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International Energy Research

Creating Shared Value For All

The multiple benefits of a residential retrofit renovation wave in Ireland

Tyndall
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About IERC

The International Energy Research Centre (IERC) is a centre of international excellence in integrated energy systems research, supported by Department of the Environment, Climate, and Communications, Government of Ireland and hosted at Tyndall National Institute, Cork, Ireland. The IERC conducts sustainable energy research and examines the knowledge gaps through five different research lenses: Technology, Data Analytics, Behaviour, Business Models, and Policy & Regulation.

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Disclaimer

Contents

Two Minute Brief

The National Climate Action Plan [1] and Programme for Government 2020 [2] outline the Irish Government's ambition to carry out 500,000 home retrofits to a B2 Building Energy Rating (BER) and install 600,000 heat pumps, in line with European policy, and in particular, Section 2.1.4 of the EU Green Deal which calls for a "Renovation Wave" [3] across Europe. *"To address the twin challenge of energy efficiency and affordability, the EU and the Member States should engage in a 'renovation wave' of public and private buildings. While increasing renovation rates is a challenge, renovation lowers energy bills, and can reduce energy poverty. It can also boost the construction sector and is an opportunity to support SMEs and local jobs."* [3] Ireland taking early and decisive action is an effective way to influence other countries to also reduce climate changing emissions, reducing the risks Ireland itself faces from cumulative sea level rise and worldwide degradation of ecological and economic resources.

> "The cheapest and cleanest energy is the energy that we do not use"[1].

An investment in retrofitting is an investment in the environmental, societal, and economic infrastructures of Ireland, from the ecological air, water and soils, and the healthcare and social welfare systems, to the energy generation and supply system. This report recommends exceeding current retrofitting ambitions in terms of speed and scale, due to both the number of benefits available and the magnitude of potential financial returns, to meet Ireland's targets for a shared, decarbonised, climate neutral future for 2030 (Climate Action Plan), 2040 (Project Ireland), 2050 (European Green Deal) and beyond. Retrofitting will also contribute towards the United Nations Sustainable Development Goals[2], help tackle fuel poverty (Goal 1), good health and wellbeing of building occupants (Goal 3), reduced inequalities and gender equality (Goals 5 & 10), affordable and clean energy (Goal 7), responsible production and consumption, re-use of existing buildings, and elimination of waste energy and carbon (Goal 12), climate action (Goal 13) and partnerships for the goals (Goal 17).
The current Programme for Government has also pledged to 'put sustainability at the heart of our fiscal, enterprise, innovation, and environmental policies' [2].

This report presents some of the potential benefits to undertaking a national retrofit renovation wave. One direct benefit from a nationwide cost optimal retrofitting programme to a B2 rating would be the reduction in energy use (53tWh) and associated carbon emissions (12.736m tonnes) from reduced energy consumption. The job creation potential could be between 24 and 32 thousand. This report shows that adopting such an ambitious programme for retrofitting could also generate other less direct benefits providing large returns on investment. A significant gain would be the rapid reduction in fuel poverty [4]. Lower energy bills for all households could lead to up to €4.496bn euro of additional disposable income within the Irish economy. There is also a benefit to the exchequer in annual savings on social welfare spending such as household fuel-allowances.

1 https://ec.europa.eu/energy/sites/ener/files/documents/ie_building_renov_2017_en.pdf

2 The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership. https://sdgs.un.org/goals

The increased health and wellbeing benefits could save up to €600m annually to the Irish economy, through gains in productivity and output, reduced sick leave and absenteeism, reduced burden on the healthcare and social welfare systems. Annual savings on the reduction of hospital admissions alone, could be over €20m for the HSE, and over €2m to patients. Ireland currently has the world's highest rate of cystic fibrosis [5], fourth highest rate of asthma [6], and the highest rate of excess winter mortality in Europe [7], all of which can either be caused by, or exacerbated by poor housing conditions. Previous analysis of cold-related deaths in Dublin, showed that each one degree Celsius drop in temperature was associated with a 2.6% increase in total mortality over the subsequent 40 days [8].

Large-scale cost optimal retrofitting to a B2 rating could also increase revenue from;

- Value Added Tax (VAT) on the retrofit works by up to €4.725bn over the period to completing the renovation of all homes C-Rated or lower in 2030 (equivalent to an average annual increase in VAT revenue of €525m based on VAT tax rate of 13.5%)
- property tax by up to €38.56m annually due to increased property values
- stamp duty by up to €11m annually due to increased values of properties sold each year.

The actual achievable increases in revenue will depend on a wide range of factors. These are discussed in this report. Decreasing residential energy demands, while increasing domestic renewable energy generation both reduce use of imported fossil fuels. Thus, these measures contribute to increasing national energy security and to macroeconomic resilience.

> "The next ten years are critical if we are to address the climate and biodiversity crisis which threatens our safe future on this planet. We have set out our ambition to more than halve our carbon emissions over the course of the decade. This will be challenging and will require fundamental changes in so many parts of Irish life, but we believe that Ireland can and will rise to this challenge. In doing so we will be able to improve the health, welfare and the security of all our people".
>
> Programme for Government 2020, Our Shared Future

For residential energy retrofits, this report provides

- a holistic perspective of their benefits
- calculations of those benefits
- a stakeholder mapping
- a set of recommendations for policymakers and other stakeholders.

This report is part of a series. Future papers will discuss the requirements to successfully realise a renovation wave. These include costs, financing, and capacity building in industry.

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1. Introduction

Housing is a fundamental necessity of life and good quality housing is critical to human health and wellbeing. In recent times, it has also become increasingly apparent that homes are the first line of defence against global pandemics, and other crises, including the climate crisis. Increasingly often people are required to stay at home due to extreme weather events, such as during Hurricane Ophelia (2017) and Storm Emma (2018). The most extreme example of this recently has been due to the COVID-19 public health emergency, which required billions of people across the entire globe to stay in their homes to stop the spread of the virus. By the end of March 2020, over 100 countries had introduced restrictions on movement [9]. To build resilience into our response to such events, we need to ensure that the first line of defence is strong, robust, and effective. However, based on the condition of much of Ireland's current housing stock this is not necessarily the case for a great number of people. Coupled with this, those who are most at risk from the negative impacts of poor housing are very often the most vulnerable in society for reasons such as ill-health, low-paid or precarious work, poverty, inequalities, and homelessness.

While much retrofitting has taken place in Ireland in recent years, there remains a significant amount of work to be done to improve the overall efficiency of Irish homes. Contributing to this is the fact that Ireland has a higher than (European) average amount of detached dwellings, and Irish dwellings tend to have larger than average floor areas and numbers of rooms [10].The larger the dwelling (in either surface to volume ratio, or floor area), the more energy required to heat, (cool), light, and power it. Approximately 43% of Irish dwellings are detached properties, 72% of these are rurally located, and 70% of these were constructed prior to any form of building regulations – and many years before the introduction of the Energy Performance of Building Directive (EPBD), or the introduction of Building Energy Ratings (BER Certificates) [10]. Building regulations began to be introduced in Ireland in the 1970s, however, these regulations were only in draft format, and building was mainly regulated on an ad-hoc basis of local by-laws through the local authorities, until the first official building regulations and technical guidance documents (TGDs) came into force in 1991.

Even without crises people in countries such as Ireland spend up to 85-90% of their time indoors [11]. Ireland also has one of the highest rates of excess winter mortality [7], and the highest rate of asthma in Europe (and the fourth highest rate of asthma in the world) [12] [6], both of which can be linked to the quality of housing. Retrofitting buildings can improve the quality of indoor spaces, and consequently, increase the occupants' quality of life. Retrofits do not just improve energy efficiency and can contribute to much more than just financial savings on energy bills. This paper examines the multiple benefits, also called co-benefits, of energy retrofits on residential buildings, not only for the buildings' occupants and users, and to Irish citizens, taxpayers, and the Irish exchequer, but most importantly, **creating shared value and benefits** to all in Irish society as a whole. In a post-COVID-19 world, investment in retrofitting could form an essential part of the economic, social, and environmental stimulus that Ireland needs.

> "The actions taken over the next five years will define this nation's future direction for decades to come"
>
> Programme for Government 2020, Our Shared Future [2]

2. Stakeholders and Beneficiaries

There are multiple benefits to implementing a national, comprehensive, deep-retrofit renovation wave in Ireland, that can have a positive impact on the lives and interests of numerous stakeholders. This report will help to inform stakeholders such as the National Retrofit Taskforce, and SEAI who are currently seeking to encourage the development of One-Stop-Shops and engage groups of private households, registered Housing Associations and Local Authorities who wish to participate in delivering energy efficiency upgrades, specifically in domestic buildings[3]. The Taskforce was created in 2019 as part of the implementation of the Climate Action Plan 2019 [13][4]. For the purposes of creating useful groupings, the benefits will be described throughout the document according to the three pillars of sustainability: **environment**, **society**, and **economy**. Figure 1 attempts to map these into related groupings. These are loose categorisations. However, they demonstrate the level of potential impact across a wide and varied range of people and organisations. They also demonstrate the complexity of the retrofit challenge and a need for the systematic examination of the wide variety of individuals or groups who can affect, or can be affected by, retrofit policy solutions. Some of the benefits that will be discussed in this document can have a positive impact on several stakeholders at once, but in different ways. For example, cheaper energy bills can help alleviate fuel poverty and can also increase the disposable income and spending power of better off occupants. This in turn can have benefits to the local economy, where more money is available to be spent on products and services and can have an impact on government department budgets and public spending, where less spending may be required on social welfare such as Fuel Allowance.

The overlapping and shared multiple benefits of a retrofit renovation wave in Ireland are also aligned with the Government's overall strategic objectives:

> "Project Ireland 2040 is the government's long-term overarching strategy to make Ireland a better country for all of us. Project Ireland 2040 is about doing things differently. We have changed how we invest in public infrastructure in Ireland, moving away from the approach of the past which saw public investment spread too thinly and investment decisions which didn't align with a clearly thought out and defined strategy." [14]
>
> Project Ireland 2040

> "The world was approaching a climate crisis long before COVID-19 hit our shores. The pandemic has acted as a catalyst, enabling us to implement radical policies that were considered impossible before; it will not and must not be used as an excuse for failure to take immediate action to deliver on all that is needed to build a better society and a secure future for all living things". [2]
>
> Programme for Government 2020, Our Shared Future

3 https://www.seai.ie/grants/national-home-retrofit/ & https://www.seai.ie/grants/national-home-retrofit/National-Home-Retrofit-Scheme-Guidelines.pdf

4 Climate Action Plan 2019 Action 41 Calls for the promotion of the integration of climate considerations into business operations through the work of the Corporate Social Responsibility Stakeholder Forum. SEAI is now part of this Forum, and have begun to engage with the Department of Business, Enterprise and Innovation (DBEI) to that end.

Both objectives, and the title of the Programme for Government 2020, "Our Shared Future", emphasise the need for policies that benefit all stakeholders, a just transition to sustainability, and ensuring no one is left behind. Stakeholders are generally viewed as individuals, groups, or organisations who could affect or be affected by organisation, event, or programmes such as a retrofit renovation wave. This is based on the definition of a stakeholder in the context of a corporation in the stakeholder theory outlined by R.E. Freeman in the 1980s [15]. Retrofits cannot take place without funding and participation from both public and private realms, and, once complete, the benefits of carrying out works will provide financial and non-financial returns to both. In order to capture the full extent of stakeholder requirements and benefits, it is advisable to design the renovation wave to include three phases. The process of initiating a retrofitting renovation wave will require actions by, and engagement with, stakeholders across all phases. The first being the phase in which **pre-rollout preparations** are made, when government departments and organisations put together a plan of action for rolling out a nationwide policy of retrofitting. This plan should include collaboration with other government departments, and stakeholder groups. This will help to ensure that the retrofit and energy sectors are ready with the personnel, products and services that will be required to carry out the retrofits. This phase should also include a comprehensive nationwide stakeholder engagement process, to ensure the needs of the all beneficiaries are considered, especially the home owners and occupants, and those in fuel poverty. Consideration could be given by the National Retrofit Taskforce as to how these actions are best progressed.

The **retrofit renovation wave** would begin once all these preparations have been made and the roll-out is launched. This is the execution phase, when all of the actual retrofitting takes place on-site through a coordinated delivery approach to achieve the required number and level of retrofits in a timely manner, while maintaining a high level of stakeholder engagement throughout. The last phase will be a **post-occupancy evaluation** phase. This phase will examine the results of the works carried out, to evaluate if they meet basic project management criteria; finished on time, on budget and according to the scope, as well as addressing the energy performance gap, i.e. ensuring that homes perform as efficiently in practice as the retrofitting works were designed to perform in theory. Where works have not been a success, this phase will provide valuable lessons learned as to why the retrofit did not meet expectations, and to ensure future works rectify systemic failings. This phase will also enable assessments of macroeconomic gains, public health and wellbeing gains, national energy and carbon emissions savings, and so on. This will be the most important phase to determine whether or not the benefits of a retrofit renovation have been realised.

Figure 1: *Retrofit Policy Stakeholder Mapping*

The map indicates that there are several main stakeholder groups; building users and occupants (including both tenants and owner-occupiers), and building operators, owners and managers (including private and social housing, landlords, property developers and building management companies) being two of the most obvious and directly impacted. The energy and retrofit sectors, and energy supply & regulated infrastructure owners, are also important stakeholder groups encompassing designers, manufacturers, suppliers, and installers of energy and retrofit materials, products and technologies. Irish government bodies, departments, and civil and public services, in particular the health and social services are critical stakeholders in the process. There are also dozens of indirectly involved stakeholders such as the trade unions, the real estate, financial, and insurance sectors, and the media for example.

Recommendation 1: Stakeholders & Phasing of Retrofit Renovation Wave

1. This document illustrates how retrofit policies benefit the exchequer, the state, the tax payer, and Irish society as a whole, therefore it is strongly recommended that the policies and programmes of other government bodies and departments are integrated to contribute to the energy retrofitting of the housing stock. Relevant bodies include: Departments of Business, Enterprise & Innovation; Education & Skills; Department of Further and Higher Education, Research, Innovation and Science, Employment Affairs & Social Protection; Finance; Health; Housing, Planning & Local Government; Culture, Heritage and the Gaeltacht; National Standards Authority, Public Expenditure and Reform; Rural & Community Affairs; The Health Service Executive (HSE); the Sustainable Energy Authority of Ireland (SEAI), and Solas[5] for example.

2. Many Irish homes are energy inefficient and carbon intensive, however, the full scale of retrofit requirements is not currently known as only homes that have been sold, rented, or upgraded in recent years have a BER certificate. It is therefore recommended to carry out regular nationwide surveys (perhaps as part of the national census) into the condition of Irish homes and households, including information on both the condition of the building, and of the occupants. By collecting (subjective and factual) data on the socio-economic, health & wellbeing, and energy poverty risk of occupants, such surveys would enable planning of retrofits to gauge retrofit solutions based not only on the building requirements, but on stakeholder requirements also[6].

3. Carry out the retrofit renovation wave in three main phases; pre-rollout planning, retrofitting, and post-occupancy evaluations. Ensure that a thorough and inclusive stakeholder engagement process is carried out from the pre-rollout planning stages of the renovation wave, to the post-occupancy evaluation phase. Ensure that lessons-learned are collected and recorded from each stage of the process, and that there is cross-sectoral, cross-departmental collaboration on all activities.

4. Gather feedback and encourage stakeholder input in all three phases.

5. Establish a co-ordinated multi-disciplinary research programme to inform policy and roll out of the retrofit programme.

6. Develop an inclusive communication and engagement plan to ensure a just transition, with a forum for all voices to be heard, and for the dissemination of information on the potential benefits of retrofits. Develop a combination of bottom-up and top-down approaches.

5 Solas is the state agency for further education and training that replaced FAS (Foras Áiseanna Saothair) in 2013 https://www.solas.ie/ The word 'solas' means light in Irish.

6 Care to be taken with subjective questions however, e.g. Are you able to heat your home adequately? Have you had difficulty in paying your utility bills over the past year? Are you satisfied with your heating facilities? As these are likely to lead to a mismatch between objective factual indicators and subjective opinions [67].

2.1 Benefits by Stakeholder Group

The following table outlines the potential benefits to each of the stakeholder groups and subgroups identified above. The box to the right categorises the benefits as environmental, social or economic benefits.

