Europe prices per unit 2008-2030=36% or 1.6% annually	1.6
World Energy Technology Outlook 2050 page 29 http://europa.eu/rapid/press-release_MEMO-07-2_en.htm Europe prices per unit 2010-2040= 192% or 6.4% annually	6.4
EU Energy Trends to 2030 page 16 http://www.energy.eu/publications/Energy-trends_to_2030.php Europe prices per unit 2010-2030= 73% or 3.65% annually	3.65
DECC https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65698/6658-decc-fossil-fuel-price-projections.pdf Europe prices per unit 2010-2030= 24% or 1.3% annually	1.3
SEAI - Energy Forecasts for Ireland (SEAI, 2011) Gas Price 2011-2020 = 20% or 2.22% annually	2.22
Average	3.034
Plus ECB inflation target Rate of close to but below 2%	2
	5.034
Carbon Tax (SEAI, 2011) 2011-2020 = 108% or 12% annually	
18% of the bill is carbon tax = 18*112%	20.16
82% is gas = 82*105.034%	86.12788
	106.28788
Gas Escalation Rate	**6.29%**

Table 3 Gas price outlook

4.2 Assumptions

In table 3 the author has sourced five gas price projections from reputable sources and averaged them. The projections are given in net value so an escalation of 2 percent is applied as per the authors' assumptions. A separate escalation rate is applied for carbon

tax which makes up 18 percent of the fuel bill annually and when added to the gas price escalation, a total escalation rate for gas of 6.29 percent is given.

4.3 Upfront cost of upgrade to property owner

Installation Cost of Deep Retrofit to Customer	
Initial deep retrofit costs	
High Efficiency Gas Boiler with Heating Controls	3662.00
Insulation to walls and roof	27971.00
Initial deep retrofit grants	
High Efficiency Gas Boiler with Heating Controls	-700.00
Insulation to walls and roof	-4000.00
Total deep retrofit cost to homeowner	**26,933.00**

Table 4 Installation cost of deep retrofit to customer

Table 4 gives the total upfront cost to the property owner after receiving grants from the SEAI for upgrades. It also shows grants received of €4,700 from the SEAI which is funded by the government.

4.4 Green deal operating figures

Green Deal Operating Figures	
Annual operating charge pounds sterling	£ 20.00
Set up charge pounds sterling	£ 63.00
Greendeal interest rates on solid wall insulation	7.96-7.67
Average	7.815
Average interest rate	8%
Converted Bi-Monthly	1.262%
Yearly	7.572%

Table 5 Britains Greendeal interest rate for solid wall insulation.

To provide an interest rate for finance to apply to the LCC, the author used the current interest rate from the Green deal in Britain and converted it to a bi-monthly repayment

plan as per current electricity supply billing system. The formula for this conversion is =(1+8%)^(1/6)-1. Comparable personal and home improvement loans in Ireland, in the locality of the upgraded property on 16-August 2013 are Blackrock credit union 9.48 percent, Ulster bank Blackrock home improvement loan 11.3 percent, Bank of Ireland personal loan 11.7 percent and Allied Irish Bank Personal loan of 10.14 percent. No special rates for Energy efficiency upgrades are currently available from any of these institutions. In the Better Energy Financing Scheme Outline Discussion Document available at (http://www.seai.ie/Better_Energy_Financing/Home/) it discusses two forms of finance, a Scheme Finance Vehicle (FV) and Over the Counter loan products (OTC), which includes banks and credit unions. The FV has yet to be set up and the OTC's have to be accredited, other stipulations for OTC's are that there must be no early repayment penalty clause and the loans offered must not be at a higher rate than any current products matching the criteria. It is expressed in this document that '*There is a threshold on the loan value, above which the consumer would deal directly with the Scheme FV.*'(Page 35) From this the author concludes that due to the case study property having a cost on the upper end of the retrofit scale the property owners would be dealing directly with the FV and the interest rates provided by the FV would be comparable to the Green deal rates. . This view is reinforced by this quote from (SEAI, 2013, p. 16) '*The availability of finance at attractive rates will be central to underpinning the scheme.'*

For this LCC the author has excluded a set up charge but included an annual service charge of €25.

4.5 Loan rate calculator with and without grants received

Fixed rate loan calculator no grants	
Amount	31633.00
rate	7.82%
term	25
Bi-Monthly rate	1.26%
Number of repayments	150
Repayments Bi-monthly	€471.00
Reypayments yearly	€2,825.98
Total repayments	€70,649.46

Table 6 Fixed rate loan calculator with no grants received.

In table 6, total repayments on an upgrade loan using the interest rate from the Green deal amount to €70,649.46. If the SEAI grant system the property owners availed of were received that cost would drop to €60,152.21 as per Table 7, a difference of €10,497.25. Under this criterion the property owners would be worse off under the new PAYS system.

Fixed rate loan calculator if grants were extended	
Amount	€26933
rate	7.82%
term	25
Bi-Monthly rate	1.26%
Number of repayments	150
Repayments Bi-monthly	€401.01
Reypayments yearly	€2,406.09
Total repayments	€60,152.21

Table 7 Fixed rate loan calculator if grants where received.

Opportunity cost	
Initial deep retrofit costs Insulation to walls and roof	€27971.00
Initial deep retrofit grants Insulation to walls and roof	-€4000.00
Total deep retrofit cost	**€23,971.00**
KBC Standard demand deposit account Gross AER 1.5%	**€359.57**

Table 8 Opportunity cost of investing savings in deep retrofit upgrade.

An annual opportunity cost of €359.57 has been incurred by the property owners by investing their savings in retrofitting their property. This is interest that they would of earned on the upgrade finance had it been left on deposit account with KBC bank at 1.5 percent AER. The property owners specified that this is where the money would be kept on deposit if it had not been invested in the upgrade.

4.6 Energy use calculations

Energy use calculations are based on invoices from energy supply companies. These invoices are grouped into three years before the upgrade and three years after the upgrade. These bills are then averaged and applied to a 2010 invoice to find the difference in the cost of energy, before and after the upgrade.

Below in table 9, there is a breakdown of energy usage before and after the retrofit based on actual gas bills and readings.

Gas usage readings taken from actual bills			
Start date 15 March 2007		Reading m3	Gas used m3
Bill period 15 mar- 22may		32734	
	Jul-07	33377	507
	Sep07	33495	643
	Nov07	34042	118
	Jan-08	35035	547
	Mar-08	36212	993
	May-08	36800	1177
	Jul-08	36910	588
	Sep-08	37060	110
	Nov-08	37684	150
	Jan-09	38933	624
	Mar-09	39794	1249
	May-09	40261	861
	Jul-09	40338	467
	Sep-09	40532	77
	Nov-09	41110	194
	Jan-10	42334	578
	Mar-10	43253	1224
			919
			Deep Retrofit carried out
	May-10	43736	483
	Jul-10	43813	77
	Sep-10	43978	165
	Nov-10	44422	444
	Jan-11	44924	502
	Mar-11	45285	361
	May-11	45483	198
	Jul-11	45483	0
	Sep-11	45573	90
	Nov-11	45859	286
	Jan-12	46410	551
	Mar-12	46724	314
	May-12	46952	228
	Jul-12	46952	0
	Sep-12	47109	157
	Nov-12	47465	356
	Jan-13	47971	506
9 Feb. - 17 April 01/03/2013 = 67 days		48595	307
48595-47971=624		624/67=9.313	
9 Feb - 14th March = 33 days			
9.313*33=307		Finish date 14 March 2013	

Table 9 Energy use breakdown before and after upgrade.

Average Annual Fuel use before and after Deep Retrofit		
Gas usage	**Before deep retrofit**	**After deep retrofit**
	507	483
	643	77
	118	165
	547	444
	993	502
	1177	361
	588	198
	110	0
	150	90
	624	286
	1249	551
	861	314
	467	228
	77	0
	194	157
	578	356
	1224	506
	919	307
Total fuel use over three years in m3	11026	5025
Average fuel use over three years in m3	3,675	1,675
Conversion factor to convert gas in m3 to kWh	11.3625	11.3625
Average fuel use over three years in kWh	41760.98	19032.188

Table 10 Difference in gas usage averaged over three years before and after retrofit.

Table 10 above clearly shows a huge reduction in gas usage after the upgrade compared to before. Fuel use has dropped to 46 percent of previous use when averaged over the three years before and after the upgrade.

2010 Charges applied to average annual fuel use before deep retrofit			
Standing charge per day	0.164	365	€ 59.86
Carbon tax per kWh	0.00277	41760.975	€ 115.68
Gas charges per kWh	0.03932	41760.975	€ 1,642.04
			€ 1,817.58
VAT at 13.5%			113.50%
Total cost			€ 2,062.95

Table 11 Average gas usage before upgrade applied to a utility suppliers 2010 bill format.

2010 Charges applied to average annual fuel use after deep retrofit			
Standing charge per day	0.164	365	€ 59.86
Carbon per kWh	0.00277	19032.188	€ 52.71
Gas charges per kWh	0.03932	19032.188	€ 748.34
			€ 860.92
VAT at 13.5%			113.50%
Total cost			€ 977.14

Table 12 Average gas usage after upgrade applied to a utility suppliers 2010 bill format.

Tables 11 and 12 show the gas usage before and after the upgrade applied to the utility suppliers bill format including standing charges, carbon tax, gas charges and VAT. It gives the annual financial value of the upgrades in lower fuel bills at €1,085.80.

4.7 Carbon emissions calculations

Carbon Emissions		
	5.4055kwh is equal to 1kg of carbon emissions	
kg of carbon emissions before deep retrofit	41760/5.4055	7725.6452
kg of carbon emissions after deep retrofit	19032/5.4055	3520.8931
Kg difference per year		4204.7521
Kg Carbon emissions saved over 30 years		126142.56
Tonnes of carbon emissions saved over 30 years		126.14256

Table 13 Applying before and after upgrade gas usage to carbon emissions.

One of the pillars of sustainability is the environment and a reduction in gas usage means a reduction in greenhouse gas emissions. When the carbon saved from the upgrade is calculated over 30 years there is a saving in carbon emissions of 126 tones.

4.8 Results of the LCC

General Guidance			
Name of Project: **Case study in deep retrofit options based on fuel use before and after retrofit**			
All figures are inclusive of VAT. Base Price Date: **01 June 2010** Construction Estimate: **Based on receipted costs** **NPV Base Date: 01 June 2010** Periods: **1st June/31st May**			
General Information			
Option Name	**Real Cost**	**Escalated Cost**	**Present Value**
Option 1 Deep retrofit with opportunity cost	**91,483.44**	**162,685.48**	**129,280.17**
Option 2 do nothing	**71,925.94**	**173,760.53**	**132,008.32**
Option 3 with PAYS	**125,037.95**	**215,196.46**	**167,584.14**

Table 14 Results of LCC on options one to three.

When the summary is compiled of the LCC, option two (do nothing) comes out best in real cost, but when costs are escalated to allow for cost price increases, option one which includes the opportunity cost of the financing the upgrade is best. When costs are brought back to their present value after being escalated, option one again is best. Option three which ran the LCC with the new PAYS system is the least financially advantageous in all three groupings. Overall option one, investing in the retro fit under the original SEAI Home Energy Saving Scheme is the most financially advantageous option.

In this case study the opportunity cost of missing out on interest the finance invested in the retro fit would make, has been taken into account, as have the investment choices of

the owners of the property, if this opportunity cost is not included in the LCC, the deep retro fit proves to even more financially advantageous to the property owners as can be seen in table 15.

Option 1 Deep Retrofit without opportunity cost	**80,696.49**	**148,985.42**	**118,493.22**

Table 15 LCC figures of option one without opportunity cost.

A breakdown of how these figures were calculated is provided in the following three tables 16, 17 and 18 which provide the breakdown of the Base costs, Escalated costs and the escalated costs brought back to their present value.

	BASE/REAL COST LIFECYCLE and Service costs	Option 1 Deep retrofit With opp. Cost	Option 2 Do nothing	Option 3 Deep retrofit With PAYS
	Initial deep retrofit costs			
	High Efficiency Gas Boiler with Heating Controls	3,662.00	3,662.00	
	Insulation to walls and roof	27,971.00		
	Initial deep retrofit grants			
	High Efficiency Gas Boiler with Heating Controls	-700.00	-700.00	
	Insulation to walls and roof	-4,000.00		
	Total deep retrofit cost	**26,933.00**	**2,962.00**	**0.00**
	Opportunity cost on Retrofit investment	10,786.95		
	Total Opportunity Cost	**10,786.95**	**0.00**	**0.00**
	1. Lifecycle costs			
1	**HEATING AND CONTROLS UPGRADE**			
1A	Replace Boiler and controls every 15yrs.	7,324.00	3,662.00	7,324.00
1B	Radiators fitted in 1995 and need replacing in 2020.(25 year cycle)	6,000.00	6,000.00	6,000.00
1C	Pipework installed in 1995 need replacing in 2035.(40 year cycle)	5,000.00	5,000.00	5,000.00
2	**External Painting**			
2A	Repainting external walls every 19 yrs	2,000.00		2,000.00
2B	Repainting external walls every 15 yrs (246m2)		4,000.00	
	Total Lifecycle costs	**20,324.00**	**18,662.00**	**20,324.00**
	Deep retrofit Finance cost			70,649.46
	Annual Deep retrofit Finance Operating Charge			625.00
	Total deep retrofit Finance cost	**0.00**	**0.00**	**71,274.46**
	FM Service Costs			
	Gas	29,314.49	48,726.94	29,314.49
	Absolute Acrylics maintenance	2,550.00	1,575.00	2,550.00
	Boiler Service	1,575.00	0.00	1,575.00
	Total FM Service Costs	**33,439.49**	**50,301.94**	**33,439.49**
	Cashflow Summary			
	Total deep retrofit cost	26,933.00	2,962.00	0.00
	Total Opportunity Cost	10,786.95	0.00	0.00
	Lifecycle Costs Building	20,324.00	18,662.00	20,324.00
	Total deep retrofit Finance cost	0.00	0.00	71,274.46
	Total FM Service Costs	33,439.49	50,301.94	33,439.49
	Total Cashflow	**91,483.44**	**71,925.94**	**125,037.95**

Table 16 Comparisons of Base Costs in the three options.

