Energy Co-operatives Ireland Ltd

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Galway Energy Co-operative Sustainable Energy Community

Energy Master Plan

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Glossary

Active Travel	Transport where most of the power supplied is from exercise: e.g., walking and cycling
ASHP Air Source Heat Pumps	A highly efficient electrically driven heating system. It is explained further in the Appendices
Auto-production	Where some or all of the electricity generated is consumed on-site and thus not exported to the grid
BER	An energy rating system where A1 is the most energy efficient to G the least efficient. The levels of the energy use for each rating are discussed in the Appendix
BEU	Baseline Energy Use: a study of the energy use in the SEC as its starting point on its sustainability journey: in this case 2019
CEG (Clean Export Premium)	Homeowners are eligible to receive a Clean Export Guarantee (CEG) tariff, for any exported electricity, at a competitive market rate from their electricity supplier
CEP (Clean Export Premium)	A payment received by a micro-generator for electricity exported to the grid
Decarbonising Zone (DZ)	This is a spatial area in which a range of climate mitigation measures are identified to address low carbon energy, greenhouse gas emissions and climate needs to contribute to national climate action targets
ECI	Energy Co-ops Ireland Ltd, authors of his report
Electoral Division (ED)	A legally defined administrative area comprising a number of townlands and small urban areas. It is a demographic unit in the Central Statistics Office data collection.
Energy Master Plan EMP	A study funded by the SEAI of the total energy requirement of a community as well as a set of recommendations as to how this can be reduced and powered by sustainable energy
EPA	Environmental Protection Agency
EPBD	European Energy Performance of Buildings Directive
EV Electric Vehicle	A vehicle driven by an electric motor powered by a plug-in rechargeable battery - sometimes referred to as BEV (Battery Electric Vehicle)
FCEVs - fuel cell vehicles	These are vehicles driven by an electric motor (similar to EVs) but that use compressed hydrogen as their energy storage
Flow Rate	How much water in m3 per second that passes over a weir
GCDP Galway City Development Plan	Policy document outlining the City Council's policy across all areas of its operation between 2023 and 2029
GEC SEC	Galway Energy Co-operative's Sustainable Energy Community
gCO2	grammes of CO2 emitted
Hybrid	In this report we refer to vehicles that are primarily powered by fossil fuel burning internal combustion engines, but also having supplementary recharging battery that reduces the need for fossil fuels
Headrace	This is the fall of water over a turbine. The higher the headrace, the faster the fall of water from gravity, and the greater the power generated by the turbine
hydro or hydroelectric	A form of renewable energy where electricity is generated by the force of flowing water turning a turbine

HVO	Hydrotreated Vegetable Oil (HVO) is a type of renewable diesel fuel that is produced by hydrotreating vegetable oil. It is a high-quality, low-emission fuel that can be used as a direct replacement for fossil diesel in diesel engines
ICE Internal Combustion Engine	An engine that burns fossil fuels (diesel, petrol, or gas) for its power - usually, and throughout this report, used in connection to road vehicles
kW	kilowatt - a measure of electrical power
kWh	kilowatt hour: a unit of electricity - the application of one kilowatt for one hour. This is determined by electricity suppliers as the basic unit of electricity
kWp	kilowatt peak power: a system that delivers one kilowatt. Over one hour at *maximum* output it will produce 1 kWh
MIC	Most relevant to commercial electricity consumers. Maximum Import Capacity (MIC) is the upper limit on the total electrical demand you can place on the network system. MIC should be set at 5% above your highest electrical load in the past year. It important that you choose the capacity that meets your needs because inappropriate MICs are an unnecessary cost on your business.
micro hydro	Small Scale Hydro-Electricity Projects (less than 50kW)
MW	Megawatt = a thousand kilowatts
MWh	Megawatt hour: a thousand-kilowatt hours
Net zero	An energy system where any generation of Carbon Dioxide from energy production is balanced by carbon offset measures such as sequestration by trees, bogs, etc
nZEB Nearly Zero Energy Buildings	Buildings that have a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby
Payback	The time taken for the nett income from a project amount to the initial investment
Pobal	A state-sponsored organisation in the Republic of Ireland with responsibility for administering and managing government and EU funding aimed at supporting social inclusion and addressing social disadvantage in the country
PV	Photovoltaic: panels that convert light (photons) into electricity (volts). These panels are discussed in the Appendix in greater detail
Register of Opportunities	A live document provided separately to the SEC which will enable it to track it's progress against the BEU through efficiency, avoidance and generation projects
SEAI	The Sustainable Energy Authority of Ireland
Solar	From the Sun. We discuss electrical energy captured from the sun's rays by photovoltaic panels in this report
Turbine	A machine which converts turning power into electricity
TWh	Terawatt hours: a million megawatt hours
Wards (electoral)	Large administrative areas in a City Council area comprised of a number of EDs
WDZ Western Decarbonization Zone	An area in Galway City comprising Shantalla, Newcastle and part of Rahoon Electoral Divisions in which a range of climate mitigation measures are identified to address low carbon energy, greenhouse gas emissions and climate needs to contribute to national climate action targets