Environmental Benefits

- Decreased Energy Consumption
- Decreased Carbon & GHG Emissions (and embodied carbon)
- Less reliance on imported Fossil Fuels
- Increased use of local Renewable Energy
- Improved indoor and outdoor Air Quality
- Energy security
- Longevity of homes
- Decreased Pollution

Social Benefits

- Increase Health & Wellbeing
- Increase Comfort & Safety
- Decrease Social welfare and Public health cost
- Reduce Fuel Poverty
- Resilience in crises
- Reduce excess mortality

Economic Benefits

- Disposable income
- Employment
- Asset Value
- Increased Sale/Rental Value (& associated tax and stamp duty)
- VAT on Retrofits
- Smaller more diverse resilient Energy System

Table 1: *Benefits by Stakeholder Group*

Stakeholder Group	Potential Benefits
Building Occupants & Users **Subgroups:** Owner-occupiers Private tenants Public tenants	Increased physical and mental health & wellbeing Increased comfort & safety Decreased energy bills Decreased fuel poverty Increased disposable income
Building Owners & Managers **Subgroups:** Private owners Local Authorities Cooperatives Developers	Increased resale value Increased rental potential Increased asset value Increased fitness for use Increased building lifespan leading to Decreased embodied energy/carbon Reduced Maintenance Costs
Energy Sector **Subgroups:** ESCOs Suppliers Retailers Research	Increased demand for energy products and services leading to increased income, employment, and job security Increased demand for retrofitting products, services, expertise and innovation leading to export potential
Retrofit Sector **Subgroups:** Contractors Manufacturers	Increased demand for energy products and services leading to increased income, employment, and job security Increased demand for retrofitting products, services, expertise and innovation leading to export potential
Government **Subgroups:** Civil & Public Services Government Departments	Decreased social welfare spending Decreased health care spending Increased resilience in crises Increased tax revenue Addressing climate action targets
Health & Social Services **Subgroups:** HSE, Hospitals, GPs NGOs Private Healthcare & Insurance	Decreased healthcare costs Decreased visits to GPs & Hospitals Decreased excess winter and summer mortality rates
Energy Infrastructure **Subgroups:** Transport Logistics Grids Transmission Networks	Increased energy security Increased resilience to external shocks Less reliance on imported fossil fuels Increased diversified indigenous energy sources coupled with reduced energy demand

3. Housing Profile and Calculation Assumptions

Calculating the exact benefits of a renovation wave is a complex process, and not entirely within the scope of this paper, therefore this section takes a brief look at available data and makes the following broad assumptions. Using these assumptions this paper sets out some basic estimates of the potential payback of a nationwide retrofit renovation wave. The average house size in Ireland in Q4 of 2019 [16] is 152.2m^2, and the average apartment size is 77.7m^2 [17]. Only 11% of Irish homes are apartments [18], therefore the average home size can be calculated as follows:

(152.2 x 0.89) + (77.7 x 0.11) = 149m^2

The SEAI website [19] provides figures[7] for the annual energy costs of a typical homes ranging from 75m^2 to 300m^2, including figures for a typical 4-bed semi-detached home of 150m^2, therefore, as this is the closest to the average home size of 149m^2, this shall be used for the remainder of this report. It should be noted that these are estimated annual fuel costs based on a typical occupancy and heating of the whole home to a comfortable level.

There are 2,003,645 dwellings in Ireland [20]. At least 80%, or 1.6 million, Irish homes have a BER of C or lower [21]. The cost of retrofit will vary depending on the age, size, condition of the buildings. In 2014 SEAI estimated that an average investment of €21,000 per home would be required to upgrade every home in the country to a minimum BER rating of B3, suggesting a total minimum investment requirement of around €35bn [18]. Estimates to retrofit to A-Rating range from a minimum of €30,000 per home [22] [23], to €40 to €50,000 per home [24]. Other estimates give an average of €54,047 per home, based on 325 homes having already undergone an SEAI funded deep retrofit [25], to a range from €35,000 to €70,000 [26]. Transition Zero, an EU Horizon 2020-funded project, carried out by Energiesprong from 2016-2018 estimated an average cost of €40,000 for zero energy retrofits [27] Therefore, the total cost for retrofitting to an A-Rating could be anywhere from €30,000 to €70,000 (based on the highest and lowest estimate), which, for 1.6 million homes, could be anywhere from €48bn to €112bn. The National Climate Action Plan aims to retrofit 500,000 homes to a B-Rating or cost-optimal equivalent by 2030, therefore it is recommended here to aim for a B-Rating where possible, and to retrofit as many homes as possible of the 1.6 million homes that are rated C or lower.

The remainder of the report shall make calculations based on the following assumptions:

- The average home size in Ireland is 150m^2 and the average energy cost per BER rating for an average sized home is as per SEAI estimates. These estimates assume typical occupancy, and heating of the whole home to a comfortable level.
- 80%, or 1.6 million, homes require retrofitting because they are C-Rated or lower.
- Retrofitting to B-Rating for 1.6 million homes is estimated to cost at least €35bn.

7 SEAI Figures are available here: https://www.seai.ie/home-energy/building-energy-rating-ber/?gclid=CjwKCAjw8df2BRA3EiwAvfZWaGNV2YNhwsNNxxh2LKX7w9H-RgIo9gW-otsVwrtSmdmwNKsm6wfabRoCRE0QAvD_BwE (Valid as of June 2020)

Figure 2: *Annual Energy Costs for an Average Home [19]*

150m²
4 Bed Semi-D

The estimated annual fuel costs are based on a typical occupancy and heating of the house to a comfortable level.

4. Environmental Benefits of Retrofits

4.1 Energy Reduction, Carbon and GHG Savings

The International Energy Agency (IEA) has, in recent years, highlighted the importance of energy efficiency (EE) to its member states, and to give it more priority it has been reframed as from being a 'hidden fuel' to being the 'first fuel' [28]. Prior to the oil crises of the 1970s Irish buildings did not have significant, if any, insulation, and were not generally designed for energy efficiency. A typical external structural cavity-wall build-up in dwelling construction between the late 1970's and the late 1990s/early 2000s, would be a 300mm cavity block wall, with approximately 40mm insulation in the cavity. Floor and ceiling or roof insulation would rarely have exceeded much more than 60-100mm. Therefore, dwellings built before Energy Performance in Buildings Directive (EPBD) was transposed into Irish legislation, and not retrofitted since, might not have insulation installed (Pre-1979), or are very poorly insulated (circa 1980-2005). The built environment in Ireland accounted for 12.7% of Ireland's GreenHouse Gas (GHG) emissions in 2017. Irish homes use 7% more energy than the EU average and emit 58% more CO_2eq [1].

Buildings Emissions CO_2 eq.	Share of Total GHG Emissions	Buildings Emissions CO_2 eq/head
7.7 Mt	12.7%	1.6t

Table 2: *GHG Emissions from the Irish Built Environment in 2017 [1]*

Recommendation 2: On Energy and Carbon Savings

7. Offer Free BER assessments to all households that do not currently have a BER to get better data on the existing energy efficiency of buildings, the extent of work required, and which homes need to be prioritised. This could be done in the Pre-Rollout Phase as part of a citizen stakeholder engagement process to open a dialogue with households with regards to energy efficiency of their homes. The process of carrying out the BER assessment will help households to get a better understanding of their current energy use, and the potential benefits of engaging with the retrofit renovation wave programme. It would also be recommended to collect data on actual energy usage via utility bills and occupancy profiles from a representative sample, in addition to the BER assessment. BER assessments are theoretical, and based on certain defaults and assumptions, that do not always provide a complete picture. This will also help the retrofit programme to engage with harder to reach groups, especially those in fuel poverty.

Not all homes built before 1979 remain as-built, as retrofitting has been taking place since then. Directly after 1979 oil crisis, ESB and Moy Insulation teamed up to offer attic insulation to customers, requiring no upfront capital investment, but instead adding the cost to the energy bills of the participating customers [10]. According to the 1979 ESB annual report, over 2,000 attics were insulated by the ESB [29], 12,000 attics in 1980 [30] and 10,000 in 1981 [31]. Electrical appliances (including installation, and repair), as well as insulation (supply and installation), could be purchased from the ESB in the 1970s. They had shops in towns and cities nationwide at that time. These services were often operated at a loss, with the ESB aiming only to break even from sales, and charging 50% less than private contractors for appliance repairs. The ESB viewed these insulation and appliance services as a social obligation, and a matter of public health and safety [30]. This would have been an early form of both a one-stop-shop, and a 'Pay-As-You-Save' (PAYS) scheme.

A PAYS scheme was trialled in the UK as part of the UK Green Deal between 2013 and 2015. The UK scheme was flawed however, as the interest rates were high (7-10% APR), and the rules regarding how much energy savings were required were prohibitive, and householders were unconvinced of its benefit [32]. The scheme is no longer in operation. The EnEv scheme in Germany, between 2002 and 2009, on the other hand is considered to be successful. Interest rates were lower (1-4%) and there was a high level of uptake, with the scheme also targeted at landlords and public housing [32].

For the past 15 years, the Sustainable Energy Authority of Ireland (SEAI) have been operating successful Government funded grant schemes aimed at improving energy efficiency of buildings. Therefore, while these older buildings may still offer significant savings, one must be cautious not to overestimate the potential savings for all pre-1979 buildings, as some will already have undergone some form of retrofit. In addition, BER assessors use nationally applicable default values, such as U-values for roofs, walls and floors based on the building regulations applicable at time of construction. Where an older dwelling has undergone an upgrade, the default U-values may be considerably higher than the real U-values of those upgraded houses, causing a systematic 'default effect' error [33].

Recommendation 3: On Financing and Data Collection

8. Introduce a low-interest Pay-As-You-Save/Save-As-You-Pay scheme as part of a broad suite of options to make retrofitting more attractive to both the public and private investor. The design of such a scheme would need to take into account and learn from similar successful and unsuccessful schemes past and present in Ireland and in other countries.

9. Collect data on previous retrofits carried out before the introduction of BER certificates to gain a clearer picture of the condition of existing building stock, and the potential for 'default effect' [33] errors. Relevant data could include energy bills, and detailed monitoring of representative samples of dwellings (see recommendation 7). Research and development of appropriate data collection methods to be carried out (perhaps in conjunction with SEAI[8], the Central Statistics Office (CSO), Local Authorities Building Control and Planning Departments, or professional representative groups such as the Royal Institute of Architects of Ireland (RIAI), Engineers Ireland, Society of Chartered Surveyors or similar.

8 In response to Action 45 of the Climate Action Plan, SEAI has commenced development of a new tool to provide BER data for supply-chain operator use in the form of an API (Application Program Interface) and Open Data. This will support the supply chain to innovate in delivery models (e.g. One-Stop-Shop, Obligated Parties, Finance Products) [13]

Ireland has some of the most carbon intensive buildings in Europe, producing more CO_2 per unit area than buildings in Germany or the UK, which can be partly attributed to the widespread use of oil for home heating and poor thermal performance of the building fabric [34] The following table calculates how much energy could be saved by retrofitting average sized homes with a C-Rating or lower based on the energy consumption by BER, for 1.6 million homes.

It should be noted that these figures are the maximum potential savings based on the following assumptions; that all homes C-Rated or lower are retrofitted, and that all homes are currently being heated to a comfortable level. However, it may not be possible to fully retrofit some homes, listed buildings for example. It is also the case that energy inefficient homes are not always fully heated to a comfortable level, especially where the household income is low. This latter point will be discussed in more detail later in this report in a section on Fuel Poverty. There is also the potential for a rebound effect, sometimes known as the take-back or comfort taking effect whereby a home that is retrofitted uses similar amounts of energy as it did before the retrofit. The household may be spending the same on energy before and after the retrofit because they were only partially heating the house before retrofit, and now they can fully heat it. Despite the rebound effect, there will still be significant benefits, less energy is being wasted through the fabric of the home, and the energy used will now be going where it is needed and producing a warmer healthier indoor environment.

Space heating is the main factor driving the energy consumption of households. Studies show that it dominates the energy consumption of households in the European Union (EU) with 67% of the total energy use. The residential sector overall accounts for 25% of the final energy consumption, comparable to the EU's entire industry sector [36]. As quality of life and expectations for higher levels of thermal comfort increase, heating requirements are also rising. Indoor air temperatures in the UK have risen steadily over the last 40 years, from around 13°C in the seventies, to a current average of around 17.5°C now, and a predicted average of 21°C in 2040 [36]. Irish building regulations have tended to be similar to those in use in the UK, and as both climate and current living standards are comparable, it is safe to assume that Irish indoor temperatures are following a very similar trend. In the future, as temperatures rise due to the combined impacts of global warming and increases in urban heat islands due to increasing urbanisation, cooling demands will also increase as homes begin to overheat. During the Celtic Tiger era (1997 to 2009) floor areas in Irish dwellings also grew at a rate of 1.3% increase in floor area per annum [10], which has a growing impact on space heating (and cooling) requirements.

BER*	Energy Consumption in kWh/m²/ year [35]	Savings by Upgrading to B-Rating
A-Rating	25	-
B-Rating	100	-
C-Rating	175	75
D-Rating	260	160
E-Rating	340	240
F-Rating	380	280
G-Rating	450	350
Average annual saving		221 kWh/m²/year
X 150m² average home size		33,150 kWh/m²/year
X 1.6 million homes		53,040 million kWh/year
Convert to terawatt		Approx. 53 tWh

*For A, B, and C ratings the mid-range has been used i.e. A2, B2, C2

Table 3: *Energy Savings Potential of a Retrofit Renovation Wave*

Superhomes and Tipperary Energy Agency[9] have seen considerable benefits to installing heat pumps as the main source of heating in Irish homes. Installation of heat pumps is now also a priority for the National Climate Action Plan [1]. Heat pumps are capable of operating in the Irish climate, and do not need a fossil-fuel based or other heating system as "back-up" to sufficiently heat even large, detached homes. Depending on the electricity supply to the home, heat pumps indirectly use fossil-fuels via the electricity used to power them.

9 Superhomes is an initiative of Tipperary Energy Agency which functions as a one-stop-shop providing energy retrofits to Irish homes. More information can be found here: https://superhomes.ie/. Tipperary Energy Agency is a non-profit social enterprise that has been successfully supporting projects to reduce energy for over 20 years. More information can be found at: https://tippenergy.ie/

This will be reduced as the share of renewable energy on the grid increases. However, homes do ideally need to be 'heat pump ready' as heat pumps work best in homes that are relatively efficient (with an appropriate minimum heat loss indicator). The cost of running a heat pump in an energy inefficient home could be expensive. Therefore, the installation of a heat pump should be done in conjunction with other measures such as increasing levels of insulation and draught-proofing for example.

For heat pumps to operate efficiently, and to be available to use more renewable electricity as it is generated, heat pumps should run for longer periods rather than in short bursts. They are also more efficient when installed with larger radiators that can heat homes comfortably without having to use extremely hot water. It may not be necessary to replace every radiator, as insulating homes allows existing radiators to provide comfort at lower water temperatures. At the point of use, in a home, there is no fossil fuel required, no transport, mining or drilling, no smoke, GHG emissions, or particulate matter. Heat pumps do require electricity; therefore, the source and timing of the electricity use will be another important factor in determining the overall sustainability of the heat pump. Retrofitting homes to reduce their energy consumption and carbon emissions, through the use of superinsulation (insulation beyond minimum standards, e.g. Passive House[10] standard), heat-pumps, and solar PV panels, and taking further advantage of wind energy and grid decarbonisation with energy storage technologies including hot water or electric batteries, would contribute to national emissions reduction targets. The following tables show the potential carbon emissions savings for an average 150m^2 home by upgrading to a B rating. These potential carbon savings[11] are averaged out in the second to last row and multiplied by 1.6 million for the number of homes rated C or lower that could be retrofitted.

Energy consumption accounted for 59% of Ireland's greenhouse gas emissions in 2018. Transport, and residential energy account for the highest shares [37]. Ireland emitted almost 61 million tonnes of greenhouse gases in 2017 from generating electricity, heating and cooling buildings, transport and agriculture. Ireland is currently facing multi-million euro fines [38] [39] for not reaching emissions targets, and has the third highest rate of emissions in the EU [40] at 13.3 tonnes of CO_2 equivalent per capita, 1.6 tonnes of which come from the built environment [1]. The Climate Action Plan aims to reduce emission from the built environment from 7.7 to 5Mt CO_2 eq. [1]. Investing in retrofitting now would possibly reduce those and potential future fines (or the cost of purchasing credits to meet compliance [41]), while paying dividends elsewhere within the economy, environment, and society. An EPA report noted that in 2016, the carbon tax raised over €434m. An additional increase of €10 per tonne would see an extra €200m raised; this could potentially be used to pay any penalties that Ireland may incur [42].