	NOMINAL (ESCALATED) Base Cost Inputs Lifecycle and Service	Option 1 Deep retrofit With opp. Cost	Option 2 Do nothing	Option 3 Deep retrofit With PAYS
	Initial deep retrofit costs			
	High Efficiency Gas Boiler with Heating Controls	3,662.00	3,735.24	
	Insulation to walls and roof	27,971.00		
	Initial deep retrofit grants			
	High Efficiency Gas Boiler with Heating Controls	-700.00	-700.00	
	Insulation to walls and roof	-4,000.00		
	Total deep retrofit cost	**26,933.00**	**3,035.24**	**0.00**
	Opportunity cost on Retrofit investment	13,700.06		
	Total Opportunity Cost	**13,700.06**	**0.00**	**0.00**
	1. Lifecycle costs			
1	**HEATING AND CONTROLS UPGRADE**			
1A	Replace Boiler and controls every 15yrs.	11,561.78	5,027.14	11,561.78
1B	Radiators fitted in 1995 and need replacing in 2020.(25 year cycle)	7,313.97	7,313.97	7,313.97
1C	Pipework installed in 1995 need replacing in 2035.(40 year cycle)	8,203.03	8,203.03	8,203.03
2	**External Painting**			
2A	Repainting external walls every 19 yrs	2,913.62		2,913.62
2B	Repainting external walls every 15 yrs (246m2)		5,283.66	
	Total Lifecycle costs	**29,992.39**	**25,827.80**	**29,992.39**
	Deep retrofit Finance cost			92,327.27
	Annual Deep retrofit Finance Operating Charge			816.77
	Total deep retrofit Finance cost	**0.00**	**0.00**	**93,144.05**
	FM Service Costs			
	Gas	86,391.86	142,746.58	86,391.86
	Absolute Acrylics maintenance	3,517.25	2,150.91	3,517.25
	Boiler Service	2,150.91	0.00	2,150.91
	Total FM Service Costs	**92,060.02**	**144,897.50**	**92,060.02**
	Cashflow Summary			
	Total deep retrofit cost	26,933.00	3,035.24	0.00
	Total Opportunity Cost	13,700.06	0.00	0.00
	Lifecycle Costs Building	29,992.39	25,827.80	29,992.39
	Total deep retrofit Finance cost	0.00	0.00	93,144.05
	Total FM Service Costs	92,060.02	144,897.50	92,060.02
	Total Cashflow	**162,685.48**	**173,760.53**	**215,196.46**

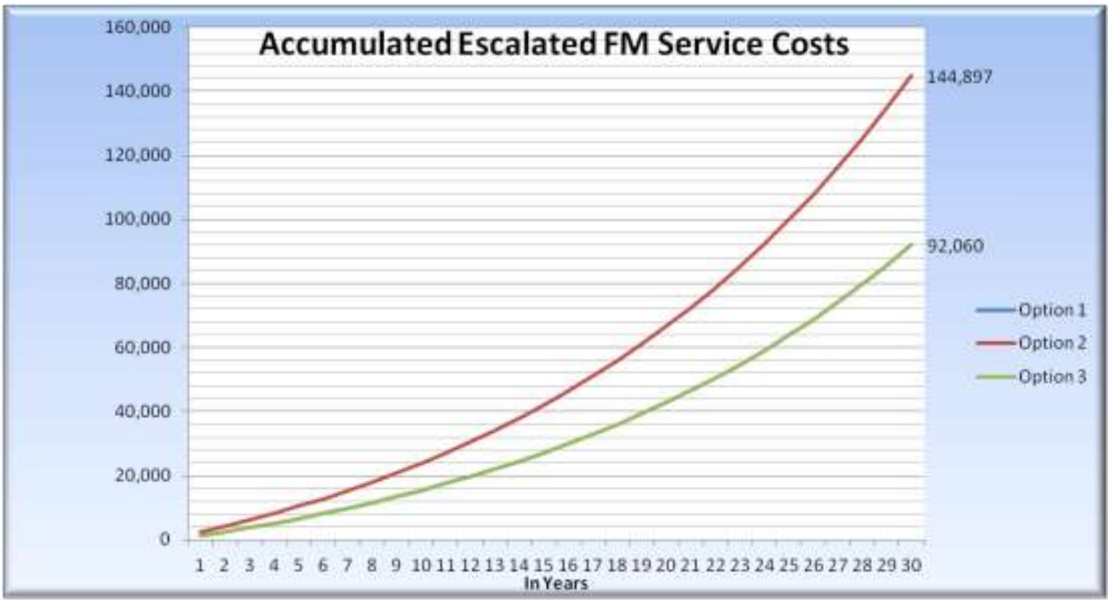
Table 17 Comparisons of Escalated Costs in the three options.

	Escalated Lifecycle and Operational Costs in PRESENT VALUE terms	Option 1 Deep retrofit With opp. Cost	Option 2 Do nothing	Option 3 Deep retrofit With PAYS
	Initial deep retrofit costs			
	High Efficiency Gas Boiler with Heating Controls	3,662.00	3,680.04	
	Insulation to walls and roof	27,971.00		
	Initial deep retrofit grants			
	High Efficiency Gas Boiler with Heating Controls	-700.00	-700.00	
	Insulation to walls and roof	-4,000.00		
	Total deep retrofit cost	**26,933.00**	**2,980.04**	**0.00**
	Opportunity cost on Retrofit investment	10,786.95		
	Total Opportunity Cost	**10,786.95**	**0.00**	**0.00**
	1. Lifecycle costs			
1	**HEATING AND CONTROLS UPGRADE**			
1A	Replace Boiler and controls every 15yrs.	8,185.80	3,961.54	8,185.80
1B	Radiators fitted in 1995 and need replacing in 2020.(25 year cycle)	6,302.21	6,302.21	6,302.21
1C	Pipework installed in 1995 need replacing in 2035.(40 year cycle)	5,653.58	5,653.58	5,653.58
2	**External Painting**			
2A	Repainting external walls every 19 yrs	2,195.73		2,195.73
2B	Repainting external walls every 15 yrs (246m2)		4,277.26	
	Total Lifecycle costs	**22,337.31**	**20,194.58**	**22,337.31**
	Deep retrofit Finance cost			75,357.27
	Annual Deep retrofit Finance Operating Charge			666.65
	Total deep retrofit Finance cost	**0.00**	**0.00**	**76,023.92**
	FM Service Costs			
	Gas	64,771.60	107,136.69	64,771.60
	Absolute Acrylics maintenance	2,754.30	1,697.01	2,754.30
	Boiler Service	1,697.01	0.00	1,697.01
	Total FM Service Costs	**69,222.91**	**108,833.69**	**69,222.91**
	Cashflow Summary			
	Total deep retrofit cost	26,933.00	2,980.04	0.00
	Total Opportunity Cost	10,786.95	0.00	0.00
	Lifecycle Costs Building	22,337.31	20,194.58	22,337.31
	Total deep retrofit Finance cost	0.00	0.00	76,023.92
	Total FM Service Costs	69,222.91	108,833.69	69,222.91
	Total Cashflow	**129,280.17**	**132,008.32**	**167,584.14**

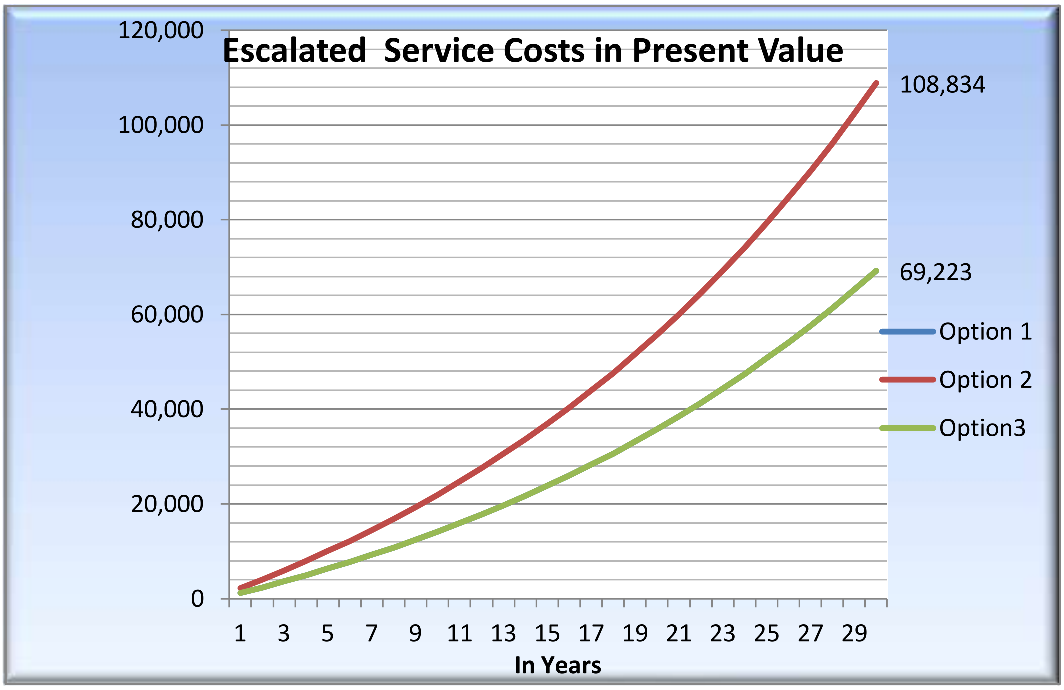
Table 18 Comparisons of Escalated Costs in Present Value.

In the following three graphs, option one and option three are the same because they share the same work and service timelines irrespective of how the original finance is provided. Both options also benefits from having lower gas consumption. Option two, the do nothing option is dearer because of the higher amount of gas used to heat the property.

Graph 1Accumulated service costs



Graph 2Accumulated escalated service costs.

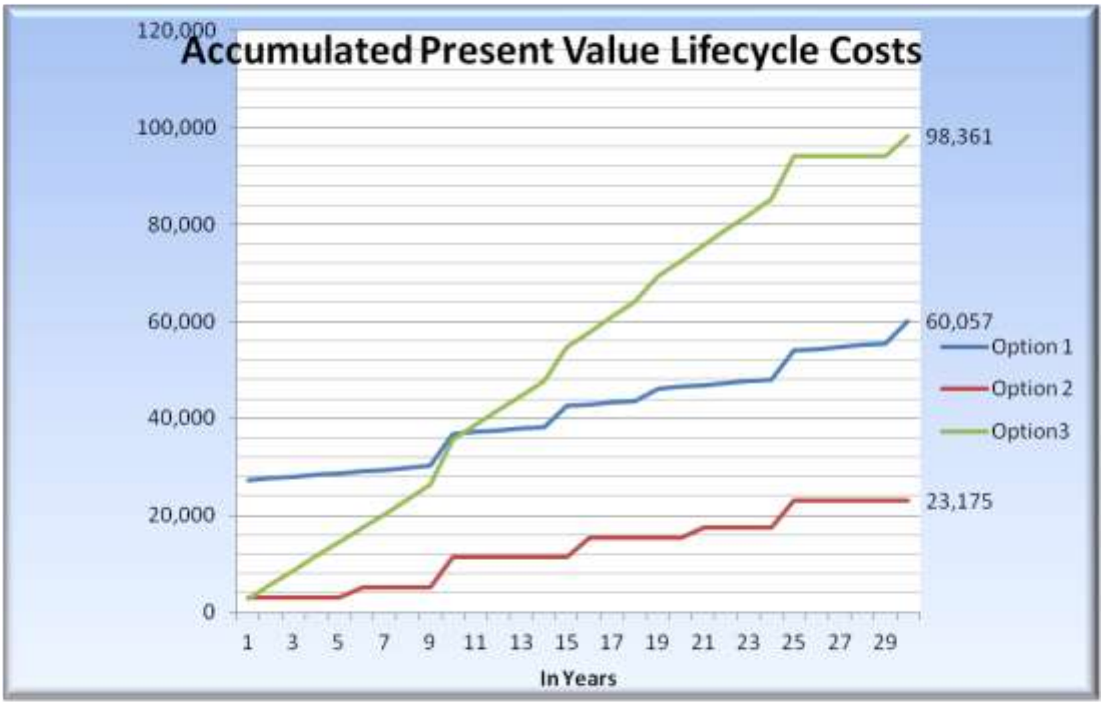


Graph 3 Escalated service costs accumulated in present value.

Of the Accumulated Life Cycle costs, Accumulated Escalated Life Cycle costs and the Accumulated Present Value Life Cycle costs, option two is cheaper because it has no initial outlay to upgrade the property. The difference between option one and three is the cost of finance for option three is much greater than the opportunity cost in option one of investing in an upgrade.

Graph 4 Accumulated lifecycle costs.

Graph 5 Accumulated escalated lifecycle costs.



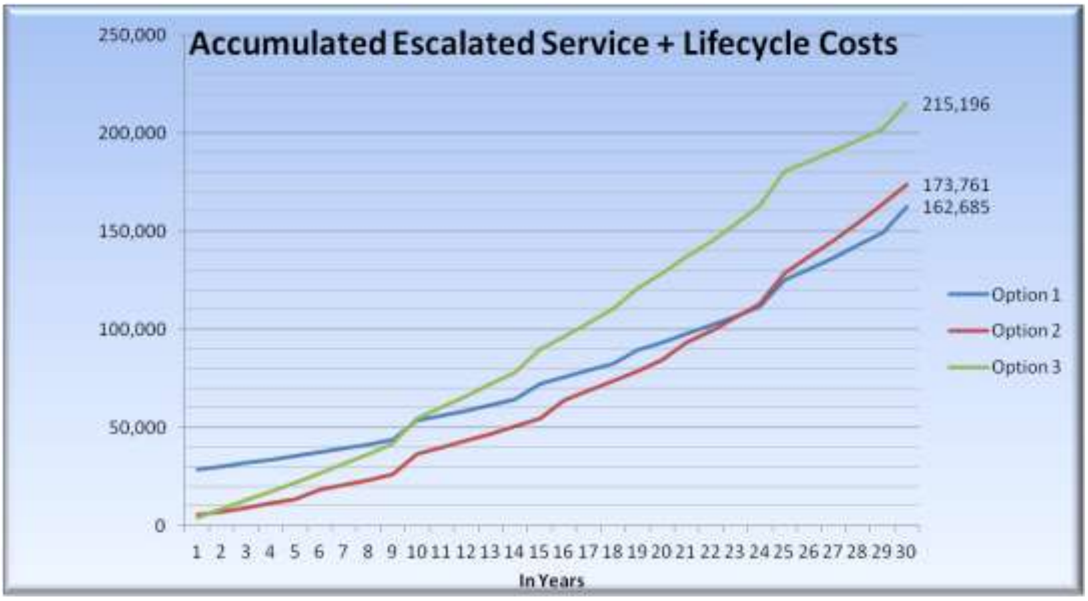
Graph 6 Lifecycle costs accumulated in their present value

When annual running costs are combined with set up costs and lifecycle costs, option two is looking the best value. However when these costs are escalated to allow for varying inflation rates, option one is shown to be the best value. When these escalated costs are brought to present values, option one is still shown to be the most financially advantageous solution. The difference between option one where the property owner had work done under the SEAI Home Energy Saving Scheme and option three where the new PAYS scheme is used is €38,304. This shows that the property owners were much better off for having availed of the scheme when they did.