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1 Summary

This Energy Master Plan describes the policy framework at EU, Ireland and Galway City level in the relevant areas of climate change, energy efficiency, renewable energy and sustainability measure. It outlines the energy usage of the Galway Energy Co-operative from a baseline in 2019 in both the domestic and non-domestic sectors. It also establishes the fuel use, cost and energy related carbon emissions arising from this energy use. The report outlines a series of measures that can be taken in each sector to achieve efficiencies, reduce the amount energy derived from fossil fuels, and to generate as much of that energy as possible from renewable sources within the SEC area. The report also outlines the supports and opportunities that exist to assist the residents in the SEC in achieving this end. The report then outlines a staged plan as to what steps can be taken and how the recommendations may be put into place highlighting the monetary and sustainability benefits that would accrue from these steps.

The report is accompanied by a Register of Opportunities (RoO) document, not for publication but presented to the SEC steering committee which involves actual case studies of energy improvements. The RoO is a living template for future actions which the SEC can use as its benchmark against which its progress can be measured.

This report shows clearly how the SEC can reduce fossil fuel energy use by over 30% by 2030. It shows how the SEC can reduce levels of energy related carbon emissions by the same degree potentially reducing CO2 emissions by 126,503 tonnes annually. This would be the equivalent of the carbon uptake from 9,035,928 mature conifer trees over a year. This energy reduction would be accompanied by a reduction of 440,106 MWh of fossil fuel use – the equivalent of 44,010,600 litres of oil.

Energy use has rightly become the focus of much of our social and political discourse. The ownership, origin, security, and effects of our energy sources is a matter of critical socio-economic importance. This fact is highlighted by the level of engagement that the members of the SEC have voluntarily committed to on behalf of their wider community.

2 Introduction and Background

This report is an Energy Master Plan produced by Energy Co-operatives Ireland (ECI) on behalf of Galway Energy Co-operative Ltd Sustainable Energy Community (GEC SEC) supported and funded by the Sustainable Energy Association of Ireland (SEAI).

An Energy Master Plan (EMP) aims to help the SEC to understand the energy demand and supply in the entire community. The EMP focusses on energy efficiency opportunities in the first instance. This is because energy efficiency actions are typically lower risk and have higher payback. It is also widely accepted that reducing the amount of resources you use is the first step to greater sustainability. This plan is also accompanied by a Register of Opportunities document (provided separately to GEC SEC) which is a live record of the community's energy status and achievements in its journey to sustainability. It is intended that it will evolve to form the foundation for applications and projects which will achieve the SEC's aims to reduce energy use, promote renewable energy and increase community sustainability.

The community designs, develops and focusses its own Energy Master Plan in line with the aims of the Community SEC Charter. No two communities are the same, and thus their EMPs are also unique.

This Energy Master Plan will provide a Baseline Energy Use report (BEU) to quantify the current energy status of GEC SEC area as a baseline of electrical, thermal and transport energy demand. It will identify any existing renewable energy sources within the community – these can be used as a model for further roll-out of renewable energy.

The plan will create a Register of Opportunities (RoO) which is a list of potential projects for energy efficiency and renewable energy. It will select suitable projects for the first three years of GEC SEC community actions, setting energy reduction targets against the baseline figures. The EMP is designed to allow periodic updating of the SEC energy status to track progress against targets.

3 Policy Background

We examine the overarching EU climate change strategy before looking at those EU policies directed at energy in buildings specifically. We will then examine Irish climate action policy, and the overall building energy upgrade targets. In Section 3.3 we look at policy on a City Council level. Other policy issues are discussed as they relate to the energy use and sustainability opportunities as they arise.

3.1 EU Climate Strategy

The EU Strategy on Adaptation to Climate Change[1] aims to address the urgent challenges posed by climate change through comprehensive policies and actions. The EU has set ambitious goals to become climate-neutral by 2050 and to lead the global fight against climate change. This strategy encompasses various initiatives, legislation, and targets designed to reduce greenhouse gas emissions, transition to renewable energy sources, promote sustainable development, and enhance climate resilience.