BER*	Annual CO_2 Emissions (in Tonnes) [35]	Maximum Potential Savings by Upgrading to B-Rating
A-Rating	1.6	-
B-Rating	3.3	-
C-Rating	5.5	2.2
D-Rating	8.8	5.5
E-Rating	11.4	8.1
F-Rating	13.6	10.3
G-Rating	17	13.7
Maximum potential average annual saving		7.96
X 1.6 million homes		12.736 million tonnes

*For A, B, and C ratings the mid-range has been used i.e. A2, B2, C2

Table 4: *Potential Carbon Emissions Savings per BER*

10 The Passive House Institute (PHI) is an independent research institute that has played an especially crucial role in the development of the Passive House concept an internationally recognised, performance-based energy standard in construction: https://passivehouse.com/

11 Figures for carbon per BER available from the SEAI Guide to Building Energy Ratings for Homeowners: https://www.seai.ie/publications/Your-Guide-to-Building-Energy-Rating.pdf

4.1.1 Embodied energy and carbon

In some situations, it may be preferable not to perform a deep retrofit to an A-Rating, or not upgrade at all depending on the existing condition of a building, risk to architectural heritage and conservation, the availability of low carbon community heating, or the potential for the retrofit works to add more energy and carbon through the retrofitting process itself than the building would save in the remainder of its lifetime. Embodied energy and carbon is that which was used to make, transport, and install the products and materials that go into the retrofit, sometimes this is called 'upfront' energy or upfront carbon. Almost all transportation of material, equipment, and staff uses considerable amounts of fossil fuels, thus contributing to the total embodied energy [43]. Retrofits should be carried out with consideration for this using life-cycle analysis, cradle-to-cradle analysis, or green public procurement methods.

Retrofitting solutions based merely on reducing operational energy use can increase embodied energy, mainly due to altering the existing trade-off between the two. Considering this trade-off is vitally important, especially for retrofitting buildings located in cold climate regions, as a deep retrofit can considerably increase the embodied energy and thus be unfavourable from a Life Cycle Energy (LCE) perspective [45]. Embodied carbon is estimated to account for 11% of all carbon emissions [44]. Care must be taken in designing retrofit solutions that do not increase the embodied energy/carbon such that it exceeds overall energy/carbon savings. While increasing the lifespan of a building can be substantially less energy and carbon intensive than demolition and replacement with a new-build, the extent of the retrofit could potentially embody more energy and carbon than the building could use in the remainder of its lifetime, and therefore adopting a Life Cycle Analysis, or Life Cycle Energy perspective is essential to examine the trade-offs.

Insulation lasts longer than many domestic renewable energy systems, and complements their use, so that 'Fabric First' is usually a good choice. Insulation and natural materials with lower embodied energy are sometimes thicker but can often resist summer overheating or mould formation better. Natural materials such as sheep's wool insulation could provide excellent insulation, from Irish sources where new business opportunities are desperately needed. The sector is currently facing severe economic challenges as prices have been exceptionally low this year where prices have dropped as low as 5c/kg for wool that costs €2.50-€3.00 a head to shear [46].

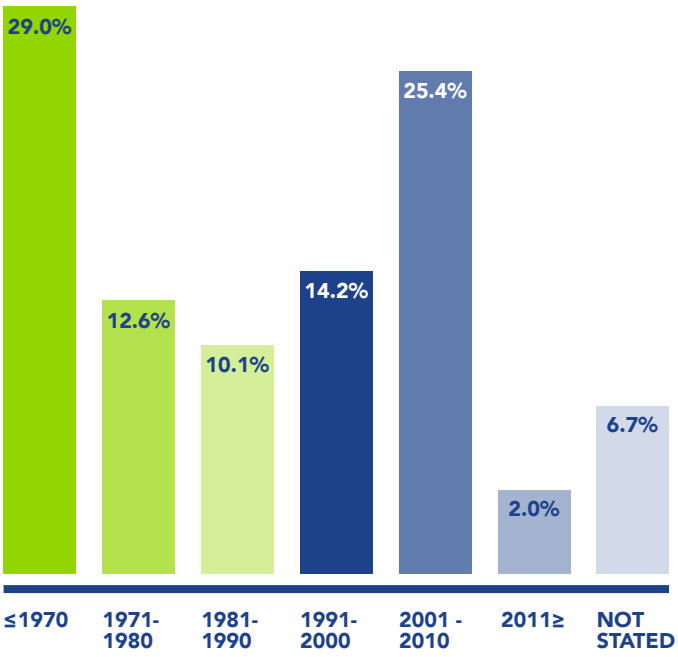

Figure 3: *Dwellings by Period Built [20]*

Europe has an ageing existing building stock and it is expected that up to 80% of buildings in use in 2050 already exist today [44]. Over half of Irish homes were built before the introduction of building regulations, and about three quarters before the introduction of the Energy Performance of Buildings Directive. Increasing the life-span on buildings and their components through good design, good quality workmanship, maintenance, repair and restoration, to avoid demolition and disposal for as long as possible is preferable for a more circular approach to Irish building stock. Construction and demolition (C&D) waste in Ireland amounted to an estimated 4,749,700 tonnes in 2017 [47]. 12.3% of dwellings in Ireland were listed in the 2016 census as unoccupied. The reasons for vacancy vary; properties for sale or rent, deceased owner, owner in nursing home, hospital, or with relatives, or abandoned, and boarded up for example [16]. There is a significant shortage of housing in Ireland, and while a residential construction boom for new dwellings is needed to tackle this, renovating, repairing, and retrofitting existing unoccupied dwellings could also be carried out to bring them back into use, not just for the sake of reviving individual buildings, but for architectural, cultural, and social reasons also, the potential rejuvenation of a street, neighbourhood, or community.

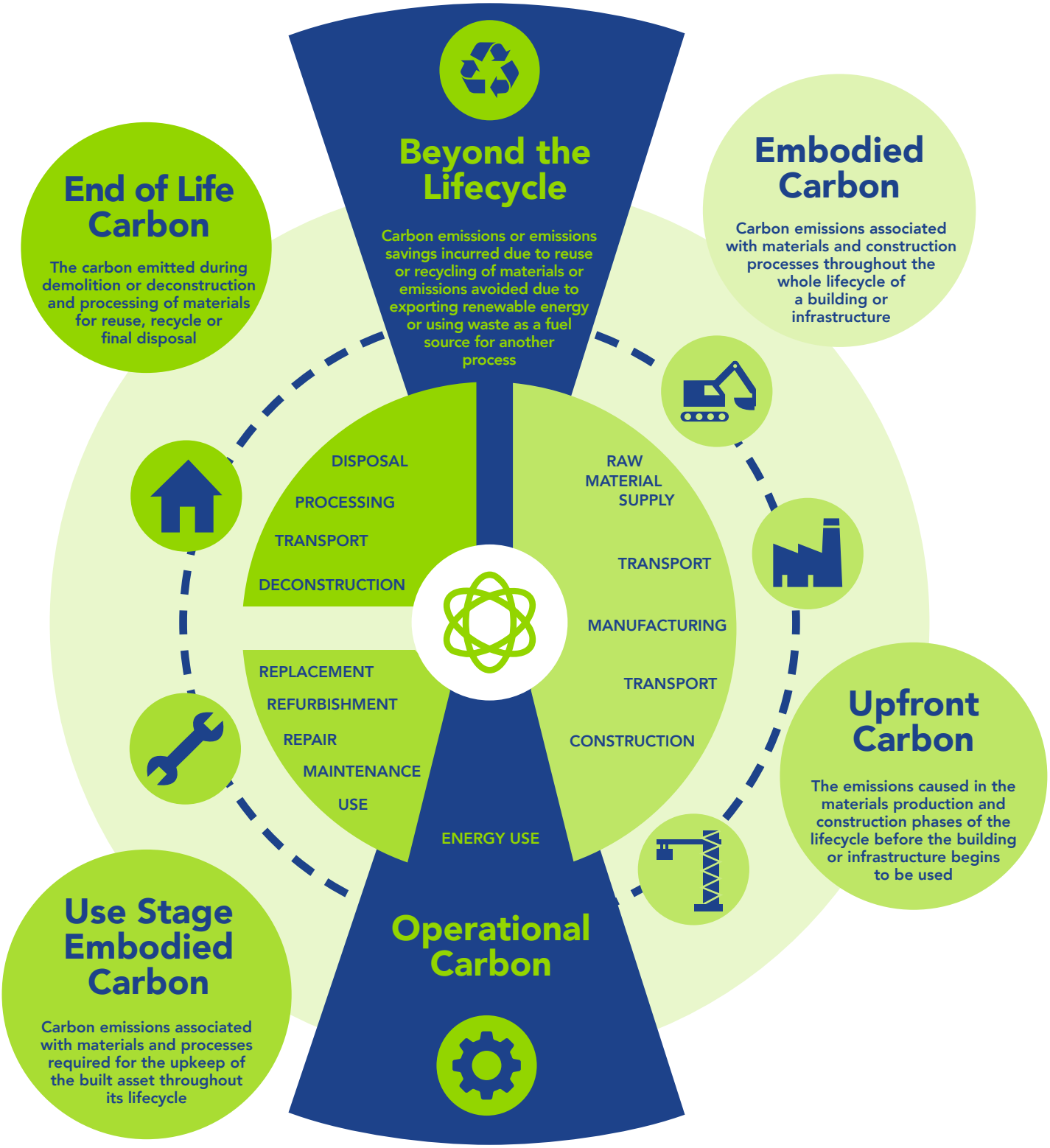

Figure 4: *Project Lifecycle Showing Both the Scope of the Definition and Need for Whole Life Consideration [44].*

Recommendation 4: On Life Cycle Analysis, Procurement & Product Specification

10. Consider the insulation properties of a home and any adjoining homes first, and the potential for shared sources of heat.

11. Adopt a whole-life-cycle approach to minimise embodied energy and carbon.

12. Utilise Environmental Product Declarations (EPD) and other environmental certifications and accreditations such as Cradle to Cradle, Living Building, Home Performance Index, Well Certification etc

13. Green public procurement should be used for publicly owned homes; for privately owned homes, incentives will be required, such as reduced tax, or increased grant-aid for certain products and materials that have lower levels of embodied energy and carbon.

14. Develop markets for natural materials such as sheep's wool insulation.

15. Consider retrofitting buildings, especially unoccupied buildings, as part of local area development planning, community development, and rejuvenation.

4.2 Energy Security and Resilience

> "Our economy must recover in a way that is fair and balanced, leaves no one behind, and is futureproofed against shocks."
>
> Programme for Government 2020, Our Shared Future [2]

Energy security relates to how reliant a nation is on imported energy, the diversity of its supply, the capacity and integrity of its infrastructure to import, generate and distribute energy, and level of risk in the face of disruptions to supply. An energy secure nation is one that can reliably, consistently, ethically, and affordably, both source and deliver energy. Ireland does not have significant indigenous fossil fuel reserves, and has therefore become reliant on importing fossil fuels[12], such as coal, gas and oil, most significantly in the form of oil for transport, but also oil for home heating. Ireland's reliance on imported energy has decreased from a peak of 91% in 2006 [48], but it still remains high at approximately 66% [49]. When the Irish energy system is assessed for energy security, energy equity, and environmental sustainability, its high import dependence and lack of diversity of supply become apparent. E.g. As scored using the World Energy Council's Energy Trilemma Index [50].

The demand for energy will rise in future, as Ireland is set to be home to numerous data centres. Electricity demand in Ireland could grow by up to 57% by the end of this decade [51]. The higher the dependency on imported energy, the greater the exposure to risk from disruptions in supply and consequently, putting energy security at risk, especially in times of crisis, trade wars, natural disasters, oil price fluctuations, and in economic downturns. Dr. Fatih Birol, Executive Director of the International Energy Agency has also recently commented on how the pandemic has further highlighted the need for energy security to ensure that nations can facilitate maintaining their economy, as well as operating the healthcare facilities battling the virus. *"Governments are rightly focused on the immediate public health emergency, but they have to remain vigilant on electricity security and safeguard vital assets amid the extreme volatility in markets. In these extraordinary times, we can manage without many things, but we can't manage without electricity"*. [52]

12 "SI 183 of 2019 and SI 292 of 2019 transposed the NZEB requirements of the Energy Performance of Buildings Directive in Q2 2019. Introducing such regulatory measures is key to support the phasing out of fossil fuel boilers and develop a more sustainable housing supply" Climate Action Plan 2019, First Progress Report. [13]

Ireland needs to improve its energy security. Insulating homes results in stocks of heating fuels lasting longer in any supply interruption, enables more heat pumps to be installed on an electricity system powered by a diversified range of fuels, and increases the amount of renewable energy that can be used directly for heating homes and hot water without extra investment in energy storage. This "first fuel" of energy conservation, or avoided energy, is the most preferable solution and provides a synergy with energy generated and delivered within the country from renewable sources. Conservation contributes both to a reduction of import dependency, to reduced pressure on power grid and fuel storage and distribution infrastructure. Energy retrofits can increase the amount of renewable electricity used in homes, by providing some flexibility in when electricity is used for providing hot water, heating, and humidity and air quality control in homes. Home electric battery systems installed as part of the renovation wave can integrate with solar photovoltaic panels, and with grid wind energy in time, but also have potential to improve the security of electrical supply to homes, especially in rural areas vulnerable to power outages.

In more compact settlements, community heating powered by large electric heat pumps and linked to long duration thermal storage may come to have a major role in decarbonising heat supply, using renewable electricity at times when it is not needed for individual heat pumps or data centres, and using surplus renewable electricity when it would otherwise be wasted. Insulation has a major role in increasing comfort, in cutting the number of days that heat is needed. If a home is better insulated it enables an increase in the numbers of homes that can be served by a given source of heat in a district heating scheme. Waste energy sources should also be utilised, such as embracing industrial symbiosis[13] on a national scale to utilise waste heat, water, and energy from industrial and commercial buildings, for reuse heating and power homes. Notably, this could include offsetting the electricity demand of data centres through capturing their waste heat for local district heating, complimenting corporate preferences for constant renewable power.

13 Industrial symbiosis, also known as Industrial Ecology is best exemplified by the Eco-Park in Kalunborg in Denmark. More information available at this link: http://www.symbiosis.dk/en/

Recommendation 5: On Waste, Storage, and Reuse of Energy

16. Develop practices across Ireland whereby waste or by-product energy from commercial or industrial buildings, complexes, campuses, data centres, or industrial estates can be harvested for use in homes via district heating.

17. To maximise the benefits of the renovation wave, special efforts should be made to upgrade rural homes at the extremities of the electricity grid, and to resolve the appropriate sizes for systems of thermal storage.

18. Introduce local area energy planning, and heat-area zoning through local and regional development planning to support the efficient deployment of technologies to decarbonise home heating[14].

14 For more information on local area heat zones, refer to the Energy Technologies Institute, Energy Catapult UK report entitled "Local Area Energy Planning: Guidance for local authorities and energy providers, available at: https://es.catapult.org.uk/wp-content/uploads/2018/12/Local-Area-Energy-Planning-Guidance-for-local-authorities-and-energy-providers.pdf

4.3 Fossil Fuel Reduction

Reducing the need for combusting fossil fuels such as coal, oil and gas, would have enormous environmental benefits, while at the same time the Government has stated that it recognises the 'moral duty to put social justice at the heart of (its) commitment to decarbonise' [2]. Oil accounts for 56% of Irish CO_2 emissions, gas for 27%, and coal/peat for 16% [53]. The entire life-cycle of fossil fuel use is environmentally degrading, from extraction (digging/mining/drilling), to transport, to burning. Fossil fuel sources are finite, and as more easily accessible resources dwindle; newer, more environmentally destructive methods are being used to extract fossil fuels. Irish buildings are currently 70% reliant on fossil fuels according to the Climate Action Plan, 2019. Decreasing reliance on fossil fuels, will need to take into consideration a just transition for those whose livelihoods depend on this sector. Creating new jobs in retrofitting, and renewable energy may require retraining or upskilling of the workforce in some cases, however, this topic is outside of the scope of this report and shall be addressed in future publications in this series. As part of EU objectives to achieve carbon neutrality by 2050, the European Green Deal has created a Just Transition Mechanism with an associated Just Transition Fund. Ireland has been allocated €176m of that fund [54]. The Just Transition Fund 2020 is €11m in grant aid (€6m from Carbon Tax and €5m from ESB), administered by the Department of Environment, Climate and Communications, directed at the Wider Midlands area of Ireland. Due to the closure of two ESB Peat-Fired plants, and its impact on regional and local employment, this is the first region in Ireland to experience a concentrated transition away from carbon intensive activities. The fund will focus on three areas; employment and enterprise supports, training supports, and community transition supports [55].