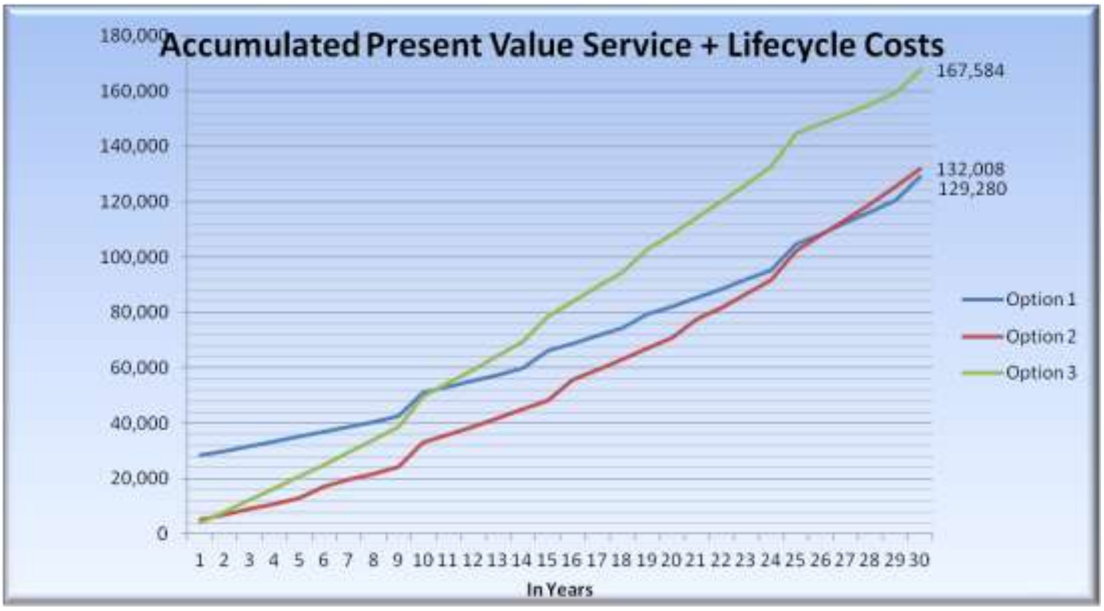
It is important to again point out that the property owners used savings and grants to pay for the upgrade. If the property owners had taken out a loan the interest would need to match or beat the given PAYS interest rate for them to retain the advantage of having received grants.

When the difference between option one and option two is examined it is shown that there is very little difference between them when the costs are brought back to present values. The difference is only €2,728. This difference is strongly influenced by the projected costs of gas and carbon tax, which if they where to rise to 7.29 percent instead of the rate of 6.29 percent used the difference between option one and two would rise to €11,000 but if it were to drop to 5.29 percent option two would be cheaper by €4,000.

Graph 7 Accumulated service and lifecycle costs



Graph 8 Escalated service and lifecycle costs



Graph 9 Escalated service and lifecycle costs in their present value.

4.9 Energy poverty

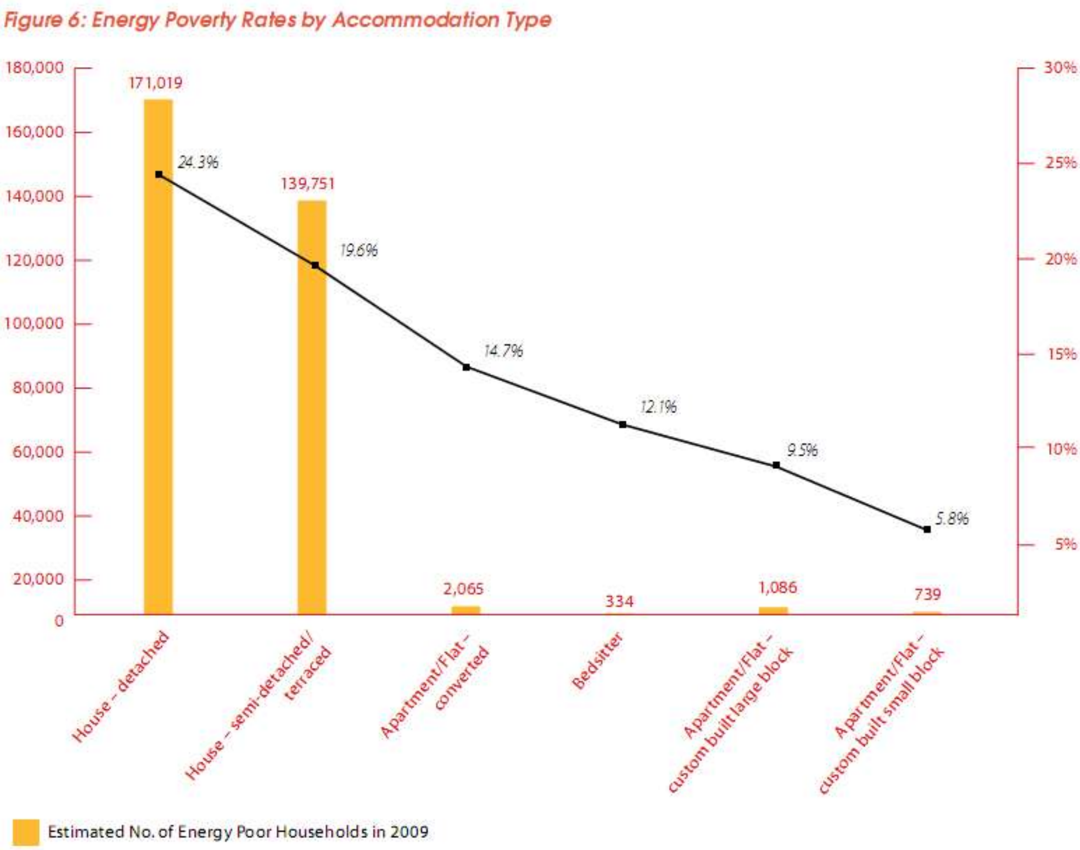


Table 19 Energy poverty rates by accommodation (Department of Communications, Energy and Natural Resources, 2011)

As can be seen in Table 19, the case study house, being a detached house is in a high risk category of fuel poverty and the deep retrofit in energy efficiency that has taken place helps to significantly lower this risk both in the short and long term. A drawback on this case study property is that a Building Energy Rating (BER) cert was not obtained before and after the upgrade but in figures published by the Department of Communications, Energy and Natural Resources (2011) on page 28, 29 and 30, the risk of energy poverty on a detached house this size (300sq/m) goes from 45.6 percent as a BER G rating to 10.1 percent for a BER B3 rating depending on the household income. The upgrade will have substantially increased the BER rating on the property leaving a reduced risk of energy poverty.

According to Curtain (2009) the exchequer spends approximately €400 Million per annum mitigating fuel poverty. The author also states that in 2005 150,000 homes experienced some form of fuel poverty. If these energy efficient upgrades were to become common place, both the exchequer bill for fuel poverty and the social suffering due to fuel poverty would be greatly reduced. One of the aims of the PAYS Scheme is making the use of the scheme so common place that '*The consumer regards the scheme as something that peers do'* (SEAI, 2013).

Joseph Curtain (2009) also provides figures to show that there were 173,327 housing units built in the period 1972-1978 which is the period our case study property was built, with a typical BER grade of E1-E2. After allowing for the fact the case study property is a large property the author will allow an average fuel saving of half that of the case study property. If these savings were to be applied to this periods housing stock, a saving of Eleven million tons of carbon and a financial saving of 2.823 billion Euros would be experienced. Bearing in mind we import most of our fuel needs, this is money kept in the Irish economy. These figures are only based on the 173,327 houses of this particular period, according to Curtain and Maguire, (2011) the government plans on retrofitting one million buildings by 2020 resulting in an even higher fuel and carbon saving.

4.10 Carbon and fuel savings from upgrade

Carbon Emissions	
Tones of carbon emissions saved over 30 years in tones	126.1425631
Allow factor of .5 for large property size	63.07128157
Multiply by number of units built between 1972-1978	173,327
	10,931,956
Tones of carbon emissions saved if all units built during this period upgraded as per case study property.	11 million

Table 20 Carbon emissions saved when 1972-1978 units upgraded to case study standard

Fuel Savings	
Fuel cost savings from upgrade	€ 1,085.80
Allow factor of .5 for large property size	€ 542.90
Multiply by number of units built between 1972-1978	173,327
	€94,099,492
Multiplied by 30 for case study period	30
Amount of money saved on fuel if all units built during this period upgraded as per case study property.	€2,822,984,768

Table 21 Financial savings when 1972-1978 units upgraded to case study standard

For table 20 and 21 the author has allowed for a factor of .5 to compensate for the large property used in the case study. The property used in the case study received grants on the larger end of the scale due to its size, grants for smaller properties are proportionately smaller, such as for external insulation an apartment or mid-terrace house receiving a grant of €1,800 and €2,700 for a semi-detached or end of terrace, these grants drop lower again for internal insulation upgrades €900 and €1350 respectively. Due to these lower grants the author has used an average grant receivable of half that of the case study in line with the fuel reduction factor of .5 already used. When these criteria are applied to the properties built in the case study build period the cost of financing the grants are 407 million euro.

4.11 Cost and return to exchequer

Cost of Grants		
Grants received for case study property	€	4,700
Allow factor of .5 for large property size	€	2,350
Multiply by number of units built between 1972-1978		173,327
		€407,318,450
Cost of grants if all units built during this period upgraded as per case study property.		407 million Euro

Table 22 Cost of grants to exchequer to up grade units built in the 1972-1978 period.

This gives a saving on fuel of 2.823 billion Euros on grants payable of 407 million Euros. This is money kept in the economy and not spent on imports. When the amount of carbon saved, calculated at 11 million tons is multiplied by a carbon credit of 16 Euro which is the average rate given in figure 3 sourced from Swartz (2013) for 2010, we get a direct saving of 176 million Euro on carbon credits. The reduction in government grants to alleviate fuel poverty is hard to quantify as it is on a case by case basis but there is definitely a saving there also.

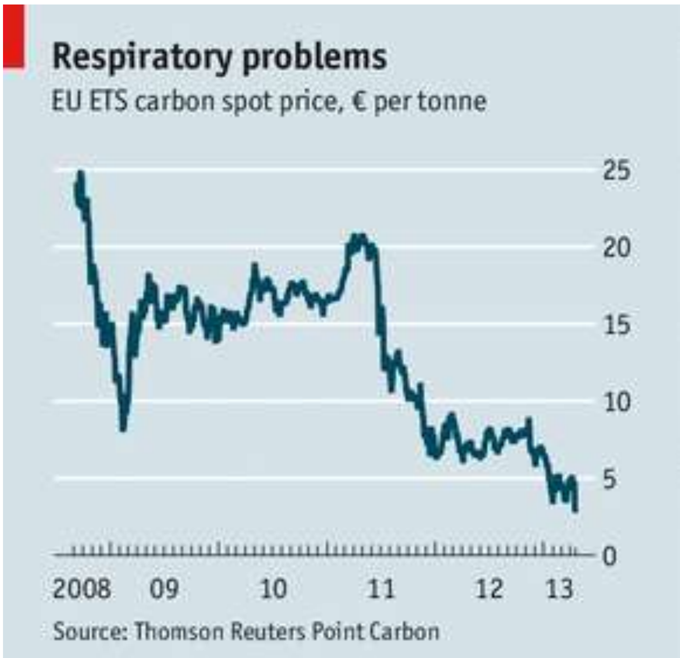


Figure 4 Carbon prices electronic trading system (ETS) trading.

4.13 Interview with case study property owners

Interview took place at the case study property on Saturday June the first 2013. The interviewer was Adrian Sheerin and the interviewees were Graham Cheery and Sinead Leyne.

Has occupancy changed over the six years of the case study in any way, resulting in a change in fuel use? No, there has been no change.

Since the upgrade has the average temperature of the property risen? The thermostat was set for 20 Degrees before and after the upgrade but the house would stay warmer longer since the upgrade.

Are you more comfortable in the property? Yes we never think about heating except to enjoy it.

Was the upgrade influenced by environmental reasons and do you thing the upgrade has had an environmental impact? It was a partial influence on our decision. Looking at the lower fuel use it must have a good environmental impact.

Was it disturbing/inconvenient having the upgrade work done? It was only slightly inconvenient for two weeks. We have no bad memories of it.

Do you find the heating zone controls convenient? Yes now we just heat downstairs during the day, before it was annoying to think of the wasted heat upstairs were it wasn't needed.

Are you glad you had the upgrade done and would you do it again in a different property? Yes and Yes.

How big an influence were the grants in your decision to upgrade the property? It drew our attention to getting an upgrade, you could call it a sweetener, the fact others were getting it done also drew our attention to it, we are not sure if the grants hadn't been available would there have been so much interest it.

Would you use the PAYS system to upgrade a property? No, too expensive with no upside.

Would you take a personal loan to upgrade a property? Only at a very low interest rate.

How did you finance the upgrade? Savings and grants.

If you placed money in a deposit account what interest rate would it receive? 1.5 percent with KBC bank.

How do you feel about the investment in the upgrade going to the local economy instead of on imported fuel? It is far more preferable than fuel imports.

Would you recommend an upgrade to others, through?

A. Savings and grants? Yes
B. Finance and grants? No from a finance view. Yes from a comfort view.
C. PAYS? No it would be cheaper to spend more on fuel.

Any Comments? Delighted with the speed the house heats up (15 minutes) and how long the house retains the heat after the boiler shuts down. The house is more comfortable now, before we would balance comfort with cost, not anymore. We had worked out a 20 year payback but hadn’t allowed for opportunity costs.

4.14 Industry take on PAYS set up process

Information gathering from Ann Finneran in Airtricity via email. Date; June 22 2013.

1. What are the outline proposals for PAYS? –

Is it going to be based on the UK Greendeal? –

Answer - There will be a public consultation in July - think towards the end, in the meantime here are some documents suggesting its format and the scope of the BEF (Better Energy Financing Project, we got a name change)

http://www.seai.ie/Better_Energy_Financing/Home/

2. Is there a reason why isn't there an agreement yet? Is January 2014 still a target date?

Answer - The project is to suggest a proposal, the implementation is in 2014.

3. Are there any re-percussions of not having PAYS up and running for the industry and the government?

Answer - In Great Britain, a poor transition to the Greendeal resulted in a loss of jobs in the installation industry.