The EU's central commitment is to achieve climate neutrality by 2050, meaning that its net greenhouse gas emissions will be reduced to zero (net zero). This goal is enshrined in the European Green Deal, a comprehensive policy framework launched in 2019, aimed at making the EU's economy sustainable and resource efficient. Additionally, the EU has set intermediate targets for reducing emissions by specific percentages, such as 55% by 2030 compared to 1990 levels.

To accelerate the shift to clean and sustainable energy sources, the EU has set binding targets for the share of renewable energy in the overall energy mix. The Renewable Energy Directive aims to ensure that at least 40% of the EU's final energy consumption comes from renewables by 2030. This involves promoting investments in wind, solar, hydroelectricity, and other renewable sources while phasing out fossil fuel subsidies and use.

Enhancing energy efficiency is a critical aspect of the EU's climate strategy. The Energy Efficiency Directive sets targets for reducing energy consumption across various sectors, including buildings, transport, and industry. Energy efficiency measures involve improving building standards, supporting energy saving retrofits to existing buildings, encouraging energy-saving practices, and promoting the use of energy-efficient appliances and technologies.

Recognizing the need to manage the social and economic impacts of the transition to a low-carbon economy, the EU has introduced the Just Transition Mechanism. It aims to support regions and sectors of the population heavily dependent on fossil fuels, helping them transition to more sustainable economic activities and ensuring that no one is left behind in the process. The Just Transition Mechanism will aim to protect citizens, most vulnerable to the transition to net zero carbon by facilitating employment opportunities in new sectors, offering re-skilling opportunities, improving energy-efficient housing, investing to combat energy poverty, and facilitating comprehensive access to clean, affordable, and secure energy.

The EU promotes sustainable and low-emission mobility solutions to reduce the environmental impact of the transport sector. This includes supporting electric vehicles, investing in public transportation, and encouraging the development of alternative fuels, and supporting the putting in place of infrastructure that will enable greater active travel.

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:82:FIN

Climate change and biodiversity loss are interconnected challenges. The EU has implemented the Biodiversity Strategy, which aims to protect and restore ecosystems, halt biodiversity loss, and ensure the sustainable use of natural resources. Thus, there is an awareness that the infrastructure roll-out that is necessary to facilitate the move towards a net zero carbon energy system must respect the protection of our existing biodiversity resources.

3.1.1 Efficiency in buildings

The European Parliament has passed amendments to the Energy Performance of Buildings Directive, focusing on increased reducing CO2 emissions, improving energy efficiency, and promoting renovations of buildings. The directive includes specific targets, support measures against energy poverty, exceptions for certain types of buildings, and provisions for member states to adapt the targets based on practical considerations.

The European Parliament adopted its position on the Energy Performance of Buildings Directive (EPBD) in March 2023. The revision of the EPBD has the goal of reducing greenhouse gas emissions and energy consumption in the EU building sector by 2030, ultimately achieving climate neutrality by 2050. It also seeks to increase the rate of renovations for energy-inefficient buildings and enhance the sharing of information on energy performance.

Key points of the proposed revision include:

1. CO2 Emissions-reduction targets:

- All new buildings should be zero-emission by 2028, with public authority-occupied buildings required to meet this standard by 2026.
- By 2028, new buildings should incorporate solar technologies where feasible, while residential buildings undergoing significant renovation have until 2032 to comply.

2. Energy performance ratings:

- By 2030, residential buildings must attain at least a BER energy performance class E, progressing to class D by 2033 (on a scale from A to G).
- Non-residential and public buildings must achieve similar ratings by 2027 and 2030, respectively.

3. National renovation plans:

- Member states will develop plans to achieve the prescribed targets and measures. These plans should include support schemes to facilitate access to funding and grants.
- Information points and cost-neutral renovation programs must be established.
- Financial incentives will be provided for extensive renovations, particularly targeting the worst-performing buildings.
- Grants and subsidies should be available to vulnerable households.

There are derogations permitted for certain historic, religious and heritage buildings.

There is therefore a requirement on member states to ensure that public buildings as well as domestic residences are retrofitted to more efficient standard. All new buildings will be required to be net-zero efficiency. All new buildings should be equipped with solar technologies by 2028, where feasible (2032 for residential buildings undergoing major renovation). Residential buildings would need to reach BER class E by 2030, and class D by 2033.