Coal mining has become extremely invasive using strip mines, and mountaintop removal, causing severe land degradation and ecological damage. In-use and abandoned mines can collapse or cause subsidence and land or mudslides. Mines also have a negative impact on surface and sub-surface water, including diverting and burying water sources, or creating acidic and toxic run-off to water sources. Coal extraction is a dirty process leading to pollution at source, then it is often used thousands of miles from where it is extracted, with its transportation resulting in additional fossil fuel use, and greenhouse gas emissions. The burning of the coal at its destination leads to more local air pollution (air pollution will be discussed in the next section). However, mining can also be a dangerous process, with workers regularly suffering work-related injuries and illness, for example black lung disease (pneumoconiosis), and many deaths in the mining industry every year.

Oil and gas are flammable and volatile, and their extraction can also be dangerous, leading to explosions, death, and extremely severe pollution. The Deepwater Horizon BP oil spill in the Gulf of Mexico in 2010 was still leaking oil two years later and took several attempts and 87 days to seal. It was the biggest oil disaster ever, and the official clean-up took four years. Wildlife species including dolphins and deep-sea coral were still showing signs of negative impact for many years afterwards. Like coal, oil and gas are also transported many thousands of miles to their end-use destination, and cause pollution and greenhouse gas emissions when burned. When oils and gasses are extracted, previously trapped, polluted water is also brought to the surface. When hydraulic fracturing (fracking) is used, this toxic wastewater impact is worsened by the amounts of water and chemicals required for this method of extraction. Most of the chemicals used are harmful to the natural environment, and to humans. The fracking process also leads to large increases in local seismic activity, and escapes of methane, (a more aggressive greenhouse gas than carbon dioxide is to the atmosphere). Reducing our requirement for fossil fuels will reduce our contribution to the negative impacts of fossil fuel extraction and contribute to our national commitments to address climate change.

4.4 Local Air Pollution

4.4.1 Outdoor Air Quality

Air pollution is known to cause millions of deaths worldwide every year [28] [56]. Outdoor air pollution is responsible for an estimated one third of lung disease deaths, one quarter of deaths from respiratory infection and one sixth of deaths from heart disease and stroke [57]. Research also shows that people living in regions with high levels of air pollution are far more likely to die from respiratory diseases and viruses like SARS and COVID-19 [58] [56]. These types of virus attack the respiratory system, and where this has already been damaged or weakened by even small increases in long term exposure to air pollution, there is a marked increase in likelihood of serious illness and death. The Irish Environmental Protection Agency (EPA) has previously reported that burning of solid fuel is the biggest threat to good air quality in Ireland. The levels of particulate matter in the air, especially during the winter months can directly impact air quality and health, with coal burning resulting in emissions of harmful polyaromatic hydrocarbons, but also acidic nitrogen and sulphuric oxides, mercury and radioactive material. The damage caused by the use of fossil fuel to health and buildings often costs more than the value of the heat produced, especially in towns [59]. Air quality data collection and monitoring, across Ireland, not just in urban centres, but adjacent to any industrial sites, roadways, and other built-up areas, including rurally, is required to assess the scale of the problem more accurately. The predominant source of fine particulate matter is from the burning of solid fuel. Recent research reviewing the heating strategies of Ireland and other countries with similar climates found that Ireland was the only one of the countries studied where coal still meets a significant portion of the heating demand [60].

Retrofitting homes to increase their energy efficiency would help to reduce, or ideally eliminate, the need to burn fossil fuels in homes, thus improving both indoor and outdoor air quality. The COVID-19 pandemic saw tens of thousands of Irish people work from home (WFH), and it has been reported in the media that many would wish to continue to do so in the future, either on a full time or part time basis. This would alleviate traffic congestion (and emissions) at peak times with fewer people travelling to work, and it would contribute to a reduction in outdoor air pollution caused by vehicular transport. Air pollution had dramatically reduced across the globe during the lockdowns, with a 60% decrease recorded in parts of Europe and China, and a 30% drop in America [61] [62]. These improvements will also be due to reduced industrial activity and aviation, however, road traffic is also a major contributory factor. At the time of writing, as lockdowns are lifting, these figures are on the rise again.

4.4.2 Indoor Air Quality

The IEA previously estimated that addressing indoor air quality could save the European Unions' economy €190bn annually [28]. An estimated 5.5 million lives were lost in 2013 to diseases associated with outdoor and household air pollution. These deaths cost the global economy about US$225bn in lost workforce productivity and over US$5 trillion in welfare losses [57]. Dampness and mould growth, to which Irish buildings are particularly prone, can cause and aggravate a range of illnesses, allergies, and respiratory diseases. A US study estimated the cost of asthma induced by dampness and mould in homes at USD$3.5bn per year [28]. Given the amount of time spent indoors, it is vital to address indoor air quality, and ensure that thermal retrofits that increase insulation (properly fitted) and eliminate cold/thermal bridging, and increased air tightness are counterbalanced with appropriate ventilation to remove indoor air pollutants such as volatile organic compounds, carbon dioxide, carbon monoxide, particulate matter and radon [63] and excess water vapour.

Radon is also a particular concern in Irish dwellings. Ireland has the eighth highest indoor radon concentration in OECD countries [63]. Radon is a naturally occurring gas formed by the radioactive decay of uranium in the earth's crust that moves through the soil where it is then diluted to harmless concentrations in the atmosphere - outdoors. Indoors however, it can be problematic as it can accumulate to high levels of concentration when it seeps up through the building via the ground floor through gaps, cracks, and structural defects. At floor level, homes may have negative pressure due to heated air rising, tending to lift radon from the ground. Radon is a known carcinogen and is linked to 300 cases of lung cancer in Ireland every year [64]. Therefore, all new dwellings are required to have radon barriers at damp proof level, and radon sumps underneath the floor. Buildings constructed prior to these building regulations, however, are not likely to have either, and as retrofitting work normally does not include digging up the floor to install radon protection, care must be taken when increasing the insulation and air-tightness of the building, that ventilation is designed in to ensure removal of indoor air pollutants and radon.

Human activities also contribute to indoor air pollution. It is well known that smoking is harmful, but recent research shows that cooking also contributes to indoor air pollution, making the requirement for retrofitting solutions to ensure adequate ventilation all the more important considering how much time is spent indoors. Frying, wok cooking, and even toasters generate potentially harmful particulate matter and toxic irritants, while gas burners can generate nitrogen dioxide, carbon monoxide, formaldehyde, and particulate matter [65]. In summary, increasing the insulation levels will help to reduce the need for burning fuels that emit harmful particulate matter, smoke, and gasses such as carbon monoxide, thus improving indoor and outdoor air quality. Ensuring adequate ventilation will help to remove any harmful substances caused by fuels, and others caused by general use of the building such as condensation and mould, Volatile Organic Compounds (VOC's) from paint, fixture and fittings, cooking, and radon build-up, especially when insulation and draught-proofing measures are increased.

POTENTIAL MAXIMUM UPPER LIMIT

energy savings
from retrofitting
1.6 million homes
53 terawatt*

POTENTIAL MAXIMUM UPPER LIMIT

carbon savings
from retrofitting
1.6 million homes
12.736 million tonnes*

Recommendation 6: On Building Condition Surveys and Air Quality Monitoring

19. As part of a national building condition survey, indoor air quality and radon levels should be measured.

20. Outdoor air quality should also be monitored nationwide, and pollutant levels measured.

21. Health conditions associated with indoor and outdoor air quality issued should be analysed in the context of patients' local outdoor and indoor air quality.

* Figures are based on the assumption that all homes that are C-Rated or lower can be upgraded to a B-Rating, and are also based on the average home size and annual energy costs set out in Section 3 of this report

5. Social Benefits of Retrofits

> "The wellbeing of our nation, however, goes beyond the narrow confines of economic growth. Over the next five years, the Government will use wellbeing indicators as well as economic indicators to point out inequalities and help ensure that policies are driven by a desire to do better by people"
>
> "Our overriding focus is to improve the wellbeing of the Irish people and society."
>
> Programme for Government, 2020, Our Shared Future [2]

5.1 Poverty Alleviation

Fuel poverty, also known as energy poverty, can be difficult to define because it is not easily measured by one single indicator [66]. However, as a 'rule of thumb' a household is generally understood to be in fuel poverty when they would have to pay more than 10% of their disposable income for energy, based on Brenda Boardman's 1991 definition, although it has since been recommended that an updated methodology be adopted by Irish policymakers [67]. Needing to pay more than 15% of household income on fuel is considered to be severe fuel poverty, and at 20% a household is considered to be in extreme fuel poverty [68] [69].

Other definitions include; "*Low Income High Cost*" states that "*a household is energy poor if its fuel costs are above the median level and were they to spend that amount they would be left with a residual income below the official poverty line*" or where *"individuals or households are not able to adequately heat or provide other required energy services in their homes at affordable cost*". [70] According to Kelly et al., there is still scope for advancing energy poverty measurement methodologies to address existing drawbacks such as the limitation on their applicability to other countries and the possibility of over-simplification associated with combining variables and their reduction into a single measure [67]. (See Table 4 below). Eurostat data for 2017 shows that on average in the EU 7.8% of households are unable to keep their home adequately heated, 7% of the population is in arrears with their bills, while 13.3% of households report the presence of a leaking roof, damp walls or rotten windows [70].The World Health Organization (WHO) has set minimum standards for home temperature, which apply to all countries of the world. WHO prescribe that living room temperatures should be 21°C, and bedrooms 18°C [71].

Categories	Indicators	Data Source[a]	Weighting	
Heating Requirements	Heating System (Type of Fuel) / Fuel Cost	Domestic Fuels Comparison of Energy Costs (SEAI) Census 2016 Theme 6 Table 5 Permanent Private Households by Central Heating Type	15%	40%
	Domestic Energy Efficiency	Building Energy Rating Certificate (BER) Dataset (SEAI)	20%	
	Temperature	Temperature Data from Met Éireann	5%	
Building Characteristics	Number of Rooms	Census 2016 -Theme 6 - permanent private households by number of rooms (CSO)	10%	20%
	Year Built	Census 2016 -Theme 6 - permanent private households by year built (CSO)	10%	
Householder Characteristics	Tenure Status	Source 2016 Census Theme 6 Housing - Permanent private households by type of occupancy (CSO)	7.5%	40%
	Age Dependency	Census 2016 Theme 1 Population aged 0-19 by sex and year of age, aged 20 and over by sex and age group (CSO)	5%	
	Employment Status	Census 2016 Theme 8: Principal Status - Population aged 15 years and over by principal economic status and sex (CSO)	10%	
	Lone Parent Social Class	Census 2016 Theme 5: Private households by type Table 1 (CSO)	7.5%	
		Census 2016 - Theme 9 - Persons in private households by socio-economic group of reference person (CSO)	10%	
Overall Energy Poverty Risk Index				**100%**

[a] Data Sources: SEAI - Sustainable Energy Authority of Ireland: Domestic Fuel Comparison of Energy Costs https://www.seai.ie/publications/Domestic-Fuel-Cost-Comparison.pdf;

Building Energy Rating (BER) Data: https://maps.seai.ie/giswiki/maps/heat-map/domestic-sector-datasets/

CSO - Central Statistics Office Census 2016: https://www.cso.ie/en/census/census2016reports/census2016smallareapopulationstatistics

Table 5: *Energy Poverty Risk Categories and Indicators [67]*

An average sized home in Ireland (150m^2) with an A-Rating should have an annual energy cost of around €560 per annum, (based on the SEAI cost estimates), necessitating an annual income of at least €5,600 to be outside of the fuel poverty range (based on the 10% of income methodology). A G-rated home on the other hand will have a potential annual energy cost of around €5,900 necessitating an annual household income of over €59,000 to be outside of the risk of fuel poverty. It is unlikely that many people living in a G-Rated home would in reality be spending the full amount and heating their homes comfortably. The SEAI figures for energy costs are based on homes being heated to a comfortable level. An AA report on the costs of running a home estimated the average spent on electricity to be €999.79, and heating to be €815.72, per annum, per household in Ireland in 2019 [72]. A survey of energy efficiency of homes which considers occupancy profiles, and utility bills would be a useful supplement to the BER database to create a clearer picture of the actual energy use (and requirements) of Irish homes (see Recommendation 7).

The following table shows the estimated energy costs per BER rating of an average home, and the third column assumes that if a household is spending 10% of its income on energy, this would be their annual household income requirement to be out of risk of fuel poverty. The highest prevalence of fuel poverty in the EU tends to be in social housing [66], however it is not limited to social housing. Poor quality private-sector rental properties and high rents can lead to fuel poverty. Retirement, redundancy, illness, the death of a life partner, or separation/divorce, may also plunge a household into fuel poverty, even homes that are owner-occupied. The creation of new types of jobs and the introduction of another wage into a household will often lift it out of fuel poverty. It is especially important to note that fuel poverty is not limited to the elderly, recipients of social welfare, and those in social housing. It is also possible to be a homeowner, and/or employed, and be in fuel poverty, as Table 6 demonstrates.

BER	Annual Energy Cost (10%) [19]	Annual Income Requirement (100%)
A-Rating	€560	€5,600
B-Rating	€1,100	€11,000
C-Rating	€1,900	€19,000
D-Rating	€2,850	€28,500
E-Rating	€3,750	€37,500
F-Rating	€4,700	€47,000
G-Rating	€5,900	€59,000

Table 6: *Minimum Annual Income Requirement to be Out of Risk of Fuel Poverty*

Households who are in fuel poverty are not likely to be spending what it would cost to adequately heat and run their homes. They are more likely to be spending less, and living in conditions below the WHO minimum standards, crowding into one single heated room, and having to make choices on which essentials (heating, food, medical bills etc) they can afford and which they must go without. When heating becomes more affordable, (either due to increased income, or decreased cost) these households are likely to begin to consume more energy to achieve higher levels of comfort, simply to achieve the basic minimum standard which they were unable to achieve previously, leading to a reduction in expected energy efficiency gains (the rebound effect). The type of heating system is also relevant. The price of heating oil appears to have been a disproportionate driver of fuel poverty prevalence [73]. Homes heated with a natural gas fired boiler and radiators have on average double the end-use heat demands as households heated with electric storage heaters. It is likely that many households are restricting their energy consumption due to the relatively high unit cost of thermal energy delivered by electrical resistive heating, and demonstrates that demand is sensitive to cost differences for heat provision, suggesting that there is realistic potential for the heat demands for many households heated with electric storage heaters to double, as per the direct rebound effect, if access to a heating option with similar costs to natural gas-fired heating is gained [74].

Households are more likely to fall into the at-risk of fuel poverty category if they are dependent on part time or low paid work, are providing support others, or are in receipt of social welfare. Job seekers allowance is normally €203 per week per person [75] (not including allowances for dependent children), or €10,556 annually. The state pension maximum rate is €248.30 per week [76] (€12,911.60 annually). Minimum wage in Ireland is €10.10 per hour [77], or €393.90 for a full time, 39 hour working week, (€20,482.80 annually before tax). 122,800 people in Ireland were on the minimum wage in the fourth quarter of 2019 according to the Central Statistics Office [17]. Based on these income figures someone with the maximum job seekers allowance, pension, or a full-time minimum wage job will most likely be in fuel poverty, unless they live in an A-Rated home, or are co-habiting and sharing the energy costs with others who have their own independent source of income. 42.3% of households have two or more people earning an income, however, 30.6% have only one earner, and 27.1% have no earned income [16]. Retrofitting all homes in Ireland (C-Rated or below) could almost eliminate fuel poverty completely.

It had previously been estimated that 28% of the Irish population lived in fuel poverty [4] [78] [79] [80]. However, more recent figures suggest that the figure is 17.5% [68] [69] closer to the EU average which is 17% [81] [82]. Most sources point to the fact that the exact figures are difficult to calculate with expenditure-based criteria alone because there is an element of self-reporting involved, and because households may be falling outside of the expenditure percentages but living in poor conditions. This report shows that it is possible to be at risk of fuel poverty in an owner-occupied home, with two adults employed full-time if they are in a low-income bracket or live in an energy inefficient home for example. Table 7 summarises three common low-income scenarios; job seekers allowance, state pension, minimum wage employment (full time). This demonstrates that risk of fuel poverty is not limited to social welfare recipients and pensioners, as a household with two adults working full time at low to minimum wage jobs could easily be in fuel poverty if living in a house with a poor BER. Households who are in chronic constant long-term poverty are more likely to be within the social welfare system, households in intermittent poverty may not be. Such households may be on the increase as jobs are being lost due to the pandemic, especially in the retail, hospitality, and tourism sectors.