4. Are the other EU countries on target for 2014?

Answer - I don't know, SEAI or Dept of Energy or Europe probably have a report on current status.

5. Have any proposals being accepted, rejected or still being debated?

Answer - Refer to high level principles and then to consultation in July.

6. How long after agreement is made with the government will industry have to implement it?

Answer - Less than a year. Some have mentioned 6 months, but that is not possible in my opinion.

7. Who is going to finance the upgrades, established banks, a new bank, and underwriters?

Answer - I don't know, it’s still being debated, and consultation in July should have a proposal.

8. Have you any further information I have not asked for?

Answer - Consultation paper in July and website should provide plenty of reading.

Chapter 5 Conclusions and Recommendations

5.1 Thesis aims

The purpose of this thesis is to assess the value of an insulation and boiler upgrade under the current SEAI Schemes based on actual fuel readings in comparison to the new PAYS scheme. The author felt the best way to do this is through Quantitative methods and applied both schemes to a case study property for Life Cycle Cost analysis. It is clear from the analysis carried out in chapter four that undertaking the retrofit under the current SEAI Warmer Homes scheme is much more financially beneficial to the property owners than the incoming PAYS scheme. The difference between the schemes is 33% in favour of the original scheme.

5.2 Thesis objectives

- To assess the property upgrades undertaken and how they contribute to fuel savings. - This is done in tables 9,10,11, and12 showing an annual fuel saving of €1,085.80
- To critically appraise the true financial savings or cost to the property owners as owner occupiers of upgrading the property using SEAI grants.- When the two LCC scenarios option 1 and option 2 in table 18 a difference of €2,728 in favour of option 1 is shown over a 30year time frame.
- To compare what the financial difference would be if they used the PAYS system instead of SEAI grants. - In table 18 the results of an LCC into the option 1 scenario and the option 3 scenario are shown side by side with a difference of €38,304 in favour of option 1.
- To find out the true cost to government of providing both schemes to the property owner after costs are offset against EU level fines. - In the interview with the property owners they stated that they would not have upgraded the property under the PAYS scheme. The savings on fuel in the case study 30 year period is €32,574 compared to government grants of €4,800. That's a return on investment of 679 percent. This is money that is not going towards paying for exports, and a carbon credit saving of €2,016. The author also discusses in chapter four the decreased risk of fuel poverty, employment instead of unemployment benefit and environmental advantages of reduced fuel use.

5.3 Limitations of thesis

At the time the retrofit was undertaken the home owner under the SEAI scheme did not need a before and after BER cert. the Author is of the opinion that these certificates would have been very useful for the case study.

Final agreement on how the PAYS system will operate in Ireland has not yet been reached. This has influenced the authors' ability to interview people in the industry. The final agreement might also influence the LCC models.

5.4 Conclusion

The grants, under the SEAI scheme have reduced since the property owners availed of their grants. The external wall insulation grant for a detached house is now €3,600, it was €4,000. The heating controls with boiler upgrade is now €560, it was €700. Therefore if the property owners had delayed their upgrade they would have missed out on €540 in grants. These changes do not influence the end result that the current system is much more financially advantageous to the property owner than the new PAYS scheme.

The most disturbing finding from the analysis is that the PAYS scheme costs the property owner more than doing nothing. The property owner is financially better off spending more on fuel than upgrading the energy efficiency of the property. The government plans on phasing out the grant scheme in 2014 and this author thinks this will have a negative effect on the number of upgrades undertaken and the governments retrofit targets will be missed. This risk is also identified by SEAI (2013) when they recommend a transition phase of grants being run in conjunction with the PAYS scheme to prevent a drop off in retrofit activity. This report also stresses the importance of finance being supplied at attractive rates for the scheme to work.

The PAYS scheme is based on Britain's Green deal and the two important aspects of the Green deal is that the loan for the energy upgrades rests with the property not the individual and the Golden Rule is that the loan repayments must be equal to or less than the monies saved by the energy upgrade making it cost neutral. In the SEAI (2013) report this is not stressed leading this author to fear financially negative upgrades being undertaken under the PAYS scheme or due to the high cost, too many properties failing to get approval in the scheme.

The reason for initiatives for the public to upgrade their property is to reduce energy consumption. For the individual this might be cost positive, negative or neutral, there may be very little difference financially from doing nothing but their home environment is improved and the risk of fuel poverty is lessened. The individual also knows that there is more cost certainty in their energy bills.

From the governments position the more homes that have energy upgrades the closer they get to their international emission target obligations. This also reduces the risk of fines or the need to buy carbon credits to cover the difference. It also leads to better energy security since less fuel imports are needed, with a current rate of 89 percent (IIEA 2009) of our fossil fuel needs being imported this risk should not be understated. Property upgrades are also monies that are spent in the local economy rather than paying for imports. Any drop off or uptake in retro fits also affects employment and social welfare claims as when one goes up the other goes down, and since the collapse in the construction industry it is one of the few construction employers. The higher the uptake in retrofits also lessens the social energy bill for the government. From an environmental viewpoint in which the government invests resources on behalf of its citizens it is also a positive step to a cleaner, healthier environment.

It is this author's assertion that moving from the current Warmer Homes scheme to the PAYS scheme will have a negative impact on the number of property owners investing in energy efficient upgrades due to the loss of grants and the high cost of finance, certainly for the case study carried out in this thesis the PAYS scheme was financially negative compared to doing nothing. If the golden rule of the upgrade being cost neutral was applied, the case study property would not have been approved for an upgrade under the PAYS scheme. The government needs to incentivize as many property owners as possible to upgrade and a financial incentive in the form of grants, tax rebate or some other financial incentive is the best way to achieve this. Since the scheme that entices the most upgrades will have the strongest effect economically, socially and environmentally the current Warmer Homes scheme is more advantageous than the incoming PAYS scheme.

5.5 Recommendations

- Keep the grants system currently in operation to keep a financial incentive. It provides the impression of a bargain.
- Tie the dept to the property not the individual. A PAYS upgrade should add value to the property so this dept should be secured on the property. It also gives security for the financial institutions and gives the customer the perception of less personal risk.
- Only introduce PAYS when finance is available close to mortgage rates. High finance costs will deter customers and give the scheme a bad reputation.
- Enforce the golden rule that any upgrades are at least cost neutral. If the public perception is that no application will be approved unless it passes the golden rule, it will reassure the public that acceptance on the scheme is good value.
- Advertise heavily to make as many people aware as possible what is being offered.

References

Works Cited

Addis, B. & Talbot, R., 2001. *Sustainable Construction Procurement.* London: CIRIA.
Anon., 2003. *Research Methods in Education.* 2 ed. Milton Keynes: Open University.
Anon., 2010. *The Green Deal A summary of the Governments Proposals,* London: Department of Energy and Climate Change.
Anon., 2011. *Warmer Homes A Strategy for Affordable Energy in Ireland,* Dublin: Department of Communications Energy and Natural Resources.
Anon., 2012. *The Case For Sustainable Energy,* Dublin: SEAI.
Anon., 2013. Part L Conservation of Fuel. In: *Building Regulations* . Dublin: Department of the environment.
BCIS-BSi, 2008. *Standardized Method of Life Cycle Costing for Construction Procurement.* London: BSi.
Bell, J., 2005. *Doing your research project.* 4 ed. Maidenhead: Open University Press.
Bothe, M. & Rehbinder, E., 2005. *Climate Change Policy.* s.l.:Eleven International Publishing.
BRE Global LTD, 2011. *BREEM new construction.* London: BRE press.
BRE trust and Cyril sweet, 2005. *Putting a price on sustainability.* london: BRE publications.
BSi, 2008. *Buildings and Constructeed assets-Service life planning.* London: BSi.
CA-EPBD, 2010. *Executive Summary Report of the CA-EPBD,* Porto: CA-EPBD.
CA-EPBD, 2013. *Implementing the Energy Performance of Buildings Directive,* Porto: CA-EPBD.
Churcher, D., 2008. *Whole- life Costing Analyses.* Bracknell: BSRIA.
CIBSE, 2007. *Sustainability.* Norwich: CIBSE publications.
Curtain, J., 2009. *Jobs growth and Secure Energy Costs Greenprint for a National Energy Efficiency Retrofit ProgrammeProgramme,* Dublin: Institute of international and European Affairs.
Curtain, J. & Hanrahan, G., 2012. *Why Legislate? Designing a Climate Law for Ireland,* Dublin: Institute of international and European Affairs.
Curtain, J. & Maguire, J., 2011. *Thinking Deeper: Financing Options for Home Retrofit,* Dublin: Institute of International and European Affairs.
Department of Communications, Energy and Natural Resources, 2011. *Warmer Homes A Strategy for Affordable Energy in Ireland,* Dublin: Government Publications.
Department of the Environment, Heritage and Local Government, 2007. *Ireland: National Climate Change stratagy 2007-2012,* Dublin: Government Publications.
Environmental Protection Agency, 2013. *Irelands Greenhouse Gas Emissions Projections 2012-2030,* Dublin: EPA .
Halliday, S., 2008. *Sustainable Construction.* London: Butterworth-Heienmann.
Hoven, M. V. D., 2012. *The Journal of the International Energy Agency* [Interview] (Autumn 2012).
IEA, 2012. *World Energy Outlook.* Paris: IEA.
Macken, D. K., 2011. *The EU Emissions Trading Scheme,* s.l.: EPA.
Macken, D. K., 2011. *The EU Emissions Trading Scheme: A Review Of The First Six Years Of Operation,* Dublin: Environmental Protection Agency.
Office of Government Commerce, 2003. *Achieving Excellance in Construction.* London: HM Treasury.
Open Europe, 2007. *Europe's dirty secret:Why the EU Emissions Trading Scheme isn't working,* London: Open europe.

Perman, R. et al., 2003. *Natural Resource and Environmental Economics.* London: Pearson Education Limited.
SEAI, 2011. *Energy Forecasts for Ireland to 2020.* 1.3 ed. Dublin: SEAI.
SEAI, 2013. *2012 Statement of Achievements,* Dublin: SEAI.
SEAI, 2013. *Better Eneregy Financing Scheme Outline Discussion Document,* Dublin: SEAI.
Stavins, R., 2012. *Climate Change on World Stage* [Interview] (19 December 2012).
Swartz, 2013. ETS RIP The failure to reform Europe's carbon market will reverberate round the world. *The Economist*, 20 April.
Tietenberg, T. H., 2013. *Reflections - Corbon Pricing in Practice.* Oxford: Oxford University Press.
Yamin, F., 2006. *Climate Change and Carbon Markets.* London: EarthScan.

Electronic sources

Background on the UNFCCC: The international response to climate change. Available at (http://unfccc.int/essential_background/items/6031.php)

Status of Ratification of the Convention. Available at http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php

Canada to withdraw from Kyoto protocol. 13 December 2011. Available at http://www.bbc.co.uk/news/world-us-canada-16151310

Green Paper - Towards a European strategy for the security of energy supply (Presented by the Commission) available at ; http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52000DC0769:EN:HTML

EU carbon edges higher for 5th day, extends 3-wk high. 25 July 2013, Point Carbon. (http://www.pointcarbon.com/news/1.2481847)

Better Energy Financing Project, SEAI, (http://www.seai.ie/Better_Energy_Financing/Home/)

IEA, World Energy Outlook, 2009 http://www.worldenergyoutlook.org/media/weowebsite/2009/WEO2009.pdf

Europa.eu, World Energy Technology Outlook to 2050, 2007http://europa.eu/rapid/press-release_MEMO-07-2_en.htm

Europes Energy Portal, EU Energy Trends to 2030 http://www.energy.eu/publications/Energy-trends_to_2030.php

Department of Energy and Climate Change, DECC Fossil Fuel Price Projections, 2012 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65698/6658-decc-fossil-fuel-price-projections.pdf

UN Special, Interview with WMO SECRETARY-GENERAL MICHEL JARRAUD,April 2009.(http://www.unspecial.org/UNS683/t22.html)

Appendices

LCC Base/Real Cost Operations

BASE/REAL COST OPERATIONS

Option 1 Deep Retrofit with opportunity costs

Cashflow Information	*Total*	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000
FM Service Costs															
Gas	29,314.49	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15
Absolute Acrylics maintenance	2,550.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
Boiler Service	1,575.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00
Total FM Service Costs	**33,439.49**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**

Option 2 do nothing

Cashflow Information	*Total*	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000
FM Service Costs															
Gas	48,726.94	2,062.95	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10
Boiler Service	1,575.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00
Other (please specify)															
Total FM Service Costs	**50,301.94**	**2,167.95**	**1,609.10**	**1,714.10**	**1,609.10**	**1,714.10**	**1,609.10**	**1,714.10**	**1,609.10**	**1,714.10**	**1,609.10**	**1,714.10**	**1,609.10**	**1,714.10**	**1,609.10**

Option 3 Deep retrofit with PAYS

Cashflow Information	*Total*	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000
FM Service Costs															
Gas	29,314.49	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15
Absolute Acrylics maintenance	2,550.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
Boiler Service	1,575.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00
Total FM Service Costs	**33,439.49**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**

31-May-24 Year 14 €000	31-May-25 Year 15 €000	31-May-26 Year 16 €000	31-May-27 Year 17 €000	31-May-28 Year 18 €000	31-May-29 Year 19 €000	31-May-30 Year 20 €000	31-May-31 Year 21 €000	31-May-32 Year 22 €000	31-May-33 Year 23 €000	31-May-34 Year 24 €000	31-May-35 Year 25 €000	31-May-36 Year 26 €000	31-May-37 Year 27 €000	31-May-38 Year 28 €000	31-May-39 Year 29 €000	31-May-40 Year 30 €000
977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15
85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00
1,062.15	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**

31-May-24 Year 14 €000	31-May-25 Year 15 €000	31-May-26 Year 16 €000	31-May-27 Year 17 €000	31-May-28 Year 18 €000	31-May-29 Year 19 €000	31-May-30 Year 20 €000	31-May-31 Year 21 €000	31-May-32 Year 22 €000	31-May-33 Year 23 €000	31-May-34 Year 24 €000	31-May-35 Year 25 €000	31-May-36 Year 26 €000	31-May-37 Year 27 €000	31-May-38 Year 28 €000	31-May-39 Year 29 €000	31-May-40 Year 30 €000
1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10	1,609.10
0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00
1,609.10	**1,714.10**	**1,609.10**	**1,714.10**	**1,609.10**	**1,714.10**	**1,609.10**	**1,714.10**	**1,609.10**	**1,714.10**	**1,609.10**	**1,714.10**	**1,609.10**	**1,714.10**	**1,609.10**	**1,714.10**	**1,609.10**