Our survey of buildings (Section 5) in the SEC area found that there are an estimated 1,767 below level BER E2 (8.71% of all homes) and 4,221 below level D (20.81% of homes)

The recommendations in this study reflect the scale of meeting these regulations as well as achieving the opportunities in sustainability and value for money they represent.

In April 2023 the Effort Sharing Regulation was amended and Ireland's new 2030 target under the Effort Sharing Regulation is to limit its greenhouse gas emissions by at least 42% by 2030. New binding annual emission limits for 2023 to 2030 for the 42% reduction will be set by the EU later in 2023.

3.2 Ireland

Ireland has developed its sustainability policy to a marked degree in the past five years. It has passed significant legislation and produced a series of policy interventions at all levels to support communities in the transition towards a low carbon future. In this section we address those interventions as the apply to the aims of the GEC SEC

3.2.1 The Climate Act 2021

This is a significant piece of legislation enacted in Ireland to address the issue of climate change. It established a comprehensive framework to guide the country's transition towards a low-carbon and climate-resilient economy. The act set ambitious targets to achieve a net-zero greenhouse gas emissions economy by 2050, aligning with global climate goals. It places an obligation on the government to develop and implement five-yearly Climate Action Plans (see next section), outlining specific measures and policies to reduce emissions across various sectors.

3.2.2 The Climate Action Plan 2023.

This is a strategy document published initially every year, to set out targets for actions whereby the aims of the Climate Act will be achieved. The plan, which is available in full here and summary here, includes many other measures, but we see those above as the most relevant to the aims of this EMP. The 2023 Plan sets identifies the following targets:

3.2.2.1 Renewable Energy Generation

25% reduction in emissions by 2030 from energy generation, facilitating large scale renewables and accelerating the deployment of offshore wind. The policy pledges to support **at least 500 MW of local community-based renewable energy projects** and increased levels of new micro-generation and small-scale generation.

3.2.2.2 Building Efficiency and Retrofits

A 45% reduction in emissions from public buildings and 40% from domestic buildings by 2030. This achieved by

Increasing the energy efficiency of existing buildings, putting in place policies to deliver zero-emissions new builds and continue to ramp up retrofitting programmes. Retrofitting 120,000 dwellings to BER B2 by 2025, up to 500,000 by 2030.

The plan requires the installation of heat pumps (explained in Appendix Section 8.6.1) into 45,000 existing and 170,000 new dwellings by 2025, up to 400,000 existing and 280,000 new dwellings by 2030. There is also a pledge to achieve up to 0.8 TWh of district heating by 2025 (enough for about 53,000 homes) and up to 2.5 TWh by 2030 (enough for 160,000 homes).

3.2.2.3 Transport

Reducing transport emissions by 50% by 2030 through improving town, cities, and rural planning, and by adopting the Avoid-Shift-Improve approach: reducing or avoiding the need for travel, shifting to public transport, walking, and cycling and improving the energy efficiency of vehicles.

The plan envisages a change in the way we use our road space, a reduction in the total distance driven across all car journeys by 20%. Through an increase in walking and cycling networks, achieving a target of 50% of all journeys to be taken walking, cycling and public transport. Increased electrification of private transport is seen to reach a target of 30% of all cars.

3.2.2.4 Decarbonization Zones

The Government's Climate Action Plan included as an action for each local authority to identify a Decarbonising Zone (DZ)[2]. This is a spatial area in which a range of climate mitigation measures are identified to address low carbon energy, greenhouse gas emissions and climate needs to contribute to national climate action targets. The range of policies and projects developed are specific to the energy and climate characteristics of the spatial area covered by the DZ. This can include a range of technologies and measures addressing electricity, heat, transport, building energy efficiency, carbon sequestration and energy storage. The DZ must at a minimum reduce its greenhouse gas emissions by 7% per annum from 2021 to 2030 (a 51% reduction over the decade), in line with targets set out Climate Action and Low Carbon Development (Amendment) Act 2021.

[2] https://www.caro.ie/news/local-authority-decarbonisation-zones

3.3 Galway City Council

Galway City Council is the local authority in the city of Galway. As a city council it is governed by the Local Government Act 2001. The council is responsible for roads and transportation, housing and community, urban planning and development, amenity and culture, and environment. The council has 18 elected members. The city administration is headed by a Chief Executive. The council meets at City Hall, College Road, Galway.

The Galway City Development Plan 2023-2029[3] (GCDP) sets out the policies and objectives for the development of the City over the plan period.

Having gone through an extensive public consultation process, Galway City Council adopted the Galway City Development Plan 2023-2029 in November 2022. It came into effect from Wednesday 4th of January 2023.