Owner-occupation in Ireland is 67.6%, while 20.2% of households are rented from a private landlord and 8.85% rented from a local authority. Renting now accounts for 36% of tenure status in urban towns and cities [83]. Split incentives are likely to be a factor in private rented accommodation, whereby the property owner would have little incentive to cover the cost of the retrofit, as the tenants, not the owner, would reap the benefits through increased comfort and lower energy bills. The owner would need to raise the rent to recoup their retrofit spend, creating the risk that they raise the rent above what the current tenants can afford. Split incentives have been identified as an significant barrier in the uptake of retrofits [84] in the rental market. Action 63 of the Climate Action Plan also aims to tackle split-incentives in the rental market. In the private rental market, 55% of private rented dwellings have a BER of D or lower, and 20% have a BER of F or G, (compared to 15% of other homes), leading the Irish Green Building Council to recommend minimum energy efficiency performance standards for the rental sector [83].

Income Type	Weekly Amount	Annual Income
Job Seekers Allowance [75]	€203	€10,556
State Pension [76]	€248.30	€12,911.60
Min Wage Full Time Job [77]	€393.90	€20,482.80

Table 7: *Potential Income Sources for Low-Income Households*

As the population ages, the negative impacts of fuel poverty will be exacerbated as the elderly will have reduced incomes after retirement, and will be spending longer periods at home, often requiring higher temperatures and more weeks of heating to remain well. By 2026, 75% of the occupants who live in their own properties will be over 65 years of age [85] (assuming share of tenure trends do not change). With cold, older people are more vulnerable to vascular stress, to falls, and to respiratory illness. They lose sensitivity to temperature, increasing their vulnerability, and can become less mobile when they are confined to one better heated room. Chronic thermal discomfort and the damp caused by inadequate heating often has a negative impact on mental health and wellbeing, as can the financial stress and worry caused by high energy bills or debt incurred attempting to achieve thermal comfort and healthy conditions for everyone in the household. There is also evidence in the literature that because of fuel poverty, occupants tend to crowd into a single room to save on heating [28], which increases exposure to communicable diseases, and limits ability of children to do homework (thus limiting their educational achievement), or to do other tasks, which can cause tensions between members of the household, and/or emotional distress and anxiety about social stigma related to their housing conditions [28]. Ireland has one of the highest rates of Excess Winter Mortality in Europe, estimated at over 2,800 deaths annually many of which could be attributed to fuel poverty and cold housing [7]. Fuel poverty also has an incredibly significant impact on children and adolescents. For infants, living in fuel poor homes is associated with a 30% greater risk of admission to hospital or primary care facilities when other contributory factors have been accounted for. For children, living in fuel poor homes is associated with a significantly greater risk of health problems, especially respiratory problems. Poorer weight-gain and lower levels of adequate nutritional intake have also been found. Adolescents living in fuel poor homes are at significantly greater risk for multiple mental health problems when other contributory factors have been accounted for [71].

Budget 2020 [86] figures indicate that 370,000 households are in receipt of fuel allowance in Ireland. Fuel allowance is paid at a rate of €24.50 [86] per week for approximately 30 weeks a year during the heating season, between October and April, costing €735 per home, or around €270m euro per annum in total. In a G-Rated home, with a potential energy cost requirement of €5,900 per annum [19], this allowance is unlikely to cover much of their required energy costs to live comfortably, the occupants will then face the 'heat or eat' dilemma, and still be in fuel poverty, despite being in receipt of fuel allowance. In a B-rated home however, where the annual energy costs are estimated at €1,100 the €735 fuel allowance will go much further, covering more than half the annual energy bill, potentially lifting the households out of fuel poverty entirely. The fuel allowance may even exceed the total annual energy costs required for an A-Rated home. Income-based financial aids (i.e. palliative policies) help households to pay a portion of their bills but do not tackle the inefficiency of the building and lack of adequate heating [70]. Fuel allowance helps treat the symptoms, but a deep retrofit would treat the cause. There are two main dimensions to fuel poverty; a high level of fuel (energy) needed to run the home (energy efficiency), and a low level of household income available to meet that need. Households can be in fuel poverty on a chronic long basis or intermittently. Intermittent poverty could be caused by changes in personal circumstances, health, or employment. Fuel poverty is likely if either of the dimensions are present (high fuel requirement, or low income), and more likely if both are present.

Recommendation 7: On Fuel Poverty

22. Allow **all** potentially low-income (both from chronic and intermittent poverty), and all potentially fuel-poor households (tenants in social housing, private housing, or home-owners) to apply for the cost of retrofitting through a means tested system that will enable low-income households both within and outside of the social welfare system to apply based on both their income (from social welfare, paid employment, or self-employment), **and** the energy efficiency of their homes[15].

23. Establish a hierarchy of need or prioritisation based on the economic, social, and health conditions of the occupants as well as the physical condition of the home.

24. Homes that would require more than 10% of the household income to be spent on energy costs are generally considered to be fuel-poor households. This could include homes where occupants are employed in minimum wage, part time, or free-lance jobs. Where homes are on the borderline of the 10% threshold, any special needs of the occupants should be considered, prioritising the elderly, chronically or seriously ill, disabled persons, and households with babies and very young children.

25. A more nuanced methodology for calculating fuel-poverty encompassing multiple indicators such as building condition and household characteristics (in addition to the 10% of household income definition) as recommended in previous research, should be adopted to ensure all of those at risk are considered when devising solutions to eradicate fuel poverty, to ensure a just transition that leaves no one behind.

15 In response to Climate Action Plan (CAP) 2019, Action 53, to identify additional options for targeted financing, the first progress report of the CAP [13] states that SEAI have prepared proposals which have been received by DECC. These proposals will be considered and taken forward as part of the work programme of the Retrofit Taskforce established. SEAI has also completed a research paper research paper that identifies and assesses options for the financing of energy efficiency projects. IERC does not have access to either the work of SEAI or of the Retrofit Taskforce, therefore there may be some development on this recommendation already, that is not known to IERC at the time of writing.

5.2 Health and Wellbeing

Retrofitting can help to make homes healthier places to be, with temperatures that sustain metabolic health and movement, and with a lower risk of falls, mould, or poor air quality. Insulation turns heat gains from occupation and from sunshine entering windows into temperature rises that help to remove moisture-laden air and common internal pollutants such as formaldehyde and the volatile organic compounds (VOCs) arising from paints and plastics. The benefits discussed here mainly pertain to the building occupants and users. Quantifying the exact health and wellbeing benefits is complex, however, a report by the IEA [28] states that they could equate to 75% of the overall benefits and return on investment therefore this is a significant area for consideration.

As stated in the introduction, Ireland has extremely high rates of respiratory illnesses, with the fourth highest incidence of Asthma [6] and the highest incidence of Cystic Fibrosis in the world [5]. Communicable illnesses from the common cold and seasonal flu, to SARS, Swine Flu, COVID-19 also attack the respiratory system.

Poor building stock also exacerbates (or perhaps in some cases is the direct cause of) respiratory and some cardiac conditions due to cold, damp, draughts, and mould. Fossil fuel heating further compounds the problem because of carbon dioxide, carbon monoxide gases, and particulates (smoke & soot), decreasing the indoor air quality. An Irish Environmental Protection Agency (EPA) study that collected indoor air quality data for 100 homes in Ireland and Scotland found that the average 24-hour $PM_{2.5}$ concentrations was almost six times the World Health Organisation (WHO, 2005) 24-hour $PM_{2.5}$ guidance concentration value of 25 $\mu g/m^3$, and over four times the US (EPA) outdoor Air Quality index 'unhealthy' level for sensitive groups of 65 $\mu g/m^3$ guidance value [87].

Even with the familiar combination of openable windows and extract fans, with some other ventilators in window frames and walls, and unplanned draughts, ventilation rates in homes are often inadequate at times, with high moisture and CO_2 levels that can compromise health, for example, by causing excessive mould formation or dust mite growth. It is advisable to improve ventilation provision in homes as well as insulation, (insulation is not to be confused with draught-stripping). A benefit of insulation is that more heat is retained to rise and drive the ventilation needed, and to remove damp and pollutants.

13.5% of the Irish population have a disability [88] [89], and according to the 2015 Irish Health Survey [90], 32% have a long-term illness, and 14% suffer from allergies. 30% of people in Ireland have a medical card [91]. Medical cards are means tested, and generally only available to low-income households. Chronic disease accounts for 80% of all GP visits, 40% of hospital admissions, and 75% of hospital bed days [92]. There are over 470,000 asthma sufferers in Ireland (9.6% of the population). Asthma is consistently in the top 20 diagnoses for admission to hospital, with one death per week. Ireland has the 4th highest prevalence of asthma worldwide [93], costing the Irish healthcare system €500m annually [6]. Asthma sufferers are vulnerable to the impacts of living in energy inefficient homes and fuel poverty. Mould, dampness, draughts, and cold exacerbate symptoms. US studies have found that home energy improvements can reduce asthma-related hospital visits by 12%, and that 40% of asthma is related to exposure to moisture, pests, or inconsistent temperatures at home [94]

Medications to treat asthma, and frequent visits to healthcare facilities because of asthma, can be expensive. Households with low levels of income and high energy bills, may not be able to afford both energy and medical care. If they forego energy spending to pay for health care, their health will deteriorate in any case due to the poor living conditions, necessitating even more health care spending, and if they chose energy over medical care, their health would deteriorate due to lack of treatment for their condition. As stated earlier, it is estimated that 833,000 people in Ireland are in fuel poverty, and 9.6% of them who have asthma could greatly benefit from energy retrofitting of their homes due to being both in fuel poverty and having asthma.

Dementia sufferers are also vulnerable to excess heat and cold, as they may be less likely to notice the changes in temperature, or to know what to do about it. Where they also forget to eat, and become weaker, or where they are living alone and suffer from falls, they may lay undiscovered in their homes in excessive heat, or cold, for a long time [95]. Excessive heat can also have negative impacts on pregnant women and can lead to lower birthweight of babies [28]. Energy efficiency measures that improve the affordability of energy can have a measurable effect on improving mental wellbeing (e.g. happiness and coping) and preventing mental disorders (e.g. anxiety and borderline depression) [28]. The UK has now identified overheating, where living area temperatures exceed 28°C or bedrooms exceed 26°C for 1% of more of occupied hours, to be the cause of 2,000 deaths a year, and estimate that this figure could rise to 5,000 per year by 2080 due to climate change [63].

Noise pollution is also a major problem for urban dwellers. 65% of Europeans who live in major urban areas are exposed to dangerously high levels of noise pollution, which lead to health issues like stress, high blood pressure, hypertension, and strokes. Chronic exposure to noise can also adversely affect children's cognitive development [57]. Installing triple-glazing would not only alleviate some of the negative impacts from noise pollution but would also be more energy efficient than single or double glazing, however, it can be and expensive and carbon intensive solution. One study looking at living in a dark home found health worsened by 50%, with headaches, insomnia, depression, Seasonally Affected Disorder (SAD) and even breast cancer and suicide among the reported effects. Natural light regulates our body's circadian rhythms, often disrupted by technology and light pollution, improving sleep quality and therefore overall health.

Studies have shown that exposure to natural light during the working day leads to 46 minutes more sleep each night, demonstrating the importance of bringing healthy natural light into our homes [57]. Allowing daylight into your home helps control damp, mould, and bacteria growth, lowering the risk of respiratory diseases [57]. Light affects physiological and psychological health, and the use of light in buildings has comfort, behavioural, economic, and environmental consequences [96]. Light is a cue for resetting the circadian pacemaker that regulates hormonal rhythms, alertness, and cognitive performance [97]. Surveys show that people tend to prefer to work by natural daylight than by artificial light, and office workers with access to windows have reported better sleep quality than those without [96]. Natural light has a spectral composition that provides the most preferable visual conditions for humans [97].

Reassessing the fenestration of buildings in addition to simply replacing existing windows in existing opes may provide additional benefits where additional natural daylight is provided through increased glazing (however, this would be a very costly and disruptive intervention). Care must be taken to avoid heat loss through over-glazing on exposed or North facing facades, or alternatively, excessive glare and over-heating through over-glazing on South and West facing facades.

Carmarthenshire County Council in Wales carried out a large study of 30,000 tenants over a ten-year period, with access to their (anonymised) medical records and (National Health Service) NHS spending, which provides real tangible evidence of the health benefits of retrofitting homes. The retrofitting measures included insulation, heating upgrades, new doors and windows. The study showed that admissions to hospital fell by between one quarter and one third across the improved homes, depending on the measures that had been installed [95].

Visiting an Accident & Emergency (A&E), or Emergency Department in Ireland costs €100 [98], GP visits are around €50. If admitted, the in-patient fee is €80 per night to a maximum of €800 [99]. There are around 17,000 hospital admissions a year in Ireland [100]. The following tables calculate the savings potential for the general public and for the Health Service Executive (HSE) if admissions were reduced by a quarter to a third, and if all patients stayed for the average length of stay; 6 nights [101]. This is based on public rates. Private hospital rates can be up to ten times as much. The average cost to the HSE of each in-patient bed per day of hospital stay is €839 [102]. It should be noted that all savings to the patient have a knock-on macroeconomic benefit in increasing disposable income.

Maximum Potential Savings on Hospital Admissions if Reduced by One Quarter	
Total annual hospital admissions	17,000
One quarter of 17,000 admissions	4250
Average stay of 6 nights X €80 per night	€480
4250 admissions @ €480 per 6 day stay	€2,040,000
Total savings to patients for a quarter less hospital admissions	**€2.04m**
Average stay of 6 nights X €839 per night	€5034
4250 admissions @ €5034 per 6 day stay	€21,394,500
Total savings to the HSE for a quarter less hospital admissions	**€21.39m**

Table 8: *Maximum Potential Savings on Hospital Admissions if Reduced by One Quarter*

In the Carmarthenshire homes where improvements included improved ventilation, and carbon monoxide and fire alarms, occupants in the over 60 age category were admitted to hospital 39% less often after the measures were installed, and there was a 57% drop in emergency admissions for respiratory illness in particular [95]. Around 2,700 of Irish annual hospital admissions are in the over 65 age category. The following table calculated the reductions for this cohort of patients.

Monetisation of the health and wellbeing impacts is a difficult and complex task. The benefits could encompass any or all of the following; days off work or school (requiring additional paid childcare), loss of pay and productivity, visits to doctors and hospitals, over the counter and prescription medications, malnutrition and mental health issues, social welfare spending, or mortality due to excess heat, cold, or chronic ailments.

Maximum Potential Savings on Hospital Admissions if Reduced by One Third	
Total annual hospital admissions	17,000
One third of 17,000 admissions	5610
Average stay of 6 nights X €80 per night	€480
5610 admissions @ €480 per 6 day stay	€2,692,800
Total savings to patients for a third less hospital admissions	**€2.69m**
Average stay of 6 nights X €839 per night	€5034
5610 admissions @ €5034 per 6 day stay	€28,240,740
Total savings to the HSE for a third less hospital admissions	**€28.24m**

Table 9: *Maximum Potential Savings on Hospital Admissions if Reduced by One Third*

Maximum Potential Savings on Hospital Admissions in the Over 65s Age Category	
Total annual hospital admissions in this age category	2700
39% of the total admissions	1053
Average stay of 6 nights X €80 per night	€480
1053 admissions @ €480 per 6 day stay	€484,380
Total savings to patients for a third less hospital admissions	**€484,380**
Average stay of 6 nights X €839 per night	€5034
1053 admissions @ €5034 per 6 day stay	€5,300,802
Total savings to the HSE for a third less hospital admissions	**€5.3m**

Table 10: *Maximum Potential Savings on Hospital Admissions in the over 65s Age Category*

This also varies by country/region depending on the cost of public healthcare, childcare, social services, pharmaceutical prices, and minimum and average wage rates. A cost-benefit analyses of the return on investment that could accrue from preventing fuel poverty amongst children and young people in Northern Ireland, suggested that, for every pound spent on reducing Fuel Poverty, a return in NHS savings of 12 pence can be expected from children's health gains. When adults in the family are also included, this increases to 42 pence [71]. The Building Research Establishment (BRE) in the UK conducted research into the cost of poor housing to the NHS (National Health Service), and found that improving 3.5 million 'poor homes' in England, could save the NHS £1.4bn in first year treatment costs alone. Their method included a list of 29 indicators of hazards in poor homes, including excess cold/heat, falls, dampness, and radon amongst others [103].