31-May-24 Year 14 €000	31-May-25 Year 15 €000	31-May-26 Year 16 €000	31-May-27 Year 17 €000	31-May-28 Year 18 €000	31-May-29 Year 19 €000	31-May-30 Year 20 €000	31-May-31 Year 21 €000	31-May-32 Year 22 €000	31-May-33 Year 23 €000	31-May-34 Year 24 €000	31-May-35 Year 25 €000	31-May-36 Year 26 €000	31-May-37 Year 27 €000	31-May-38 Year 28 €000	31-May-39 Year 29 €000	31-May-40 Year 30 €000
977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15	977.15
85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00	105.00	0.00
1,062.15	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**	**1,167.15**	**1,062.15**

LCC Base/Real Cost Lifecycle

Option 1 Deep Retrofit with opportunity costs

BASE/REAL COST LIFECYCLE	***Total***	31-May-11	31-May-12	31-May-13	31-May-14	31-May-15	31-May-16	31-May-17	31-May-18	31-May-19	31-May-20	31-May-21	31-May-22	31-May-23	31-May-24
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14
		€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000
Initial deep retrofit costs															
High Efficiency Gas Boiler with Heating Controls	3662.00														
Insulation to walls and roof	27971.00														
Initial deep retrofit grants															
High Efficiency Gas Boiler with Heating Controls	-700.00														
Insulation to walls and roof	-4000.00														
Total deep retrofit cost	**26,933.00**														
Opportunity cost on Retrofit investment	10,786.95	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57
Total Opportunity Cost	**10,786.95**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**
1. Lifecycle costs															
1.00 HEATING AND CONTROLS UPGRADE															
1A Replace Boiler and controls every 15yrs.	7,324.00														
1B Radiators fitted in 1995 and need replacing in 2020.(25 year cycle)	6,000.00										6,000.00				
1C Pipework installed in 1995 need replacing in 2035.(40 year cycle)	5,000.00														
2.00 INSULATION															
2A Replace insulation every 40yrs															
2B Repainting external walls every 19 yrs (246m2)	2,000.00														
Total Lifecycle costs	**20,324.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**6,000.00**	**0.00**	**0.00**	**0.00**	**0.00**
Cashflow Summary															
Total deep retrofit cost	**26,933.00**														
Total Opportunity Cost	**10,786.95**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**
Lifecycle Costs Building	**20,324.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**6,000.00**	**0.00**	**0.00**	**0.00**	**0.00**
Total Cashflow	**58,043.95**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**6,359.57**	**359.57**	**359.57**	**359.57**	**359.57**

Option 2 do nothing

BASE/REAL COST LIFECYCLE	***Total***	31-May-11	31-May-12	31-May-13	31-May-14	31-May-15	31-May-16	31-May-17	31-May-18	31-May-19	31-May-20	31-May-21	31-May-22	31-May-23	31-May-24
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14
		€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000
1. Lifecycle costs															
1.00 HEATING SYSTEM															
1A Existing boiler fitted in 1995 and due replacement in 2010.(15yrs cycle)	7,324.00	3662.00													
1B Radiators fitted in 1995 and need replacing in 2020.(25 year cycle)	6,000.00										6,000.00				
1C Pipework installed in 1995 need replacing in 2035.(40 year cycle)	5,000.00														
2.00 PAINTING EXTERNAL WALLS															
2A External walls painted in 2001 next painting 2016. (15yr cycle)	4,000.00						2,000.00								
3.00 Grant to upgrade boiler															
3A High Efficiency Gas Boiler with Heating Controls	-700.00	-700.00													
Total Lifecycle costs	**21,624.00**	**2,962.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2,000.00**	**0.00**	**0.00**	**0.00**	**6,000.00**	**0.00**	**0.00**	**0.00**	**0.00**
Cashflow Summary															
Lifecycle Costs Building	**21,624.00**	**2,962.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2,000.00**	**0.00**	**0.00**	**0.00**	**6,000.00**	**0.00**	**0.00**	**0.00**	**0.00**
Total Cashflow	**21,624.00**	**2,962.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2,000.00**	**0.00**	**0.00**	**0.00**	**6,000.00**	**0.00**	**0.00**	**0.00**	**0.00**

Option 3 Deep retrofit with PAYS

BASE/REAL COST LIFECYCLE	***Total***	31-May-11	31-May-12	31-May-13	31-May-14	31-May-15	31-May-16	31-May-17	31-May-18	31-May-19	31-May-20	31-May-21	31-May-22	31-May-23	31-May-24
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14
		€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000
1. Lifecycle costs															
1.00 HEATING AND CONTROLS UPGRADE															
1A Replace Boiler and controls every 15yrs.	7,324.00														
1B Radiators fitted in 1995 and need replacing in 2020.(25 year cycle)	6,000.00										6,000.00				
1C Pipework installed in 1995 need replacing in 2035.(40 year cycle)	5,000.00														
2.00 INSULATION															
2A Replace insulation every 40yrs	0.00														
2B Repainting external walls every 19 yrs (246m2)	2,000.00														
Total Lifecycle costs	**20,324.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**6,000.00**	**0.00**	**0.00**	**0.00**	**0.00**
Deep retrofit Finance cost	70,649.46	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98
Annual Deep retrofit Finance Operating Charge	625.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Total deep retrofit Finance cost	**71,274.46**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**
Cashflow Summary															
Lifecycle Costs Building	**20,324.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**6,000.00**	**0.00**	**0.00**	**0.00**	**0.00**
Total deep retrofit Finance cost	**71,274.46**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**
Total Cashflow	**91,598.46**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**8,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**

Year 14 €000	Year 15 €000	Year 16 €000	Year 17 €000	Year 18 €000	Year 19 €000	Year 20 €000	Year 21 €000	Year 22 €000	Year 23 €000	Year 24 €000	Year 25 €000	Year 26 €000	Year 27 €000	Year 28 €000	Year 29 €000	Year 30 €000

359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57
359.57	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**

	3662.00															3662.00
											5,000.00					
					2,000.00											
0.00	**3,662.00**	**0.00**	**0.00**	**0.00**	**2,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**5,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3,662.00**

359.57	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**
0.00	**3,662.00**	**0.00**	**0.00**	**0.00**	**2,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**5,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3,662.00**
359.57	**4,021.57**	**359.57**	**359.57**	**359.57**	**2,359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**5,359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**4,021.57**

31-May-24 Year 14 €000	31-May-25 Year 15 €000	31-May-26 Year 16 €000	31-May-27 Year 17 €000	31-May-28 Year 18 €000	31-May-29 Year 19 €000	31-May-30 Year 20 €000	31-May-31 Year 21 €000	31-May-32 Year 22 €000	31-May-33 Year 23 €000	31-May-34 Year 24 €000	31-May-35 Year 25 €000	31-May-36 Year 26 €000	31-May-37 Year 27 €000	31-May-38 Year 28 €000	31-May-39 Year 29 €000	31-May-40 Year 30 €000
		3662.00														
											5,000.00					
							2,000.00									
0.00	**0.00**	**3,662.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2,000.00**	**0.00**	**0.00**	**0.00**	**5,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

0.00	**0.00**	**3,662.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2,000.00**	**0.00**	**0.00**	**0.00**	**5,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
0.00	**0.00**	**3,662.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2,000.00**	**0.00**	**0.00**	**0.00**	**5,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

31-May-24 Year 14 €000	31-May-25 Year 15 €000	31-May-26 Year 16 €000	31-May-27 Year 17 €000	31-May-28 Year 18 €000	31-May-29 Year 19 €000	31-May-30 Year 20 €000	31-May-31 Year 21 €000	31-May-32 Year 22 €000	31-May-33 Year 23 €000	31-May-34 Year 24 €000	31-May-35 Year 25 €000	31-May-36 Year 26 €000	31-May-37 Year 27 €000	31-May-38 Year 28 €000	31-May-39 Year 29 €000	31-May-40 Year 30 €000
	3662.00															3662.00
											5,000.00					
					2,000.00											
0.00	**3,662.00**	**0.00**	**0.00**	**0.00**	**2,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**5,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3,662.00**

2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98	2,825.98					
25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00					
2,850.98	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**					

0.00	**3,662.00**	**0.00**	**0.00**	**0.00**	**2,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**5,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3,662.00**
2,850.98	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**					
2,850.98	**6,512.98**	**2,850.98**	**2,850.98**	**2,850.98**	**4,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**2,850.98**	**7,850.98**	**0.00**	**0.00**	**0.00**	**0.00**	**3,662.00**

LCC Escalated Base Costs Operational

NOMINAL (ESCALATED) Base Cost Inputs (Operational)

Inflation / Indices

Authority Inflation / Indexation Assumptions

		%	
Period	01/06/2010 to 31/05/2070	6.29%	(per ITN)
		2.00%	(per ITN)
			(per ITN)

Indexation Date	01-Jun-10

	SCA Y1	*SCA Y2*	*SCA Y3*	*SCA Y4*	*SCA Y5*	*SCA Y6*	*SCA Y7*	*SCA Y8*	*SCA Y9*	*SCA Y10*	*SCA Y11*	*SCA Y12*	*SCA Y13*	*SCA Y14*
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Year ending	*May-11*	*May-12*	*May-13*	*May-14*	*May-15*	*May-16*	*May-17*	*May-18*	*May-19*	*May-20*	*May-21*	*May-22*	*May-23*	*May-24*
Indexation Factor - Cost category 1	1.063	1.130	1.201	1.276	1.356	1.442	1.532	1.629	1.731	1.840	1.956	2.079	2.209	2.348
Indexation Factor - Cost category 2	1.020	1.040	1.061	1.082	1.104	1.126	1.149	1.172	1.195	1.219	1.243	1.268	1.294	1.319

Option 1 Deep Retrofit with opportunity cost

Cashflow Information	***Total***	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000
FM Service Costs															
Gas	86,391.86	1,038.59	1,103.90	1,173.31	1,247.09	1,325.50	1,408.85	1,497.43	1,591.59	1,691.67	1,798.04	1,911.10	2,031.27	2,158.99	2,294.75
Absolute Acrylics maintenance	3,517.25	86.70	88.43	90.20	92.01	93.85	95.72	97.64	99.59	101.58	103.61	105.69	107.80	109.96	112.16
Boiler Service	2,150.91	107.10	0.00	111.43	0.00	115.93	0.00	120.61	0.00	125.48	0.00	130.55	0.00	135.83	0.00
Total FM Service Costs	**92,060.02**	**1,232.39**	**1,192.33**	**1,374.94**	**1,339.09**	**1,535.28**	**1,504.57**	**1,715.68**	**1,691.18**	**1,918.74**	**1,901.65**	**2,147.34**	**2,139.07**	**2,404.78**	**2,406.90**

Option 2 do nothing

Cashflow Information	***Total***	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000
FM Service Costs															
Gas	142,746.58	2,192.67	1,817.82	1,932.13	2,053.62	2,182.74	2,319.99	2,465.87	2,620.92	2,785.73	2,960.89	3,147.07	3,344.95	3,555.28	3,778.83
Boiler Service	2,150.91	107.10	0.00	111.43	0.00	115.93	0.00	120.61	0.00	125.48	0.00	130.55	0.00	135.83	0.00
Other (please specify)															
Total FM Service Costs	**144,897.50**	**2,299.77**	**1,817.82**	**2,043.55**	**2,053.62**	**2,298.67**	**2,319.99**	**2,586.48**	**2,620.92**	**2,911.21**	**2,960.89**	**3,277.62**	**3,344.95**	**3,691.11**	**3,778.83**

Option 3 Deep retrofit with PAYS

Cashflow Information	***Total***	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000
FM Service Costs															
Gas	86,391.86	1,038.59	1,103.90	1,173.31	1,247.09	1,325.50	1,408.85	1,497.43	1,591.59	1,691.67	1,798.04	1,911.10	2,031.27	2,158.99	2,294.75
Absolute Acrylics maintenance	3,517.25	86.70	88.43	90.20	92.01	93.85	95.72	97.64	99.59	101.58	103.61	105.69	107.80	109.96	112.16
Boiler Service	2,150.91	107.10	0.00	111.43	0.00	115.93	0.00	120.61	0.00	125.48	0.00	130.55	0.00	135.83	0.00
Total FM Service Costs	**92,060.02**	**1,232.39**	**1,192.33**	**1,374.94**	**1,339.09**	**1,535.28**	**1,504.57**	**1,715.68**	**1,691.18**	**1,918.74**	**1,901.65**	**2,147.34**	**2,139.07**	**2,404.78**	**2,406.90**

SCA Y14	*SCA Y15*	*SCA Y16*	*SCA Y17*	*SCA Y18*	*SCA Y19*	*SCA Y20*	*SCA Y21*	*SCA Y22*	*SCA Y23*	*SCA Y24*	*SCA Y25*	*SCA Y26*	*SCA Y27*	*SCA Y28*	*SCA Y29*	*SCA Y30*
14	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*
May-24	*May-25*	*May-26*	*May-27*	*May-28*	*May-29*	*May-30*	*May-31*	*May-32*	*May-33*	*May-34*	*May-35*	*May-36*	*May-37*	*May-38*	*May-39*	*May-40*
2.348	2.496	2.653	2.820	2.997	3.186	3.386	3.599	3.825	4.066	4.321	4.593	4.882	5.189	5.515	5.862	6.230
1.319	1.346	1.373	1.400	1.428	1.457	1.486	1.516	1.546	1.577	1.608	1.641	1.673	1.707	1.741	1.776	1.811

31-May-24 Year 14 €000	31-May-25 Year 15 €000	31-May-26 Year 16 €000	31-May-27 Year 17 €000	31-May-28 Year 18 €000	31-May-29 Year 19 €000	31-May-30 Year 20 €000	31-May-31 Year 21 €000	31-May-32 Year 22 €000	31-May-33 Year 23 €000	31-May-34 Year 24 €000	31-May-35 Year 25 €000	31-May-36 Year 26 €000	31-May-37 Year 27 €000	31-May-38 Year 28 €000	31-May-39 Year 29 €000	31-May-40 Year 30 €000
2,294.75	2,439.04	2,592.40	2,755.41	2,928.67	3,112.82	3,308.55	3,516.59	3,737.71	3,972.73	4,222.53	4,488.04	4,770.24	5,070.19	5,389.00	5,727.86	6,088.02
112.16	114.40	116.69	119.02	121.40	123.83	126.31	128.83	131.41	134.04	136.72	139.45	142.24	145.09	147.99	150.95	153.97
0.00	141.32	0.00	147.03	0.00	152.97	0.00	159.14	0.00	165.57	0.00	172.26	0.00	179.22	0.00	186.46	0.00
2,406.90	**2,694.75**	**2,709.09**	**3,021.46**	**3,050.07**	**3,389.61**	**3,434.85**	**3,804.56**	**3,869.12**	**4,272.34**	**4,359.25**	**4,799.76**	**4,912.48**	**5,394.50**	**5,536.99**	**6,065.27**	**6,241.98**