The following points attempt to make some calculations for the overall health and wellbeing savings based on two different international studies, which show a potential for approximately €600m euro per annum in healthcare savings.

- A Catalonian study concluded that renovating 1.5 million dwellings would save the Spanish public administration €555m in healthcare and labour costs savings annually. [104] The Irish scenario seeks to retrofit a similar number of dwellings (1.6 million).
- Another study in France estimated that the indirect costs (including absenteeism at work or school, productivity losses, grade retention) cost almost 22 times more than direct medical costs of poor housing [104]. We have already calculated above that the direct costs to the HSE could be up to €28m annually, therefore the indirect cost savings could be €616m annually (28x22=616).

Recommendation 8: On Grants and Incentives

26. SEAI currently provides grants to homes for: insulation, heat pumps, heating controls, solar water, and solar electricity [105]. Increase the scope of grant aid available to cover additional works, such as window and door replacements and adjustments to fenestration to improve access to natural ventilation, passive solar gain, and day light, installation of passive stack ventilation, or mechanical heat recovery ventilation systems, upgrade of uninsulated floors and installation of radon barriers, for example.

27. Facilitate development of more one-stop-shop and aggregation initiatives like the An Post Green Hub, Superhomes, and Three Counties Energy Agency (3CEA) for example to encourage and simplify access to deep-retrofits where multiple areas such as insulation, ventilation, heating, fenestration and so on are all tackled simultaneously. (e.g. Retrofitting to include effective ventilation provision, and protection against radon infiltration).

5.3 Addressing Inequalities

Retrofitting to improve the energy efficiency of buildings can also help to alleviate some of the symptoms of inequality in the impact of poor building quality in Ireland. Inequalities in housing quality can also be linked to inequalities in general quality of life, health and wellbeing, and access to educational and career prospects. Women, children, and the elderly and disabled are most at risk from fuel poverty, and/or poor health and wellbeing from spending long periods in inefficient homes. The health impacts of living in a cold home on children, includes significant adverse effects in terms of infants' weight gain, hospital admission rates, developmental status and the severity and frequency of asthmatic symptoms [78]. A 15% reduction in days off school has been measured among children in homes that received energy efficiency upgrades [28]. Older people experience a 'dual burden' in terms of fuel poverty. They are more likely to experience fuel poverty and are also particularly vulnerable to health and social harm because of this experience and over-represented among houses which are in poor condition and which lack central heating [8].

Fuel poverty rates for disabled people in the UK private rented sector are particularly high, for example 35% of UK households with a disabled occupant are in fuel poverty [95]. This is likely because the disabled occupant may be unable to secure employment due to their disability and exacerbated by the fact that another member of the household may also be unable to secure employment because they may be required to perform caring duties for the disabled person (depending on the nature of the disability). Certain disabilities may have little bearing on thermal comfort and heating requirements however, they can potentially have an impact on the ability of a person to live independently, and secure well-paid employment, which will in turn have an impact on their ability to pay for energy. A disability may also incur significant medical expenses, leading the household to have to choose between medical expenses and energy use, and foregoing the latter, or incurring debt. Retrofitting works could be scheduled to coincide with upgrading a home to make it more accessible for a disabled occupant to minimise disruption and maximise the benefits.

Energy is a gendered issue, men and women can use energy differently, they can have different energy requirements, different decision-making methods, different views on pro-environmental behaviours, and different levels of power over energy-related choices. There is also a significant gender imbalance in levels of stay-at-home parenting in Ireland. A total of 88% of men who are part of a couple with children are in the labour force, compared with just 68% women [106]. This means that women are more likely to be spending longer periods of time in the home on a daily basis. While the gender pay gap in Ireland is relatively low, it is still currently around 7.5% [107]. A study by the ESRI in 2008 found that households with a female as the chief economic supporter were 30% more likely to be at risk of fuel poverty [108]. Women are less likely to be represented in decision-making positions of authority and influence in energy research, design, policymaking, and governance, and are also less likely to be working in the energy and retrofit sectors (for example: globally women represent only 6% of ministerial positions responsible for national energy policies and programs) [109]. This creates a risk that the policies and solutions that get designed and built may not meet the requirements of women.

Women are also much more likely than men to be the head of a single parent family household. The number of one parent families stood at 218,817 in the 2016 census of which 189,112 were mothers (mainly single) and 29,705 were fathers (mainly widowed). There are over six times as many female-led single parent households than male-led single parent households. According to a policy briefing on the impact of fuel poverty on children in Northern Ireland, being employed offers only limited protection from Fuel Poverty for couples with families. For lone parents it offers even less since lone parents who work part-time are more likely to be fuel poor than are lone parents not in work [71]. According to a report by the Society of Saint Vincent de Paul, 31% of single parent households are in fuel poverty in Ireland [78].

The full extent of the fallout from the current pandemic is not yet known, however, it would appear that the gender pay gap may rise, and that the types of employment most adversely impacted are low-paid and 'gig-economy'[16] jobs that are more likely to be filled by women, younger people, and persons of lower levels of education [66]. Since women often work part-time, perform unpaid work, have lower wages, and have an average of 5 years shorter working life than men, women also face a significant risk of poverty in old age [109] as they also live longer than men on average, often surviving alone. These factors are likely to exacerbate inequalities in fuel poverty.

16 The Gig Economy generally consists of short term fixed contracts and free-lance working

Recommendation 9: On Just Transitions; Engagement and Inclusion for Equity and Equality.

28. Ensure that the pre-rollout phase involves significant citizen and stakeholder engagement, and preparation of rollout bodies within government, as well as preparation of the energy and retrofit sector for a smooth execution phase capable of meeting demand. The potential for disruption to home occupants and owners must be minimised and planned for in conjunction with the occupants and owners to design solutions that are mutually suitable, while also protecting existing tenants from the potential of eviction and rent increases post-retrofit.

29. All policies regarding retrofitting should adopt an intersectional approach and ensure that they acknowledge the differing energy requirements and impacts on different demographic groups, and gender aspects in policy-making. Household data should be disaggregated by age, disability/illness, gender, income, and family or household size. The design of the retrofit renovation wave, especially in the pre-rollout phase and citizen stakeholder engagement activities, and post-occupancy evaluation phase should be inclusive and create shared value for all in society.

MAXIMUM POTENTIAL HEALTHCARE SAVINGS

direct to the patients

€2.69m

ANNUALLY

MAXIMUM POTENTIAL HEALTHCARE SAVINGS

direct to the HSE

€28.24m

ANNUALLY

MAXIMUM POTENTIAL

indirect healthcare savings

€600m

ANNUALLY

* Figures are based on the assumption that all buildings that are C-Rated or lower can be upgraded to a B-Rating, and are also based on the average home size and energy costs set out in Section 3 of this report

6. Economic Benefits of Retrofits

6.1 Macroeconomic Benefits

> "We will stimulate the economy through investment in public infrastructure, and critical areas such as housing, healthcare, transport, and energy".
>
> Programme for Government, 2020, Our Shared Future [2]

Familiar investments may offer a financial return of several percent over a several years, but on a climate altering trajectory that leads to collapses in agricultural productivity, coastal flooding, and social and economic dislocation, so that the aggregated returns over time are likely to be much less than the sums invested. There is thus a need to divert investment to sectors that provide sustained real returns, but which also reduce or eliminate the risks of catastrophic climate change.

Retrofitting Ireland's homes has the potential to deliver benefits across the whole economy, in line with the current Programme for Government, with direct and indirect impacts on economic activity, infrastructure, housing, transport, employment levels, business formation, trade balances, and energy, reduced public spending in other (non-energy) areas e.g. healthcare and social welfare. While the cost of retrofitting buildings will initially be significant, in the long run, reduced ongoing spending on energy, (and reduced spending on healthcare due to the accrued health and wellbeing benefits) will help to increase Ireland's cost-effectiveness and competitiveness through savings in the public budgets (discussed later in this section), and increased disposable incomes (also discussed later in this section) and quality of life for private citizens. A renovation wave could be viewed as an infrastructural programme, due to the far-reaching implications across the economy, society, and the environment.

Previous research that has attempted to quantify the cost benefits of health and wellbeing benefits have found that these benefits can outweigh other economic benefits because of the savings in avoided hospitalisation and pharmaceutical costs, and reduced absenteeism from work and school for example, [28]. There is also potential for a return on public investment through taxes, such as income tax from jobs created, and in the longer term, VAT on products and services bought with wages earned in retrofit-related employment, VAT on projects and services bought with the increased disposable income of households paying less for energy, increased property tax and stamp duty on property sales and increased rental tax potential of properties due to increased property values. Based on the current Value Added Tax (VAT) rate in Ireland for energy efficient products at 13.5%, the retrofitting works alone (to a B-Rating) would generate around €4.725bn VAT. As with gambling, or smoking, the reduction of fossil fuel use is preferable to reliance on taxation alone as a deterrent. In addition, some of the most carbon intensive fossil fuels, are the cheapest, and most accessible to those who are already at risk of fuel poverty, and least in a position to afford increased taxes on fuel. For example, coal and peat turf can be bought locally, and in small quantities, this makes them more accessible and affordable than fuels that need to be bought and delivered in bulk (e.g. oil), or that require capital outlay on technologies (e.g. renewables). This is an important factor to consider when seeking a just and inclusive energy transition. The annual income derived from energy-related taxes is approx. €3bn [42], and is, largely cancelled out by the various fossil fuel subsidies totalling over €2.5bn [110], and other costs related to the impacts of fossil fuel use. Research by the Economic and Social Research Institute of Ireland (ESRI) found that simultaneously removing seven fossil fuel subsidies would have a modest adverse effect on real GDP and household income. However, it would have a sizeable impact on reducing economy-wide emissions [111].

There is continuous and considerable ongoing private investment in home repair and improvement, often to improve kitchens, bathrooms, and exterior landscaping. According to the Construction Industry Federation, Irish homeowners have spent over €2,471m in total through the Home Renovation Incentive (HRI)[17] since its launch in 2013, and economically it has yielded in excess of a 12-fold return on state investment by private homeowners in the domestic economy [112]. Unlike energy retrofit schemes, this scheme does not necessarily lead to notable improvements in efficiency or renewable energy output, as it is typically used to build extensions, and for general repair and maintenance works. To invest more in energy retrofitting, it will be important that quality and performance are promoted, developed, maintained, and recognised over time, so that owners can have confidence to invest more in the energy performance of what is usually their most valuable asset, without risks of technical failure.

6.2 Employment

Due to COVID-19, economies have been stalled all over the globe. Business have been closed for prolonged periods and millions are losing their jobs. Some sectors will lose jobs permanently. This will be the largest annual economic 'slump' in the history of the state. In previous crises from the famines of the 1800s, to the economic downturns of the 50s, 80s, and the most recent recession a mere decade ago, Irish people would emigrate to the UK, America or elsewhere. Emigration is not an option this time. The virus has struck almost every country and region on the planet, and the UK and America have been badly hit. Creating and sustaining employment in Ireland will be vital to the rebuilding the Irish economy, improving national economic resilience, and boosting entrepreneurship and the development of retrofitting solutions and new types of energy related services by SMEs. Job creation would also lead to savings in the social welfare system, especially in Job Seekers allowance and benefit payments.

The Programme for Government aims to create 200,000 new jobs by 2025 [2]. As discussed in Section 4.3 Ireland has been allocated €176m from the just transition fund, and re-skilling, or up-skilling in the energy and retrofit sectors will be required to ensure that those employed in less sustainable sector have the opportunity to move to more sustainable sectors without loss of livelihood, and that the energy and retrofit sectors have enough capacity of people with the right skills to meet the demands of a retrofit renovation wave. (This topic shall be covered in detail in a future IERC retrofit report.) A renovation wave to bring all homes currently rated C or lower to a B-Rating would generate €35bn worth of work, the vast majority of which would be in the construction industry over the period from 2021 to 2030, equating to an average of approximately €3.8bn per annum over 9 years[18]. This work would also be spread across the country, not centralised in the major urban hubs.

17 The Home Renovation Incentive (HRI) is a relief from Income Tax (IT) for homeowners, landlords and local authority tenants. You can claim the HRI Tax Credit for repairs, renovations and improvements to your home or rental property. More information available on the Irish Tax and Customs Revenue website: https://www.revenue.ie/en/property/home-renovation-incentive/hri-for-homeowners-and-landlords/index.aspx

18 "A Stakeholder Group has been formed, supported from the Department of Housing, Planning, and Local Government and the Department of Communications, Climate Action and the Environment (now DECC). Waterford and Wexford Education and Training Board have developed skills specifications for existing construction workers in areas including electrical, plumbing, bricklaying, carpentry and joinery and plastering as well as NZEB Fundamentals and a specification for site supervisors. These have been developed in consultation with industry, the SEAI and DHPLG" [13].

> "We will ensure that people in all parts of the country can capitalise on the new opportunities that a Just Transition can bring."
>
> Programme for Government 2020, Our Shared Future [2]

According to a recent report by the Buildings Performance Institute of Europe (BPIE), for every €1m invested in retrofits, an EU average of 18 jobs are created [104]. Much of the spending in home retrofitting is in labour and services, including site labour, technical expertise, and provision of financial services. 33% of which would be directly employed in retrofitting, 52% indirectly employed in manufacturing, and 15% 'induced' employment i.e. adjacent neighbourhoods, coffee shops etc. [104]. Although there are heat pump and insulation manufacturers in Ireland, not all the materials used in retrofits are manufactured in Ireland. The following tables indicated the total job creation potential, and the job creation potential for direct and induced employment only (extracting the 52% figure employment indirectly in manufacturing).

Job Creation Potential from Retrofitting to B-Rating	
Total investment required	€35bn
Annual investment from 2021-2030 (Nine years)	€3.8bn
Job Creation at 18 jobs per €1m invested	68,400
Minus 52% indirect manufacturing jobs	35,568
Total Direct & Induced Job Creation	**32,832**

Table 11: *Job Creation Potential from Retrofitting to B-Rating*

For a more conservative estimation, we can look to the recent output and employment figures in the construction industry in Ireland. In 2019 the Irish construction industry output was around €23bn annually with almost 150,000 employed in the sector [113] [114]. If it currently takes 150,000 workers to produce an output of €23bn, it could take approximately 24,782 workers to produce an annual retrofit output of €3.8bn each year for the next nine years to 2030. The potential for job creation could be significant across all three phases of the retrofit renovation wave.

Phase 1 Pre-Rollout Preparation: People will be required to plan, manage, and administer the day-to-day running of the retrofit programme, including, but not limited to the following: Project Managers, Administrators, Grant Administrators, Procurement Professionals, Finance and HR personnel, PR and Marketing personnel. Funding and grant agencies will also require additional personnel in the same skills areas. Industry training and upskilling organisations will need trainers and certifiers to ensure that there are enough fully qualified and trained personnel available to carry out works. A programme of Quality Improvement should be initiated, capturing learning and implementing process innovations to reduce the cost over time of achieving high quality and energy performance, with detailed pre- and post-occupancy monitoring and assessment of a sample of upgrades. To make appropriate advice available, including and up to advice on architectural, engineering, or building physics, without undue expense, a system of 'Triage' can be set up for cases, with experts on call.

Phase 2 Retrofit Renovation Wave: There will be an increased demand for construction skills, and trades such as carpenters, plumbers, electricians, equipment manufacturers, insulation system installers, equipment commissioners, designers, LCA or C2C analysts, BER assessors, scaffolders, roofers, and plasterers. Personnel will be required to supervise and certify works, including designers, architects, quantity surveyors, engineers, and BER assessors. Materials and equipment will require manufacturers, suppliers, retailers, and logistics. Personnel will also be required to manage relationships with householders, suppliers, and others. These could be employed by a special management company set up for the purpose, by private consultants, government bodies, or research institutions. Personnel skills could include market research, behavioural economics, human geographers, social science, public relations, media, marketing, professional facilitators, project managers, and others. Financiers and others may require upskilling to design and implement new initiatives such as green finance, loans, and investments.

Phase 3 Post-Occupancy Evaluation: A similarly broad level of personnel will be required for the post-occupancy evaluation; specialists in statistics, data analysis, energy monitoring, public policy, public healthcare, market analysis, energy analysis, sociological analysis, air quality monitoring, heat mapping and thermographic imaging, air-tightness testing, and so on. Again, this could be carried out by private or public sector, by industry or research and academia. The pre-rollout stakeholder engagement and post occupancy evaluation would provide valuable insights for other countries, if our Irish retrofit renovation wave is ambitious and comprehensive enough to warrant international interest, the engagement and evaluation processes could be co-funded as part of EU, IEA, or other globally funded research.

6.3 Working from Home

During the COVID-19 pandemic, Irish homes have become multi-functional. Homes have been acting as schools and workplaces, and places of isolation, convalescence, and recuperation. The Programme for Government 2020 plans to develop a strategy for more remote working and remote service delivery. It is likely that there will be a desire or a necessity for increased levels of working from home beyond the current pandemic's requirements to do so. In some cases, this may be because some workplaces will struggle with going back to full occupation while maintaining social distancing, in others they may simply wish to reduce the spend on office space, or it may be because the employee prefers a change to the work-life balance and lack of commute. Several surveys in Ireland, and other countries indicate that there is a desire from some large companies, and the majority of workers surveyed to work from home either part time, or full time in future [115] [116] [117] CSO figures from the 2016 census show that only 1 in 4 commuters had a travel time of 15 minutes or less, and conversely nearly 1 in 5 commuters had a travel time over 45 minutes. Reducing the requirement to commute to work every day reduces traffic congestion, vehicular fossil fuel use, and emissions associated with vehicular traffic. The average commute time is 28.2 minutes, an average of almost hour a day. Recent research also shows that energy renovation of offices increased productivity by 12% [104]. Homes may also serve as offices with increased working from home more often in the future, therefore retrofitting homes could have a positive impact on productivity. It will also have an impact on energy consumption, as homes that were previously unoccupied (and unheated) during office hours, will now be consuming more energy throughout the day. This will not necessarily be off-set by less energy use in workplaces, as the same workplaces may still be consuming energy, as they may still be partially occupied, especially during the near-term transition period to increased more permanent levels of remote working, and pandemic-related workplace restrictions on occupancy levels.

Building Performance Institute of Europe (BPIE) analysis [118] reveals that:

- a holistic people-centric renovation of a typical office can lead to up to a 12% increase in employee productivity
- maintaining ideal thermal comfort levels can increase productivity by 7-12%
- plenty of fresh, clean air makes for a healthier working environment, boosting productivity by 3-6%
- getting lighting right – including through good access to daylight and appropriate levels and quality of electric light – means 3-6% more output per employee
- better acoustics reduce distraction and make for a more conducive working environment. The resulting improvement in productivity is 2-3%

Increased working from home has also resulted in hundreds of thousands of international meetings, conferences and events moving to online videoconferencing. Interacting with people from further afield is now more convenient. Events that might previously been attended by 100 people, can now be attended by tens of times as many. While the face-to-face networking element is lost, the increased reach may lead organisations to consider the virtual environment more often in future, leading to a potential decrease in business travel, and work-related air travel as workers can now attend multiple meetings or events, hosted in different countries, all in the one day, from the comfort of their own home.

A key element in the feasibility of working or studying from home is access to good broadband, which is not available in many areas, especially rural areas, across Ireland. As energy and "smart" technologies develop, good broadband is also essential to allow citizens to access community energy grids, virtual power plants for energy storage, and peer to peer energy trading and making best use of local renewable energy resources by quickly responding to changing generation outputs. Access to good quality broadband is now being recognised by many[19] as a social divider, and a civil rights issue where inequalities have been highlighted and exacerbated by recent lockdowns. Many households were unable to access educational resources or carry out paid employment from home due to lack of broadband.

19 New York Times "Doing Schoolwork in the Parking Lot is Not a Solution, In a pandemic-plagued country, high-speed internet connections are a civil rights issue [131], HuffPost "Broadband: The Civil Rights Issue of Our Time" [132], The Conversation "Free Broadband: Internet access is now a human right, no matter who pays the bills" [133], Financial Times "Internet access is both a human right and a business opportunity" [134]

The Digital Agenda for Europe acknowledges the socio-economic benefits of broadband [119]. As part of its Europe 2020 strategy, in 2010 the EU set targets for broadband provision across the EU [120]. Ireland has not yet met these targets. Ireland has only 21% coverage of Fixed very high-capacity network (VHCN) and still lags behind the EU average of 44%. Further, it slightly lags the EU average in overall fixed broadband take up (76%, compared to 78% the EU average). In addition, Ireland is also one of the EU's most expensive countries in terms of broadband [121]. This places many Irish households at a disadvantage, impeding their ability to work or study from home, and to avail of smart energy technologies. Care must be taken when specifying retrofitting products and materials so as not to interfere with communications technologies. Research indicates that certain materials such as foil backed insulation, and foil coated windows can interfere with the radio waves used by televisions, mobile phones, AM/FM radios, and wireless networking [63]. Alternative insulants without foil, though bulkier, can be more affordable, with a lower energy content. Communications and energy are becoming more interlinked, as is also evidenced by their placement under the single umbrella of the Department of the Environment, Climate, and Communications.

Recommendation 10: On Working From Home, Broadband, and Energy Technologies.

30. Carry out a detailed national survey on current broadband availability including both upload and download speeds, data limitations, and services available nationwide. (Perhaps as part of the national census). Follow up with provision for equal access to good quality high speed broadband (for communication, education, work, and energy services) to all households in Ireland, including rural and remote households, in accordance with Europe 2020 and EU broadband requirements and to enable equal access to online educational resources and working from home facilities.

31. Install smart energy systems to enable homes to take advance of new innovations in smart devices, monitoring and controlling of energy, energy storage, peer-to-peer and other energy trading mechanisms, and interaction between appliances, renewables technologies, and the grid.

6.4 Disposable Income

When homes are retrofitted to increase their energy efficiency and lower energy bills, the householders have the potential for increased disposable income (after they have re-paid any loans that they may have been required for them to undertake the works). In the case of those who had been experiencing fuel poverty, this means that they can achieve increased comfort, and reduced negative impacts from living in inadequately heated/cooled accommodation. They may also have increased capacity to pay for other essentials such as food or medicine, which will further increase their health and wellbeing. Fuel poverty often means having to choose between essentials, for example between heating or food. Having a long-term illness or disability makes you a lot likelier to be in fuel poverty – not least because your income is highly likely to be constrained. The ESRI recently predicted that 400,000 families will see a 20% drop in their disposable income due to the impact of COVID-19 [122] Tens of thousands of people in Ireland have lost their jobs either temporarily, or permanently, due to the pandemic. Therefore, it is extremely important to make household income go as far as it possibly can to help build a more resilient society.

The OECD [123] Better Life Index estimates that the average household net-adjusted disposable income per capita in Ireland is €22,416, and below the OECD average of €29,762. The index also shows that the top 20% earn almost five times as much as the bottom 20%, creating a significant gap in disposable incomes in Ireland. The following table calculates the annual financial savings to be made by upgrading to a B-Rating (Third Column). For example, going from a G-Rating (€5,900) to an A-Rating (€560) equates to a theoretical annual saving of €5,340. The savings are averaged in the second last row and multiplied by 1.6 million homes for the final total annual savings a potential disposable income and divided by 9 for an additional annual saving each year from 2021 to 2030 if the works are to be carried out by 2030 in accordance with timeline for the National Climate Action Plan.

In higher income households the additional disposable income may go on non-essentials, and other products and services, which could help to boost the local or national economy, for example, socialising in local pubs, clubs, and restaurants. In lower income scenarios, a deep retrofit could bring a household completely out of fuel poverty. If retrofitting uptake is increased significantly on a national scale, through a 'Renovation Wave', as required by the EU Green Deal, the macroeconomic impact of all that increased disposable income could be significant.

BER	Annual Energy Cost	Maximum Potential Savings by Upgrading to B-Rating
A-Rating	€560	-
B-Rating	€1,100	-
C-Rating	€1,900	€800
D-Rating	€2,850	€1,750
E-Rating	€3,750	€2,650
F-Rating	€4,700	€3,600
G-Rating	€5,900	€4,800
Average Saving		€2,720
X 1.6 million homes		**€4.49bn**

Table 12: *Potential Disposable Income from Financial Savings / Energy Savings per BER Rating*

6.5 Property Values

According the Daft.ie[20] third quarter report housing property market report for 2019, the national average list price for a house was €257,000 [124]. The ESRI [125] previously estimated that increasing the BER of a building can add up 10% of the property value, which, based on the national average list price above, could be around €25,000 extra on average. This is slightly lower than the cost of a deep retrofit, so works would need to have been carried out with significant grant schemes, or due to other motivations and incentives, to stimulate retrofitting volumes. The role of Building Energy Ratings in influencing market pricing should be maximised, for example, by displaying both BER values and associated expected energy costs on online property search mapping tools. (See Recommendation 7 also).

A 10% higher resale value also means that the stamp duty from the sales will be increased by 10%. Stamp Duty on property sales worth under €1m is 1% of the property value [126]. The Consumer Market Monitor report from 2019 [127], showed that 57,000 homes were sold in 2019. With the average list price of 257k, and if we assume that 80% of those could benefit from a retrofit, that would be around 11.7bn euro of the properties having the potential to increase their value by 10% (1.17bn), leading an annual increase in stamp duty of €11. This is a hypothetical scenario of course, included here as an illustration of the wide reaching potential benefits, however, not all retrofitted properties may be able to achieve a 10% higher resale value, as there are many other factors that impact on resale value such as location, amenities, aesthetic appeal, outdoor space, and number of bedrooms and bathrooms.

Property tax in 2018 totalled €482m [128]. If we assume that 80% of that figure (€385.6m) was from properties that could be retrofitted, and that their property values could increase by 10% if retrofitted to an A-Rating, that could lead to a potential increase in annual property tax revenue of up to €38.56m. While these are crude calculations, they show the potential for financial benefits from retrofitting in ways other than reducing household energy bills. Again, it should be noted that these are merely illustrations of the potential benefits. Not all properties retrofitted are equally likely to achieve significant resale value increases due to the many other factors that impact property values.

Description	Total
80% of 57k homes sold	45,000 homes
x €257k average list price	€11.7bn sales needing retrofit
1% stamp duty on those properties as is	€117m
10% potential value increase after retrofit	€1.17bn
Retrofitted potential property value	€12.87bn
@1% stamp duty on retrofitted properties	€128m
Potential stamp duty increase €128m - €117m	**€11m in total**

Table 13: *Potential Property Costs and Revenues from Retrofits*

Description	Total
Total property tax collected in 2018 [128]	€482m
@80% assumed to require retrofitting	€385.6m
@10% property tax increase	**€38.56m**

Table 14: *Potential Property Tax Revenue from Increased Property Values*

20 Daft.ie is Ireland's largest online property search facility, and producer of regular reports on property market trends and analysis: https://www.daft.ie/about/

Recommendation 11: On Property Values, Taxation, and Financial Incentives

32. Introduce preferential property tax rates for more efficient homes to incentivise private property owners and landlords to carry out retrofitting works. Property owners (those who pay property tax) are not necessarily able to afford retrofit measures because they own a home. It is possible to own a property and also be in fuel poverty, chronic, or intermittent property for various other reasons, low income, retirement, loss of income, divorce, illness or death in the household, for example.

33. Display potential energy costs when advertising properties for sale or rent BER ratings are currently shown, but estimated energy costs are not. The latter might provide more of an incentive to retrofit as a more impactful understandable indicator of the actual potential impact of a homes' energy efficiency, with potential sellers and buyers incentivised to retrofit to get a better resale price (seller) and lower running costs (buyers).

34. Linking the BER Database with Property Price Register (The Climate Action Plan, Action 46, is already looking into the feasibility of linking BER to Commercial Rates also [1]).

35. Promote the provision of technical and financial incentives, especially where there is a potential for a split incentive between landlord and tenant, low interest-rate green loans, fossil fuel duties or supplier obligations, tax rebates, supports for using materials with low embodied energy to incentivise property owners to carry out retrofits prior to renting or selling[21].

36. Allow for tax refunds on the purchase of certain retrofit materials to incentivise households to carry out works that do not require specialist registered installers, such as buying and laying additional quilt insulation in the attic, replacing light fittings with LED lights, buying a lagging jacket for a water tank, or insulating an attic hatch door.

37. Introduce Building Renovation Passports[22] that incorporate information on EPDs and other certifications and accreditations achieved.

21 In response to Action 54 of the Climate Action Plan 2019, a working group to design new financing schemes has been set up in conjunction with the Retrofit Taskforce, SEAI, and others [13]. IERC does not have access to either the work of SEAI or of the Retrofit Taskforce, therefore there may be some development on this recommendation already, that is not known to IERC at the time of writing.

22 Building Renovation Passports are masterplans for retrofit and include a record of works. The passports could become extremely useful in addressing the barriers to consumer decision-making, and allow a new owner to take up where a previous owner left off. It also improves the availability of data for valuers and lenders, passports should de-risk investments in that area and facilitate phased deep retrofit. For more information for the Irish Green Building Council Website here: https://www.igbc.ie/policy-and-regulation/renovation-strategies/building-renovation-passports/

Up to 10%
potential value
increase for
retrofitting
TO (AVG. €25,700)

Increased
property tax
potential:
€38.56m
ANNUALLY

Increased
stamp duty
potential:
€11m
ANNUALLY

Job creation
potential:
24 to 32 thousand
jobs per annum
(24,782 TO 32,832)

VAT
on €35bn of
retrofit works:
€4.725bn

7. Conclusions & Recommendations

The recommendations build upon the aims of the current plan for government for a renovation wave in Ireland as announced in June 2020.

The Contribution of the Built Environment to Climate Action:

We will commence an ambitious retrofitting programme to make our buildings warmer and more energy-efficient, reduce our emissions, and deliver a crucial economic stimulus.

We will publish our National Retrofitting Plan as part of the National Economic Plan. It will set out our commitment to:

- Developing a new area-based and one-stop-shop approach to retrofitting to upgrade at least 500,000 homes to a B2 energy rating by 2030.
- Grouping homes together to lower cost, starting in the Midlands area.
- Leveraging smart finance (e.g. loan guarantee, European Investment Bank, Strategic Banking Corporation of Ireland).
- Developing easy pay-back mechanisms (i.e. through utility bills).
- We will ensure economies of scale and employment generation by combining social homes owned by local authorities and approved housing bodies (AHBs) with privately owned homes in the wider community in a single-area-based scheme.

(Programme for Government 2020, Our Shared Future)

7.1 Conclusions

Ireland's building stock is carbon intensive, and a significant proportion is in need of energy retrofit. Ireland also has one of the highest rates of excess winter mortality in Europe, the fourth highest rate of asthma, and highest rate of cystic fibrosis in the world, all of which can be linked to or exacerbated by poor quality energy efficient housing. The majority of Irish homes are C-Rated or lower, and a vast proportion of these were built before the introduction of building regulations and energy performance requirements. The process of initiating a retrofitting renovation wave will require actions by stakeholders across three main phases. The first being the phase in which pre-rollout preparations are made. The retrofit renovation wave (execution phase) would begin once all of these preparations have been made and the roll-out is launched. The third and final phase is a post-occupancy evaluation phase.

This report has highlighted multiple benefits to carrying out an intensive retrofit renovation wave in Ireland. The beneficiaries are many and varied, and benefits have been categorised into three main groups; environmental, social and economic. The environmental benefits (Figure 5) include a reduction in fossil energy use, which in turn leads to a reduction in carbon and GHG emissions. Increased use of local renewable energy, e.g. from the wind and sun, increases indigenous energy supply, and improves national energy security and resilience. The combination of both a decrease in energy demand, and an increase in renewable energy supply reduces the ecological degradation, pollution and emissions associated with fossil fuel extraction and use, with the knock-on effect of reducing harmful pollution of local air, soil, and water.