31-May-24 Year 14 €000	31-May-25 Year 15 €000	31-May-26 Year 16 €000	31-May-27 Year 17 €000	31-May-28 Year 18 €000	31-May-29 Year 19 €000	31-May-30 Year 20 €000	31-May-31 Year 21 €000	31-May-32 Year 22 €000	31-May-33 Year 23 €000	31-May-34 Year 24 €000	31-May-35 Year 25 €000	31-May-36 Year 26 €000	31-May-37 Year 27 €000	31-May-38 Year 28 €000	31-May-39 Year 29 €000	31-May-40 Year 30 €000
3,778.83	4,016.44	4,268.99	4,537.42	4,822.73	5,125.98	5,448.29	5,790.88	6,155.00	6,542.02	6,953.38	7,390.60	7,855.31	8,349.24	8,874.24	9,432.24	10,025.33
0.00	141.32	0.00	147.03	0.00	152.97	0.00	159.14	0.00	165.57	0.00	172.26	0.00	179.22	0.00	186.46	0.00
3,778.83	**4,157.76**	**4,268.99**	**4,684.44**	**4,822.73**	**5,278.94**	**5,448.29**	**5,950.02**	**6,155.00**	**6,707.59**	**6,953.38**	**7,562.86**	**7,855.31**	**8,528.47**	**8,874.24**	**9,618.70**	**10,025.33**

31-May-24 Year 14 €000	31-May-25 Year 15 €000	31-May-26 Year 16 €000	31-May-27 Year 17 €000	31-May-28 Year 18 €000	31-May-29 Year 19 €000	31-May-30 Year 20 €000	31-May-31 Year 21 €000	31-May-32 Year 22 €000	31-May-33 Year 23 €000	31-May-34 Year 24 €000	31-May-35 Year 25 €000	31-May-36 Year 26 €000	31-May-37 Year 27 €000	31-May-38 Year 28 €000	31-May-39 Year 29 €000	31-May-40 Year 30 €000
2,294.75	2,439.04	2,592.40	2,755.41	2,928.67	3,112.82	3,308.55	3,516.59	3,737.71	3,972.73	4,222.53	4,488.04	4,770.24	5,070.19	5,389.00	5,727.86	6,088.02
112.16	114.40	116.69	119.02	121.40	123.83	126.31	128.83	131.41	134.04	136.72	139.45	142.24	145.09	147.99	150.95	153.97
0.00	141.32	0.00	147.03	0.00	152.97	0.00	159.14	0.00	165.57	0.00	172.26	0.00	179.22	0.00	186.46	0.00
2,406.90	**2,694.75**	**2,709.09**	**3,021.46**	**3,050.07**	**3,389.61**	**3,434.85**	**3,804.56**	**3,869.12**	**4,272.34**	**4,359.25**	**4,799.76**	**4,912.48**	**5,394.50**	**5,536.99**	**6,065.27**	**6,241.98**

LCC Escalated Base Cost Inputs Lifecycle

NOMINAL (ESCALATED) Base Cost Inputs Lifecycle

Inflation / Indices

Authority Inflation / Indexation Assumptions

	%	
Period 01/05/2010 to 31/05/2070	2.00%	(per ITN)
	1.50%	(per ITN)
		(per ITN)
Indexation Date	01-Jun-10	

	SCA Y1	*SCA Y2*	*SCA Y3*	*SCA Y4*	*SCA Y5*	*SCA Y6*	*SCA Y7*	*SCA Y8*	*SCA Y9*	*SCA Y10*	*SCA Y11*	*SCA Y12*	*SCA Y13*	*SCA Y14*	*SCA Y15*
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
Year ending	*May-11*	*May-12*	*May-13*	*May-14*	*May-15*	*May-16*	*May-17*	*May-18*	*May-19*	*May-20*	*May-21*	*May-22*	*May-23*	*May-24*	*May-25*
Indexation Factor - Cost category 1	1.020	1.040	1.061	1.082	1.104	1.126	1.149	1.172	1.195	1.219	1.243	1.268	1.294	1.319	1.346
Indexation Factor - Cost category 2	1.015	1.030	1.046	1.061	1.077	1.093	1.110	1.126	1.143	1.161	1.178	1.196	1.214	1.232	1.250

Option 1 Deep Retrofit with opportunity costs

Cashflow Information	***Total***	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000	31-May-25 Year 15 €000
Initial deep retrofit costs																
High Efficiency Gas Boiler with Heating Controls	3662.00															
Insulation to walls and roof	27971.00															
Initial deep retrofit grants																
High Efficiency Gas Boiler with Heating Controls	-700.00															
Insulation to walls and roof	-4000.00															
Total deep retrofit cost	**26,933.00**															
Opportunity cost on Retrofit investment	13,700.06	364.96	370.43	375.99	381.63	387.35	393.16	399.06	405.05	411.12	417.29	423.55	429.90	436.35	442.90	449.54
Total Opportunity Cost	**13,700.06**	**364.96**	**370.43**	**375.99**	**381.63**	**387.35**	**393.16**	**399.06**	**405.05**	**411.12**	**417.29**	**423.55**	**429.90**	**436.35**	**442.90**	**449.54**
1. Lifecycle costs																
1.00 HEATING AND CONTROLS UPGRADE																
1A Replace Boiler and controls every 15yrs.	11,561.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,928.57
1B Radiators fitted in 1995 and need replacing in 2020.(25 year cycle)	7,313.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7,313.97	0.00	0.00	0.00	0.00	0.00
1C Pipework installed in 1995 need replacing in 2035.(40 year cycle)	8,203.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00 INSULATION																
2A Replace insulation after 30 years	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2B Repainting external walls every 19 yrs (246m2)	2,913.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Lifecycle costs	**29,992.39**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**7,313.97**	**0.00**	**0.00**	**0.00**	**0.00**	**4,928.57**
Cashflow Summary																
Lifecycle Costs Building	**29,992.39**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**7,313.97**	**0.00**	**0.00**	**0.00**	**0.00**	**4,928.57**
Total deep retrofit cost	**26,933.00**															
Total Opportunity Cost	**13,700.06**	**364.96**	**370.43**	**375.99**	**381.63**	**387.35**	**393.16**	**399.06**	**405.05**	**411.12**	**417.29**	**423.55**	**429.90**	**436.35**	**442.90**	**449.54**
Total Cashflow	**70,625.45**	**364.96**	**370.43**	**375.99**	**381.63**	**387.35**	**393.16**	**399.06**	**405.05**	**411.12**	**7,731.26**	**423.55**	**429.90**	**436.35**	**442.90**	**5,378.11**

Option 2 do nothing

Cashflow Information	***Total***	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000	31-May-25 Year 15 €000
1. Lifecycle costs																
1.00 HEATING SYSTEM																
1A Existing boiler fitted in 1995 and due replacement in 2010. (15 yrs cycle)	8,762.38	3,735.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1B Radiators fitted in 1995 and need replacing in 2020.(25 year cycle)	7,313.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7,313.97	0.00	0.00	0.00	0.00	0.00
1C Pipework installed in 1995 need replacing in 2035.(40 year cycle)	8,203.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00 PAINTING EXTERNAL WALLS																
2A External walls painted in 2001 next painting 2016. (15yr cycle)	5,283.66	0.00	0.00	0.00	0.00	0.00	2,252.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00 Grant to upgrade boiler																
3A High Efficiency Gas Boiler with Heating Controls	-700.00	-700.00														
Total Lifecycle costs	**28,863.04**	**3,035.24**	**0.00**	**0.00**	**0.00**	**0.00**	**2,252.32**	**0.00**	**0.00**	**0.00**	**7,313.97**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Cashflow Summary																
Lifecycle Costs Building	28,863.04	3,035.24	0.00	0.00	0.00	0.00	2,252.32	0.00	0.00	0.00	7,313.97	0.00	0.00	0.00	0.00	0.00
Total Cashflow	**28,863.04**	**3,035.24**	**0.00**	**0.00**	**0.00**	**0.00**	**2,252.32**	**0.00**	**0.00**	**0.00**	**7,313.97**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Option 3 Deep retrofit with PAYS

Cashflow Information	***Total***	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000	31-May-25 Year 15 €000
1. Lifecycle costs																
1.00 HEATING AND CONTROLS UPGRADE																
1A Replace Boiler and controls every 15yrs.	11,561.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,928.57
1B Radiators fitted in 1995 and need replacing in 2020.(25 year cycle)	7,313.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7,313.97	0.00	0.00	0.00	0.00	0.00
1C Pipework installed in 1995 need replacing in 2035.(40 year cycle)	8,203.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00 INSULATION																
2A Replace insulation every 40yrs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2B Repainting external walls every 19 yrs (246m2)	2,913.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Lifecycle costs	**29,992.39**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**7,313.97**	**0.00**	**0.00**	**0.00**	**0.00**	**4,928.57**
Deep retrofit Finance cost	92,327.27	2,882.50	2,940.15	2,998.95	3,058.93	3,120.11	3,182.51	3,246.16	3,311.08	3,377.31	3,444.85	3,513.75	3,584.02	3,655.70	3,728.82	3,803.39
Annual Deep retrofit Finance Operating Charge	816.77	25.50	26.01	26.53	27.06	27.60	28.15	28.72	29.29	29.88	30.47	31.08	31.71	32.34	32.99	33.65
Total deep retrofit Finance cost	**93,144.05**	**2,908.00**	**2,966.16**	**3,025.48**	**3,085.99**	**3,147.71**	**3,210.66**	**3,274.88**	**3,340.38**	**3,407.18**	**3,475.33**	**3,544.83**	**3,615.73**	**3,688.04**	**3,761.81**	**3,837.04**
Cashflow Summary																
Lifecycle Costs Building	**29,992.39**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**7,313.97**	**0.00**	**0.00**	**0.00**	**0.00**	**4,928.57**
Total deep retrofit Finance cost	**93,144.05**	**2,908.00**	**2,966.16**	**3,025.48**	**3,085.99**	**3,147.71**	**3,210.66**	**3,274.88**	**3,340.38**	**3,407.18**	**3,475.33**	**3,544.83**	**3,615.73**	**3,688.04**	**3,761.81**	**3,837.04**
Total Cashflow	**123,136.44**	**2,908.00**	**2,966.16**	**3,025.48**	**3,085.99**	**3,147.71**	**3,210.66**	**3,274.88**	**3,340.38**	**3,407.18**	**10,789.29**	**3,544.83**	**3,615.73**	**3,688.04**	**3,761.81**	**8,765.61**

SCA Y15	SCA Y16	SCA Y17	SCA Y18	SCA Y19	SCA Y20	SCA Y21	SCA Y22	SCA Y23	SCA Y24	SCA Y25	SCA Y26	SCA Y27	SCA Y28	SCA Y29	SCA Y30
15	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*
May-25	*May-26*	*May-27*	*May-28*	*May-29*	*May-30*	*May-31*	*May-32*	*May-33*	*May-34*	*May-35*	*May-36*	*May-37*	*May-38*	*May-39*	*May-40*
1.346	1.373	1.400	1.428	1.457	1.486	1.516	1.546	1.577	1.608	1.641	1.673	1.707	1.741	1.776	1.811
1.250	1.269	1.288	1.307	1.327	1.347	1.367	1.388	1.408	1.430	1.451	1.473	1.495	1.517	1.540	1.563

31-May-25	31-May-26	31-May-27	31-May-28	31-May-29	31-May-30	31-May-31	31-May-32	31-May-33	31-May-34	31-May-35	31-May-36	31-May-37	31-May-38	31-May-39	31-May-40
Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000
449.54	456.28	463.13	470.07	477.13	484.28	491.55	498.92	506.40	514.00	521.71	529.53	537.48	545.54	553.72	562.03
449.54	**456.28**	**463.13**	**470.07**	**477.13**	**484.28**	**491.55**	**498.92**	**506.40**	**514.00**	**521.71**	**529.53**	**537.48**	**545.54**	**553.72**	**562.03**
4,928.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6,633.21
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8,203.03	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	2,913.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4,928.57	**0.00**	**0.00**	**0.00**	**2,913.62**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**8,203.03**	**0.00**	**0.00**	**0.00**	**0.00**	**6,633.21**
4,928.57	**0.00**	**0.00**	**0.00**	**2,913.62**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**8,203.03**	**0.00**	**0.00**	**0.00**	**0.00**	**6,633.21**
449.54	**456.28**	**463.13**	**470.07**	**477.13**	**484.28**	**491.55**	**498.92**	**506.40**	**514.00**	**521.71**	**529.53**	**537.48**	**545.54**	**553.72**	**562.03**
5,378.11	**456.28**	**463.13**	**470.07**	**3,390.75**	**484.28**	**491.55**	**498.92**	**506.40**	**514.00**	**8,724.74**	**529.53**	**537.48**	**545.54**	**553.72**	**7,195.24**

31-May-25	31-May-26	31-May-27	31-May-28	31-May-29	31-May-30	31-May-31	31-May-32	31-May-33	31-May-34	31-May-35	31-May-36	31-May-37	31-May-38	31-May-39	31-May-40
Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000
0.00	5,027.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8,203.03	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	3,031.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	**5,027.14**	**0.00**	**0.00**	**0.00**	**0.00**	**3,031.33**	**0.00**	**0.00**	**0.00**	**8,203.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
0.00	5,027.14	0.00	0.00	0.00	0.00	3,031.33	0.00	0.00	0.00	8,203.03	0.00	0.00	0.00	0.00	0.00
0.00	**5,027.14**	**0.00**	**0.00**	**0.00**	**0.00**	**3,031.33**	**0.00**	**0.00**	**0.00**	**8,203.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

31-May-25	31-May-26	31-May-27	31-May-28	31-May-29	31-May-30	31-May-31	31-May-32	31-May-33	31-May-34	31-May-35	31-May-36	31-May-37	31-May-38	31-May-39	31-May-40
Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000	€000
4,928.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6,633.21
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8,203.03	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	2,913.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4,928.57	**0.00**	**0.00**	**0.00**	**2,913.62**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**8,203.03**	**0.00**	**0.00**	**0.00**	**0.00**	**6,633.21**
3,803.39	3,879.46	3,957.05	4,036.19	4,116.92	4,199.26	4,283.24	4,368.91	4,456.28	4,545.41	4,636.32					
33.65	34.32	35.01	35.71	36.42	37.15	37.89	38.65	39.42	40.21	41.02					
3,837.04	**3,913.78**	**3,992.06**	**4,071.90**	**4,153.34**	**4,236.40**	**4,321.13**	**4,407.55**	**4,495.71**	**4,585.62**	**4,677.33**					
4,928.57	**0.00**	**0.00**	**0.00**	**2,913.62**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**8,203.03**	**0.00**	**0.00**	**0.00**	**0.00**	**6,633.21**
3,837.04	**3,913.78**	**3,992.06**	**4,071.90**	**4,153.34**	**4,236.40**	**4,321.13**	**4,407.55**	**4,495.71**	**4,585.62**	**4,677.33**					
8,765.61	**3,913.78**	**3,992.06**	**4,071.90**	**7,066.96**	**4,236.40**	**4,321.13**	**4,407.55**	**4,495.71**	**4,585.62**	**12,880.36**	**0.00**	**0.00**	**0.00**	**0.00**	**6,633.21**

LCC Escalated Operational Costs in Present Value

Escalated Operational costs in PRESENT VALUE terms

Authority discount Assumptions

		%	
Period	01/05/2010 to 31/05/2070	1.50%	(per ITN)
			(per ITN)
			(per ITN)

Indexation Date: 01-Jun-10

	SPV Y1	SPV Y2	SPV Y3	SPV Y4	SPV Y5	SPV Y6	SPV Y7	SPV Y8	SPV Y9	SPV Y10	SPV Y11	SPV Y12	SPV Y13	SPV Y14
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Year ending	May-11	May-12	May-13	May-14	May-15	May-16	May-17	May-18	May-19	May-20	May-21	May-22	May-23	May-24
Indexation Factor - Cost category 1	0.99	0.97	0.96	0.94	0.93	0.91	0.90	0.89	0.87	0.86	0.85	0.84	0.82	0.81
Indexation Factor - Cost category 2														

Option 1 Deep Retrofit with opportunity costs

Cashflow Information	Total	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000
FM Service Costs															
Gas	64,771.60	1,023.24	1,071.51	1,122.06	1,174.98	1,230.41	1,288.45	1,349.23	1,412.87	1,479.52	1,549.31	1,622.40	1,698.93	1,779.07	1,862.99
Absolute Acrylics maintenance	2,754.30	85.42	85.84	86.26	86.69	87.11	87.54	87.97	88.41	88.84	89.28	89.72	90.16	90.61	91.05
Boiler Service	1,697.01	105.52	0.00	106.56	0.00	107.61	0.00	108.67	0.00	109.75	0.00	110.83	0.00	111.93	0.00
Total PV FM Service Costs	**69,222.91**	**1,214.18**	**1,157.35**	**1,314.88**	**1,261.67**	**1,425.14**	**1,375.99**	**1,545.88**	**1,501.28**	**1,678.11**	**1,638.59**	**1,822.95**	**1,789.09**	**1,981.60**	**1,954.04**

Option 2 do nothing

Cashflow Information	Total	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000
FM Service Costs															
Gas	107,136.69	2,160.27	1,764.49	1,847.72	1,934.88	2,026.16	2,121.73	2,221.82	2,326.62	2,436.37	2,551.30	2,671.65	2,797.68	2,929.65	3,067.84
Boiler Service	1,697.01	105.52	0.00	106.56	0.00	107.61	0.00	108.67	0.00	109.75	0.00	110.83	0.00	111.93	0.00
Other (please specify)															
Total FM Service Costs	**108,833.69**	**2,265.78**	**1,764.49**	**1,954.28**	**1,934.88**	**2,133.77**	**2,121.73**	**2,330.49**	**2,326.62**	**2,546.12**	**2,551.30**	**2,782.48**	**2,797.68**	**3,041.57**	**3,067.84**

Option 3 Deep retrofit with PAYS

Cashflow Information	Total	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000
FM Service Costs															
Gas	64,771.60	1,023.24	1,071.51	1,122.06	1,174.98	1,230.41	1,288.45	1,349.23	1,412.87	1,479.52	1,549.31	1,622.40	1,698.93	1,779.07	1,862.99
Absolute Acrylics maintenance	2,754.30	85.42	85.84	86.26	86.69	87.11	87.54	87.97	88.41	88.84	89.28	89.72	90.16	90.61	91.05
Boiler Service	1,697.01	105.52	0.00	106.56	0.00	107.61	0.00	108.67	0.00	109.75	0.00	110.83	0.00	111.93	0.00
Total PV FM Service Costs	**69,222.91**	**1,214.18**	**1,157.35**	**1,314.88**	**1,261.67**	**1,425.14**	**1,375.99**	**1,545.88**	**1,501.28**	**1,678.11**	**1,638.59**	**1,822.95**	**1,789.09**	**1,981.60**	**1,954.04**

SPV Y14	SPV Y15	SPV Y16	SPV Y17	SPV Y18	SPV Y19	SPV Y20	SPV Y21	SPV Y22	SPV Y23	SPV Y24	SPV Y25	SPV Y26	SPV Y27	SPV Y28	SPV Y29	SPV Y30
14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
May-24	May-25	May-26	May-27	May-28	May-29	May-30	May-31	May-32	May-33	May-34	May-35	May-36	May-37	May-38	May-39	May-40
0.81	0.80	0.79	0.78	0.76	0.75	0.74	0.73	0.72	0.71	0.70	0.69	0.68	0.67	0.66	0.65	0.64

31-May-24 Year 14 €000	31-May-25 Year 15 €000	31-May-26 Year 16 €000	31-May-27 Year 17 €000	31-May-28 Year 18 €000	31-May-29 Year 19 €000	31-May-30 Year 20 €000	31-May-31 Year 21 €000	31-May-32 Year 22 €000	31-May-33 Year 23 €000	31-May-34 Year 24 €000	31-May-35 Year 25 €000	31-May-36 Year 26 €000	31-May-37 Year 27 €000	31-May-38 Year 28 €000	31-May-39 Year 29 €000	31-May-40 Year 30 €000
1,862.99	1,950.87	2,042.89	2,139.26	2,240.17	2,345.84	2,456.50	2,572.38	2,693.72	2,820.79	2,953.85	3,093.18	3,239.09	3,391.89	3,551.89	3,719.43	3,894.88
91.05	91.50	91.95	92.41	92.86	93.32	93.78	94.24	94.70	95.17	95.64	96.11	96.58	97.06	97.54	98.02	98.50
0.00	113.03	0.00	114.15	0.00	115.28	0.00	116.41	0.00	117.56	0.00	118.73	0.00	119.90	0.00	121.08	0.00
1,954.04	**2,155.40**	**2,134.85**	**2,345.81**	**2,333.03**	**2,554.44**	**2,550.28**	**2,783.03**	**2,788.42**	**3,033.52**	**3,049.49**	**3,308.02**	**3,335.68**	**3,608.84**	**3,649.42**	**3,938.53**	**3,993.39**

31-May-24 Year 14 €000	31-May-25 Year 15 €000	31-May-26 Year 16 €000	31-May-27 Year 17 €000	31-May-28 Year 18 €000	31-May-29 Year 19 €000	31-May-30 Year 20 €000	31-May-31 Year 21 €000	31-May-32 Year 22 €000	31-May-33 Year 23 €000	31-May-34 Year 24 €000	31-May-35 Year 25 €000	31-May-36 Year 26 €000	31-May-37 Year 27 €000	31-May-38 Year 28 €000	31-May-39 Year 29 €000	31-May-40 Year 30 €000
3,067.84	3,212.56	3,364.10	3,522.79	3,688.96	3,862.97	4,045.20	4,236.01	4,435.83	4,645.08	4,864.19	5,093.64	5,333.92	5,585.53	5,849.00	6,124.91	6,413.83
0.00	113.03	0.00	114.15	0.00	115.28	0.00	116.41	0.00	117.56	0.00	118.73	0.00	119.90	0.00	121.08	0.00
3,067.84	**3,325.59**	**3,364.10**	**3,636.93**	**3,688.96**	**3,978.25**	**4,045.20**	**4,352.43**	**4,435.83**	**4,762.64**	**4,864.19**	**5,212.37**	**5,333.92**	**5,705.42**	**5,849.00**	**6,245.99**	**6,413.83**

31-May-24 Year 14 €000	31-May-25 Year 15 €000	31-May-26 Year 16 €000	31-May-27 Year 17 €000	31-May-28 Year 18 €000	31-May-29 Year 19 €000	31-May-30 Year 20 €000	31-May-31 Year 21 €000	31-May-32 Year 22 €000	31-May-33 Year 23 €000	31-May-34 Year 24 €000	31-May-35 Year 25 €000	31-May-36 Year 26 €000	31-May-37 Year 27 €000	31-May-38 Year 28 €000	31-May-39 Year 29 €000	31-May-40 Year 30 €000
1,862.99	1,950.87	2,042.89	2,139.26	2,240.17	2,345.84	2,456.50	2,572.38	2,693.72	2,820.79	2,953.85	3,093.18	3,239.09	3,391.89	3,551.89	3,719.43	3,894.88
91.05	91.50	91.95	92.41	92.86	93.32	93.78	94.24	94.70	95.17	95.64	96.11	96.58	97.06	97.54	98.02	98.50
0.00	113.03	0.00	114.15	0.00	115.28	0.00	116.41	0.00	117.56	0.00	118.73	0.00	119.90	0.00	121.08	0.00
1,954.04	**2,155.40**	**2,134.85**	**2,345.81**	**2,333.03**	**2,554.44**	**2,550.28**	**2,783.03**	**2,788.42**	**3,033.52**	**3,049.49**	**3,308.02**	**3,335.68**	**3,608.84**	**3,649.42**	**3,938.53**	**3,993.39**

Escalated Lifecycle Costs in Present Value

Escalated Lifecycle Costs in PRESENT VALUE terms

Authority discount Assumptions

		%	
Period	01/05/2010 to 31/05/2070	1.50%	(per ITN)
			(per ITN)
			(per ITN)
Indexation Date		01-Jun-10	

	SPV Y1	*SPV Y2*	*SPV Y3*	*SPV Y4*	*SPV Y5*	*SPV Y6*	*SPV Y7*	*SPV Y8*	*SPV Y9*	*SPV Y10*	*SPV Y11*	*SPV Y12*	*SPV Y13*	*SPV Y14*
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Year ending	*May-11*	*May-12*	*May-13*	*May-14*	*May-15*	*May-16*	*May-17*	*May-18*	*May-19*	*May-20*	*May-21*	*May-22*	*May-23*	*May-24*
Indexation Factor - Cost category 1	0.99	0.97	0.96	0.94	0.93	0.91	0.90	0.89	0.87	0.86	0.85	0.84	0.82	0.81
Indexation Factor - Cost category 2														
Indexation Factor - Cost category 3														

Option 1 Deep Retrofit with opportunity costs

Cashflow Information		***Total***	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000
	Initial deep retrofit costs															
	High Efficiency Gas Boiler with Heating Controls	3662.00														
	Insulation to walls and roof	27971.00														
	Initial deep retrofit grants															
	High Efficiency Gas Boiler with Heating Controls	-700.00														
	Insulation to walls and roof	-4000.00														
	Total deep retrofit cost	**26,933.00**														
	Opportunity cost on Retrofit investment	10,786.95	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57
	Total Opportunity Cost	**10,786.95**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**
1. Lifecycle costs																
1.00	**HEATING AND CONTROLS UPGRADE**															
1A	Replace Boiler and controls every 15yrs.	8,185.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1B	Radiators fitted in 1995 and need replacing in 2020.(25 year cycle)	6,302.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6,302.21	0.00	0.00	0.00	0.00
1C	Pipework installed in 1995 need replacing in 2035.(40 year cycle)	5,653.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	**INSULATION**															
2A	Replace insulation every 40yrs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2B	Repainting external walls every 19 yrs (246m2)	2,195.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Lifecycle costs	**22,337.31**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**6,302.21**	**0.00**	**0.00**	**0.00**	**0.00**
	Cashflow Summary															
	Total deep retrofit cost	**26,933.00**														
	Total Opportunity Cost	**10,786.95**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**
	Lifecycle Costs Building	**22,337.31**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**6,302.21**	**0.00**	**0.00**	**0.00**	**0.00**
	Total Cashflow	**60,057.26**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**6,661.77**	**359.57**	**359.57**	**359.57**	**359.57**

Option 2 do nothing

Cashflow Information		***Total***	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000
1. Lifecycle costs																
1.00	**HEATING SYSTEM**															
1A	Existing boiler fitted in 1995 and due replacement in 2010. (15 yrs cycle)	7,641.58	3,680.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1B	Radiators fitted in 1995 and need replacing in 2020.(25 year cycle)	6,302.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6,302.21	0.00	0.00	0.00	0.00
1C	Pipework installed in 1995 need replacing in 2035.(40 year cycle)	5,653.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	**PAINTING EXTERNAL WALLS**															
2A	External walls painted in 2001 next painting 2016. (15yr cycle)	4,277.26	0.00	0.00	0.00	0.00	0.00	2,059.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	**Grant to upgrade boiler**															
3A	High Efficiency Gas Boiler with Heating Controls	-700.00	-700.00													
	Total Lifecycle costs	**23,174.62**	**2,980.04**	**0.00**	**0.00**	**0.00**	**0.00**	**2,059.85**	**0.00**	**0.00**	**0.00**	**6,302.21**	**0.00**	**0.00**	**0.00**	**0.00**
	Cashflow Summary															
	Lifecycle Costs Building	**23,174.62**	**2,980.04**	**0.00**	**0.00**	**0.00**	**0.00**	**2,059.85**	**0.00**	**0.00**	**0.00**	**6,302.21**	**0.00**	**0.00**	**0.00**	**0.00**
	Total Cashflow	**23,174.62**	**2,980.04**	**0.00**	**0.00**	**0.00**	**0.00**	**2,059.85**	**0.00**	**0.00**	**0.00**	**6,302.21**	**0.00**	**0.00**	**0.00**	**0.00**