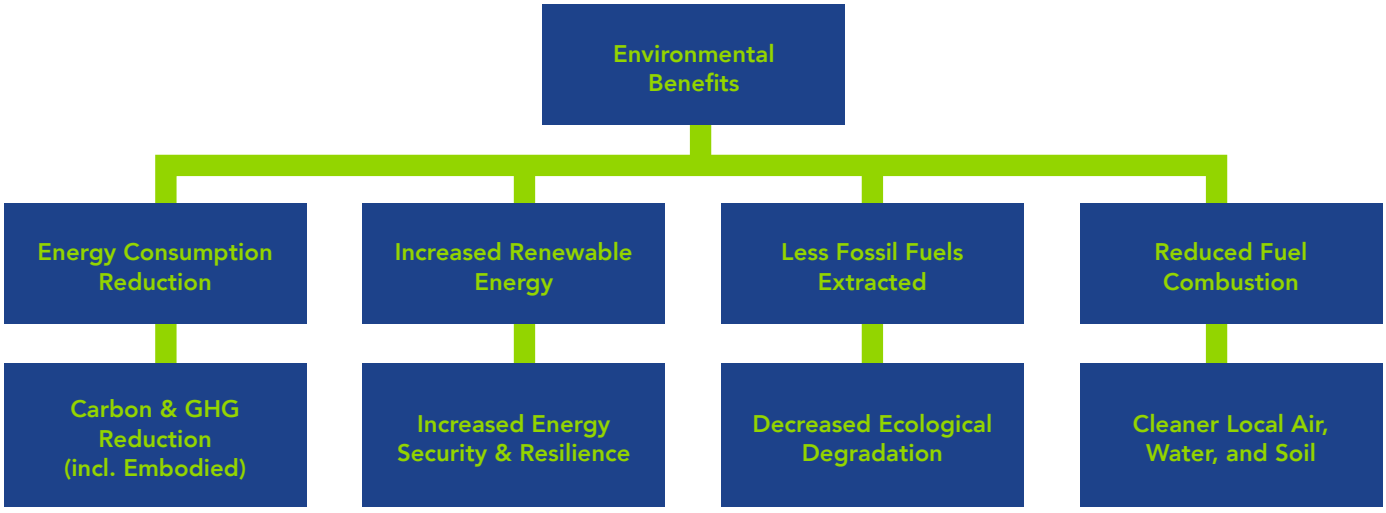

Figure 5: *Environmental Benefits of a Retrofit Renovation Wave*

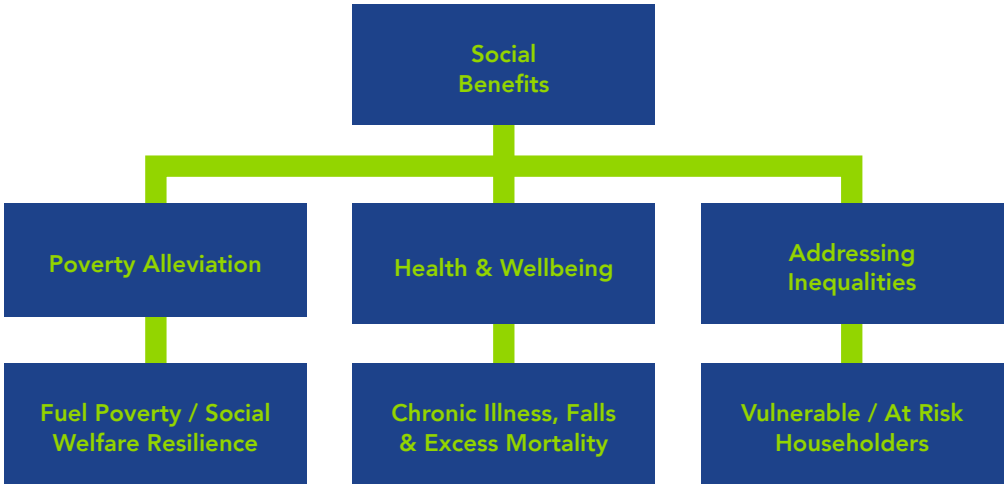

Figure 6: *Social Benefits of a Retrofit Renovation Wave*

The Social benefits (Figure 6) include a reduction in poverty through tackling fuel poverty prevalent in a significant number of Irish households where energy costs in a home exceed 10% of the households' income, where occupants may find themselves having to choose between food and other essentials or heating their homes. Energy retrofits have added benefit of improving the health and wellbeing of the occupants in all homes, not just those in fuel poverty, through improved heating, cooling, lighting and overall comfort levels and improved internal air quality, leading to a reduction in chronic ailments, GP and hospital visits, medications, and sick leave from education or work. Improving the energy efficiency of homes also helps to address some of the negative effects of inequalities in society and those most vulnerable and at risk from the negative impacts of poor-quality housing such as women, children, the elderly, and the disabled and can cushion any individual from the impacts of major life changes such as retirement, divorce, illness, bereavement, or redundancy.

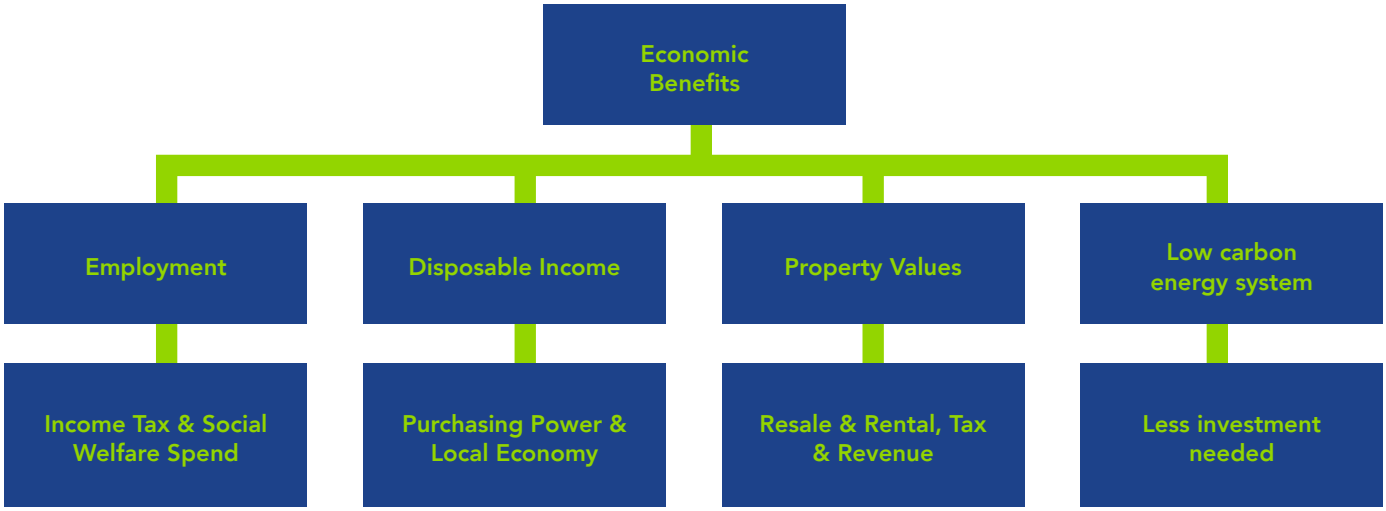

Figure 7: *Economic Benefits of a Retrofit Renovation Wave*

The economic benefits (Figure 7) include increased employment (nationwide) in the energy and retrofit construction sectors, as well as in the government departments and bodies tasked with the retrofit renovation wave, and a spill-over effect of jobs in other sectors providing ancillary services such as local food and accommodation for those directly employed. The Value Added Tax (VAT) on the works alone will be significant. The increased disposable income from saving energy, and being employed, will increase household purchasing power, and spend within the local and national economy providing a macro-economic benefit. Increasing the energy efficiency of homes has the potential to increase the property value (and property tax revenue), which also increases its resale value (and the stamp duty on sales) rental income (and tax from rental income).

7.2 Recommendations

The recommendations made throughout the document are compiled below. These will also be discussed in more detail in our future EPICA policy reports dealing with topics such as communication, capacity building, and financing the retrofit renovation wave.

1. This document illustrates how retrofit policies benefit the exchequer, the state, the taxpayer, and Irish society as a whole, therefore it is strongly recommended that the policies and programmes of other government bodies and departments are integrated to contribute to the energy retrofitting of the housing stock. Relevant bodies include: Departments of Business, Enterprise & Innovation; Education & Skills; Department of Further and Higher Education, Research, Innovation and Science, Employment Affairs & Social Protection; Finance; Health; Housing, Planning & Local Government; Culture, Heritage and the Gaeltacht; National Standards Authority, Public Expenditure and Reform; Rural & Community Affairs; The Health Service Executive (HSE); the Sustainable Energy Authority of Ireland (SEAI), and Solas for example.

2. Many Irish homes are energy inefficient and carbon intensive; however, the full scale of retrofit requirements is not currently known as only homes that have been sold, rented, or upgraded in recent years have a BER certificate. It is therefore recommended to carry out regular nationwide surveys (perhaps as part of the national census) into the condition of Irish homes and households, including information on both the condition of the building, and of the occupants. By collecting (subjective and factual) data on the socio-economic, health & wellbeing, and energy poverty risk of occupants, such surveys would enable planning of retrofits to gauge retrofit solutions based not only on the building requirements, but on stakeholder requirements also.

3. Carry out the retrofit renovation wave in three phases: pre-rollout planning, retrofitting, and post-occupancy evaluations. Ensure that a thorough and inclusive stakeholder engagement process is carried out from the pre-rollout planning stages of the renovation wave, to the post-occupancy evaluation phase. Ensure that lessons-learned are collected and recorded from each stage of the process, and that there is cross-sectoral, cross-departmental collaboration on all activities.

4. Gather feedback and encourage stakeholder input in all three phases.

5. Establish a co-ordinated multi-disciplinary research programme to inform policy and roll out of the retrofit programme.

6. Develop an inclusive communication and engagement plan to ensure a just transition, with a forum for all voices to be heard, and for the dissemination of information on the potential benefits of retrofits. Develop a combination of bottom-up and top-down approaches.

7. Offer Free BER assessments to all households that do not currently have a BER to get better data on the existing energy efficiency of buildings, the extent of work required, and which homes need to be prioritised. This could be done in the Pre-Rollout Phase as part of a citizen stakeholder engagement process to open a dialogue with households with regards to energy efficiency of their homes. The process of carrying out the BER assessment will help households to get a better understanding of their current energy use, and the potential benefits of engaging with the retrofit renovation wave programme and the supports available. It would also be recommended to collect data on actual energy usage via utility bills and occupancy profiles from a representative sample, in addition to the BER assessment. BER assessments are theoretical, and based on certain defaults and assumptions, that do not always provide a complete picture. This will also help the retrofit programme to engage with harder to reach groups, especially those in fuel poverty.

8. Introduce a low-interest Pay-As-You-Save/Save-As-You-Pay scheme as part of a broad suite of options to make retrofitting more attractive to both the public and private investor. The design of such as scheme would need to consider and learn from similar successful and unsuccessful schemes past and present in Ireland and in other countries.

9. Collect data on previous retrofits carried out before the introduction of BER certificates to gain a clearer picture of the condition of existing building stock, and the potential for 'default effect' errors. Relevant data could include energy bills, and detailed monitoring of representative samples of dwellings (see recommendation 7). Research and development of appropriate data collection methods to be carried out (perhaps in conjunction with SEAI, the Central Statistics Office (CSO), Local Authorities Building Control and Planning Departments, or professional representative groups such as the Royal Institute of Architects of Ireland (RIAI), Engineers Ireland, Society of Chartered Surveyors or similar.

10. Consider the insulation properties of a home and any adjoining homes first, and the potential for shared sources of heat.

11. Adopt a whole-life-cycle approach to minimise embodied energy and carbon.

12. Utilise Environmental Product Declarations (EPD) and other environmental certifications and accreditations such as Cradle to Cradle, Living Building, Home Performance Index, Well Certification etc

13. Green public procurement should be used for publicly owned homes; for privately owned homes, incentives will be required, such as reduced tax, or increased grant-aid for certain products and materials that have lower levels of embodied energy and carbon.

14. Develop markets for natural materials such as sheep's wool insulation.

15. Consider retrofitting buildings, especially unoccupied buildings, as part of local area development planning, community development, and rejuvenation.

16. Develop practices across Ireland whereby waste or by-product energy from commercial or industrial buildings, complexes, campuses, data centres, or industrial estates can be harvested for use in homes via district heating.

17. To maximise the benefits of the renovation wave, special efforts should be made to upgrade rural homes at the extremities of the electricity grid, and to resolve the appropriate sizes for systems of thermal storage.

18. Introduce local area energy planning, and heat-area zoning through local and regional development planning to support the efficient deployment of technologies to decarbonise home heating.

19. As part of a national building condition survey, indoor air quality and radon levels should be measured.

20. Outdoor air quality should also be monitored nationwide, and pollutant levels measured.

21. Health conditions associated with indoor and outdoor air quality issued should be analysed in the context of patients' local outdoor and indoor air quality.

22. Allow all potentially low-income (both from chronic and intermittent poverty), and all potentially fuel-poor households (tenants in social housing, private housing, or home-owners) to apply for the cost of retrofitting through a means tested system that will enable low-income households both within and outside of the social welfare system to apply based on both their income (from social welfare, paid employment, or self-employment), and the energy efficiency of their homes .

23. Establish a hierarchy of need or prioritisation based on the economic, social, and health conditions of the occupants as well as the physical condition of the home.

24. Homes that would require more than 10% of the household income to be spent on energy costs to be considered fuel-poor households. This could include homes where occupants are employed in minimum wage, part time, or free-lance jobs. Where homes are on the borderline of the 10% threshold, any special needs of the occupants should be considered, prioritising the elderly, chronically or seriously ill, disabled persons, and households with babies and very young children.

25. A more nuanced methodology for calculating fuel-poverty encompassing multiple indicators such as building condition and household characteristics (in addition to the 10% of household income definition) as recommended in previous research, should be adopted to ensure all of those at risk are considered when devising solutions to eradicate fuel poverty, to ensure a just transition that leaves no one behind.

26. SEAI currently provides grants to homes for: insulation, heat pumps, heating controls, solar water, and solar electricity [103]. Increase the scope of grant aid available to cover additional works, such as window and door replacements and adjustments to fenestration to improve access to natural ventilation, passive solar gain, and day light, installation of passive stack ventilation, or mechanical heat recovery ventilation systems, upgrade of uninsulated floors and installation of radon barriers, for example.

27. Facilitate development of more one-stop-shop and aggregation initiatives like the An Post Green Hub, Superhomes, and Three Counties Energy Agency (3CEA) for example to encourage and simplify access to deep-retrofits where multiple areas such as insulation, ventilation, heating, fenestration and so on are all tackled simultaneously. (e.g. Retrofitting to include effective ventilation provision, and protection against radon infiltration).

28. Ensure that the pre-rollout phase involves significant citizen and stakeholder engagement, and preparation of rollout bodies within government, as well as preparation of the energy and retrofit sector for a smooth execution phase capable of meeting demand. The potential for disruption to home occupants and owners must be minimised and planned for in conjunction with the occupants and owners to design solutions that are mutually suitable, while also protecting existing tenants from the potential of eviction and rent increases post-retrofit.

29. All policies regarding retrofitting should adopt an intersectional approach and ensure that they acknowledge the differing energy requirements and impacts on different demographic groups, and gender aspects in policymaking. Household data should be disaggregated by age, disability/ illness, gender, income, and family or household size. The design of the retrofit renovation wave, especially in the pre-rollout phase and citizen stakeholder engagement activities, and post-occupancy evaluation phase should be inclusive and create shared value for all in society.

30. Carry out a detailed national survey on current broadband availability including both upload and download speeds, data limitations, and services available nationwide. (Perhaps as part of the national census). Follow up with provision for equal access to good quality high speed broadband (for communication, education, work, and energy services) to all households in Ireland, including rural and remote households, in accordance with Europe 2020 and EU broadband requirements and to enable equal access to online educational resources and working from home facilities.

31. Install smart energy systems to enable homes to take advance of new innovations in smart devices, monitoring and controlling of energy, energy storage, peer-to-peer and other energy trading mechanisms, and interaction between appliances, renewables technologies, and the grid.

32. Introduce preferential property tax rates for more efficient homes to incentivise private property owners and landlords to carry out retrofitting works. Property owners (those who pay property tax) are not necessarily able to afford retrofit measures because they own a home. It is possible to own a property and also be in fuel poverty, chronic, or intermittent property for various other reasons, low income, retirement, loss of income, divorce, illness or death in the household, for example.

33. Display potential energy costs when advertising properties for sale or rent BER ratings are currently shown, but estimated energy costs are not. The latter might provide more of an incentive to retrofit as a more impactful understandable indicator of the actual potential impact of a homes' energy efficiency, with potential sellers and buyers incentivised to retrofit to get a better resale price (seller) and lower running costs (buyers).

34. Linking the BER Database with Property Price Register (The Climate Action Plan, Action 46, is already looking into the feasibility of linking BER to Commercial Rates also [1])

35. Promote the provision of technical and financial incentives, especially where there is a potential for a split incentive between landlord and tenant, low interest-rate green loans, fossil fuel duties or supplier obligations, tax rebates, supports for using materials with low embodied energy to incentivise property owners to carry out retrofits prior to renting or selling.

36. Allow for tax refunds on the purchase of certain retrofit materials to incentivise households to carry out works that do not require specialist registered installers, such as buying and laying additional quilt insulation in the attic, replacing light fittings with LED lights, buying a lagging jacket for a water tank, or insulating an attic hatch door.

37. Introduce Building Renovation Passports that incorporate information on EPDs and other certifications and accreditations achieved.

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