Option 3 Deep retrofit with PAYS

Cashflow Information		***Total***	31-May-11 Year 1 €000	31-May-12 Year 2 €000	31-May-13 Year 3 €000	31-May-14 Year 4 €000	31-May-15 Year 5 €000	31-May-16 Year 6 €000	31-May-17 Year 7 €000	31-May-18 Year 8 €000	31-May-19 Year 9 €000	31-May-20 Year 10 €000	31-May-21 Year 11 €000	31-May-22 Year 12 €000	31-May-23 Year 13 €000	31-May-24 Year 14 €000
1. Lifecycle costs																
1.00	**HEATING AND CONTROLS UPGRADE**															
1A	Replace Boiler and controls every 15yrs.	8,185.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1B	Radiators fitted in 1995 and need replacing in 2020.(25 year cycle)	6,302.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6,302.21	0.00	0.00	0.00	0.00
1C	Pipework installed in 1995 need replacing in 2035.(40 year cycle)	5,653.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	**INSULATION**															
2A	Replace insulation every 40yrs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2B	Repainting external walls every 19 yrs (246m2)	2,195.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Lifecycle costs	**22,337.31**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**6,302.21**	**0.00**	**0.00**	**0.00**	**0.00**
	Deep retrofit Finance cost	**75,357.27**	**2,839.90**	**2,853.89**	**2,867.95**	**2,882.08**	**2,896.27**	**2,910.54**	**2,924.88**	**2,939.29**	**2,953.77**	**2,968.32**	**2,982.94**	**2,997.63**	**3,012.40**	**3,027.24**
	Annual Deep retrofit Finance Operating Charge	**666.65**	**25.12**	**25.25**	**25.37**	**25.50**	**25.62**	**25.75**	**25.87**	**26.00**	**26.13**	**26.26**	**26.39**	**26.52**	**26.65**	**26.78**
	Total deep retrofit Finance cost	**76,023.92**	**2,865.02**	**2,879.14**	**2,893.32**	**2,907.57**	**2,921.89**	**2,936.29**	**2,950.75**	**2,965.29**	**2,979.90**	**2,994.58**	**3,009.33**	**3,024.15**	**3,039.05**	**3,054.02**
	Cashflow Summary															
	Lifecycle Costs Building	**22,337.31**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**6,302.21**	**0.00**	**0.00**	**0.00**	**0.00**
	Total deep retrofit Finance cost	**76,023.92**	**2,865.02**	**2,879.14**	**2,893.32**	**2,907.57**	**2,921.89**	**2,936.29**	**2,950.75**	**2,965.29**	**2,979.90**	**2,994.58**	**3,009.33**	**3,024.15**	**3,039.05**	**3,054.02**
	Total Cashflow	**98,361.23**	**2,865.02**	**2,879.14**	**2,893.32**	**2,907.57**	**2,921.89**	**2,936.29**	**2,950.75**	**2,965.29**	**2,979.90**	**9,296.78**	**3,009.33**	**3,024.15**	**3,039.05**	**3,054.02**

SPV Y14	*SPV Y15*	*SPV Y16*	*SPV Y17*	*SPV Y18*	*SPV Y19*	*SPV Y20*	*SPV Y21*	*SPV Y22*	*SPV Y23*	*SPV Y24*	*SPV Y25*	*SPV Y26*	*SPV Y27*	*SPV Y28*	*SPV Y29*	*SPV Y30*
14	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*
May-24	*May-25*	*May-26*	*May-27*	*May-28*	*May-29*	*May-30*	*May-31*	*May-32*	*May-33*	*May-34*	*May-35*	*May-36*	*May-37*	*May-38*	*May-39*	*May-40*
0.81	0.80	0.79	0.78	0.76	0.75	0.74	0.73	0.72	0.71	0.70	0.69	0.68	0.67	0.66	0.65	0.64
31-May-24 Year 14 €000	31-May-25 Year 15 €000	31-May-26 Year 16 €000	31-May-27 Year 17 €000	31-May-28 Year 18 €000	31-May-29 Year 19 €000	31-May-30 Year 20 €000	31-May-31 Year 21 €000	31-May-32 Year 22 €000	31-May-33 Year 23 €000	31-May-34 Year 24 €000	31-May-35 Year 25 €000	31-May-36 Year 26 €000	31-May-37 Year 27 €000	31-May-38 Year 28 €000	31-May-39 Year 29 €000	31-May-40 Year 30 €000
359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57	359.57
359.57	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**
0.00	3,942.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,243.68
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5,653.58	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	2,195.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	**3,942.12**	**0.00**	**0.00**	**0.00**	**2,195.73**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**5,653.58**	**0.00**	**0.00**	**0.00**	**0.00**	**4,243.68**
359.57	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**
0.00	**3,942.12**	**0.00**	**0.00**	**0.00**	**2,195.73**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**5,653.58**	**0.00**	**0.00**	**0.00**	**0.00**	**4,243.68**
359.57	**4,301.69**	**359.57**	**359.57**	**359.57**	**2,555.29**	**359.57**	**359.57**	**359.57**	**359.57**	**359.57**	**6,013.14**	**359.57**	**359.57**	**359.57**	**359.57**	**4,603.24**
31-May-24 Year 14 €000	31-May-25 Year 15 €000	31-May-26 Year 16 €000	31-May-27 Year 17 €000	31-May-28 Year 18 €000	31-May-29 Year 19 €000	31-May-30 Year 20 €000	31-May-31 Year 21 €000	31-May-32 Year 22 €000	31-May-33 Year 23 €000	31-May-34 Year 24 €000	31-May-35 Year 25 €000	31-May-36 Year 26 €000	31-May-37 Year 27 €000	31-May-38 Year 28 €000	31-May-39 Year 29 €000	31-May-40 Year 30 €000
0.00	0.00	3,961.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5,653.58	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,217.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	**0.00**	**3,961.54**	**0.00**	**0.00**	**0.00**	**0.00**	**2,217.41**	**0.00**	**0.00**	**0.00**	**5,653.58**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
0.00	**0.00**	**3,961.54**	**0.00**	**0.00**	**0.00**	**0.00**	**2,217.41**	**0.00**	**0.00**	**0.00**	**5,653.58**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
0.00	**0.00**	**3,961.54**	**0.00**	**0.00**	**0.00**	**0.00**	**2,217.41**	**0.00**	**0.00**	**0.00**	**5,653.58**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
31-May-24 Year 14 €000	31-May-25 Year 15 €000	31-May-26 Year 16 €000	31-May-27 Year 17 €000	31-May-28 Year 18 €000	31-May-29 Year 19 €000	31-May-30 Year 20 €000	31-May-31 Year 21 €000	31-May-32 Year 22 €000	31-May-33 Year 23 €000	31-May-34 Year 24 €000	31-May-35 Year 25 €000	31-May-36 Year 26 €000	31-May-37 Year 27 €000	31-May-38 Year 28 €000	31-May-39 Year 29 €000	31-May-40 Year 30 €000
0.00	3,942.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,243.68
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5,653.58	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	2,195.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	**3,942.12**	**0.00**	**0.00**	**0.00**	**2,195.73**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**5,653.58**	**0.00**	**0.00**	**0.00**	**0.00**	**4,243.68**
3,027.24	**3,042.15**	**3,057.14**	**3,072.20**	**3,087.33**	**3,102.54**	**3,117.82**	**3,133.18**	**3,148.62**	**3,164.13**	**3,179.71**	**3,195.38**					
26.78	**26.91**	**27.04**	**27.18**	**27.31**	**27.45**	**27.58**	**27.72**	**27.85**	**27.99**	**28.13**	**28.27**					
3,054.02	**3,069.06**	**3,084.18**	**3,099.38**	**3,114.64**	**3,129.99**	**3,145.40**	**3,160.90**	**3,176.47**	**3,192.12**	**3,207.84**	**3,223.64**					
0.00	**3,942.12**	**0.00**	**0.00**	**0.00**	**2,195.73**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**5,653.58**	**0.00**	**0.00**	**0.00**	**0.00**	**4,243.68**
3,054.02	**3,069.06**	**3,084.18**	**3,099.38**	**3,114.64**	**3,129.99**	**3,145.40**	**3,160.90**	**3,176.47**	**3,192.12**	**3,207.84**	**3,223.64**					
3,054.02	**7,011.19**	**3,084.18**	**3,099.38**	**3,114.64**	**5,325.71**	**3,145.40**	**3,160.90**	**3,176.47**	**3,192.12**	**3,207.84**	**8,877.22**	**0.00**	**0.00**	**0.00**	**0.00**	**4,243.68**

Thesis Proposal

SCHOOL OF REAL ESTATE AND CONSTRUCTION ECONOMICS

CONSTRUCTION ECONOMICS AND MANAGEMENT DEGREE

DT111 AND DT155

THESIS PROPOSAL FORM

2012/2013

THESIS PROPOSALS MUST ONLY BE SUBMITTED IN THIS FORMAT.

SUBMISSION DATE: WEDNESDAY 24th OCTOBER 2012

STUDENT NAME: Adrian Sheerin STUDENT NO: D10124291

FULL TIME *or* PART TIME: Part Time

MOBILE NO: 087 6867639 HOME PHONE: 01 2122893

DIT EMAIL: D10124291@mydit.ie OTHER EMAIL: as.sheerin@gmail.com

1. WORKING TITLE OF THESIS

True value of an insulation and boiler upgrade under SEAI schemes based on actual fuel savings in comparison to the proposed new PAYS scheme.

2. SUBJECT AREA

Please select the general subject area(s) within which your proposed thesis lies

- ☐ **Cost and Value Management**
- ☐ **QS Practice**
- √ **Sustainable Development**
- ☐ **Other (please specify)**
- ☐ **Contract Administration and Law**
- ☐ **Construction Economics**
- ☐ **I.T and QS Software**

3. RESEARCH OBJECTIVES

Identify the **primary** objectives or hypothesis of the dissertation/thesis.

- To assess the property upgrades undertaken and how they contribute to fuel savings.
- To critically appraise the true financial savings or cost to the property owners as owner occupiers of upgrading the property using SEAI grants.
- To compare what the financial difference would be if they used the PAYS system instead of SEAI grants.
- To find out the true cost to government of providing both schemes to the property owner after costs are offset against EU level fines.

4. INDICATIVE CHAPTER HEADINGS

- Include brief outline of topics to be covered in each chapter.

- Indicate proposed sources of information for each chapter.
- Indicate proposed methodology for each chapter, where appropriate

Chapter 1 – Introduction

- What is the insulation upgrade?
- What is the boiler upgrade?
- What are the SEAI schemes?
- What is the proposed new PAYS system?

Information obtained from Government Publications.

Chapter 2 – Literature Review

- Kyoto Agreement - Global level
- EU Directives – European level
- Government implementation policy - National level

Information obtained from International Agreements, EU Directives and Government Publications.

Documentary

Chapter 3 – Research methodology

- Documentary research -
- Case study - Quantitative
- Mathematical appraisal of data. - Quantitative

Naoum, S. G., 2007. *Dissertation Research and Writting for Construction Students.* 2 ed. Oxford: Elsevier.

Chapter 4 – Data Analysis and Discussion

- Financial value to property owners - Based on financial calculations taken from fuel savings and upgrade costs.
- Value to economy - Employment gained, lowering amount of emissions lowers carbon fines at EU level.
- Value to environment - Less fuel used means less emissions which results in less damage to the environment.
- Social value - The social value to the property owner, more comfortable living conditions, smaller carbon footprint. Based on interviews with property owners. The social value to society, if incentives taken up on a large scale a cleaner environment.

Caplehorn, P., 2011. *Whole Life Costing : A New Approach.* London: Taylor & Francis.

Chapter 5 – Conclusions and Recommendations

- What is the result of the comparison between the SEAI Scheme and the PAYS System?
- Which scheme has the most value economically, socially and environmentally?

5 LIST AND OUTLINE OTHER SOURCES OF INFORMATION INCLUDING ORGANISATIONS/INDIVIDUALS WHO YOU HAVE OR INTEND TO CONSULT DURING THE COURSE OF YOUR RESEARCH

Sinead Lane and Graham Cherry the property owners.

Kevin Middleton, Home Energy Services, Airtricity.

SEAI (Sustainable energy authority Ireland)

Department of Communications, Energy and Natural Resources

Department of Environment, Community and Local Government

6. RESEARCH METHODOLOGY.

- Which of the following methods do you intend to utilise in your study? (Students may choose more than one method if appropriate and provide a brief note on the rational for the use of mixed methods research).

Please Tick

* Documentary Research	√
* Interviews	√
* Questionnaire Survey(s)	____
* Case Study	√
* Other (Specify)	____

Please state why you consider this/these method(s) to be appropriate and whether confirmation of participation by individuals or organisations has been confirmed.

Participation of Sinead Lane and Graham Cherry the property owners has been confirmed. They have agreed to allow access to all data needed to undertake this thesis and to participate in interviews. This will provide valuable primary data to be analysed.

A case study of the amount of fuel used before the upgrades and after the upgrades will give an accurate representation of the fuel savings due to the upgrades. This will be based on Fuel invoices over the periods in question. It will also be based on upgrade bills and SEAI grant receipts for the upgrades.

Kevin Middleton, Home Energy Services, Airtricity, has confirmed he will be available to provide information from the industry on the implementation of PAYS (Pay as you save).

Documentary research of the Kyoto agreement, EU Directives and Government proposals will provide the background information and the bases for a financial comparison of the value of the SEAI grant and the PAYS system to the property owner and the economy.

7. KEY REFERENCES INCLUDING TEXTBOOKS, JOURNALS, CONFERENCE PRECEEDINGS, LIBRARY CATALOGUES, DATABASES, THESES

Journals

Science direct

Ebesco host

Policy Documents

Climate Policy Review 2011 - Department of the Environment, Community and Local Government

EU Climate and Energy Package

EU Directive on Energy from Renewable Sources

Kyoto Protocol

National Climate Change Strategy

Recast Energy Performance of Buildings Directive

EC Energy Performance of Buildings Regulation 2006 (S.I. No. 666 of 2006)

Directive 2002/91/EC of the European Parliment on the energy performance of buildings

Implementation of the Energy Performance of Buildings Directive in other Member States 2010

European Union (Energy Performance of Buildings) Regulations 2012 (S.I. 243 of 2012).

National Energy Efficiency Action Plan (NEEAP)

The Green Deal (Dyson, 1997)- A summary of the Government's proposals

Energy Efficiency Directive

Compromise text on the proposed energy Efficiency Directive

The final form of the Energy Efficiency Directive

Towards a New National Climate Policy

Websites

http://www.europa.eu

http://www.energy.eu

http://www.seai.ie

http://www.energymarketprice.com

Textbooks

Caplehorn, P., 2011. *Whole Life Costing : A New Approach.* London: Taylor & Francis.

Cartilidge, D., 2009. *Quantity Surveyors Pocket Book.* 1 ed. Oxford: Elseveir.

Dyson, J. R., 1997. *Accounting for Non-Accounting Students.* 4 ed. London: Pitman Publishing.

Naoum, S. G., 2007. *Dissertation Research and Writting for Construction Students.* 2 ed. Oxford: Elsevier.

Wilkinson, S. & Reed, R., 2008. *Property Development.* 5 ed. New York: Routledge.