The plan contains many policies that are relevant to the aims of this EMP.

Planning legislation mandates Local Authority Development Plans to address energy demand reduction, greenhouse gas emission reduction, and climate change adaptation measures. In light of this requirement, the Core Strategy of the GCDP outlines how the plan promotes this objective, particularly in terms of achieving sustainable settlement and transport strategies emphasizing the need to transition towards a low-carbon and climate-resilient city. This approach complements the existing Galway City Council Climate Adaptation Strategy 2019-2024.

3.3.1 Westside Decarbonization Zone

Galway City Council selected the 'Westside' area of the city as a DZ (see Section 3.2.2.4) and said it will work in partnership with local stakeholders and the established Sustainable Energy Communities including Galway Energy Co-op SEC, University of Galway SEC, and Galway City Council SEC to prepare and deliver an implementation plan for a DZ in 2023. The range of policies and projects that will be developed will be specific to the energy and climate characteristics of Westside DZ.

The Westside DZ is comprised of the Newcastle and Shantalla Electoral Divisions as well as part of Rahoon. The area is shown mapped in Figure 1 below.

[3] https://www.galwaycity.ie/development-plan-2023-2029

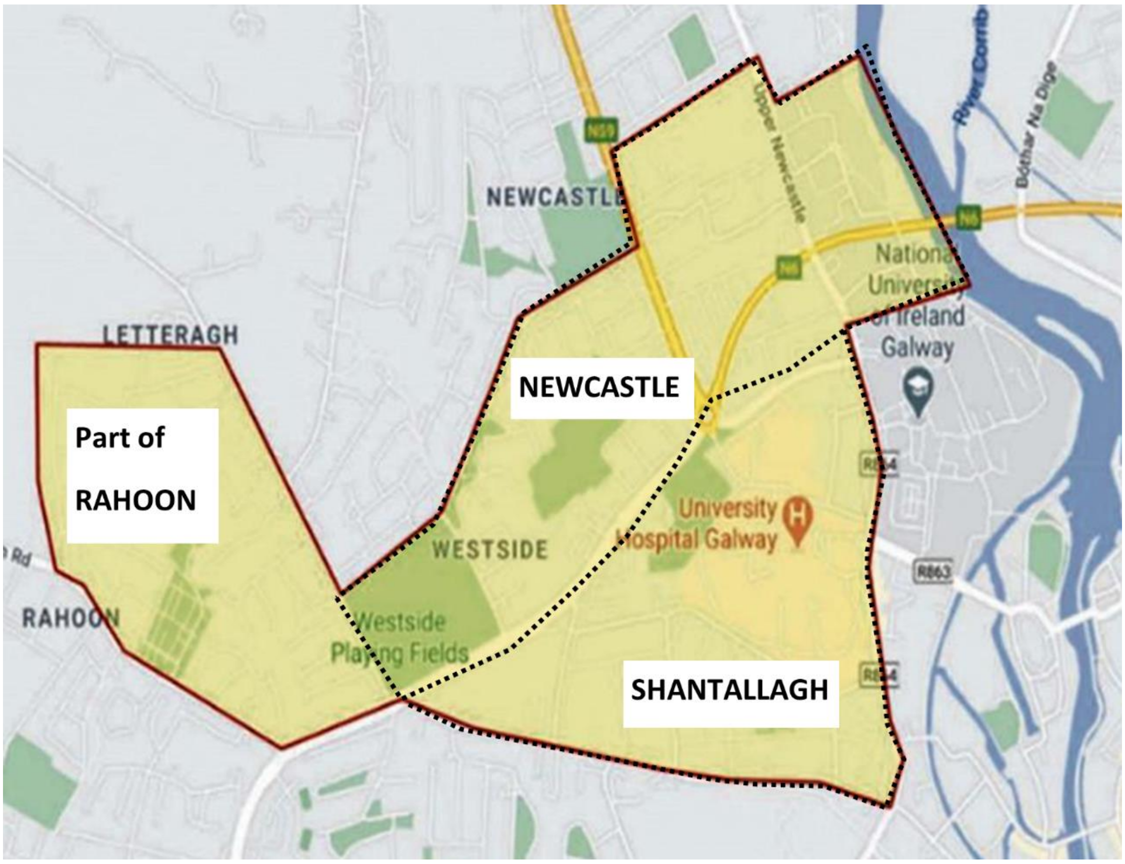


Figure 1: Map of the Westside Decarbonisation Zone (DZ)

The GCDP requires that the plans should address the wider co-benefits which can include air quality, improved health, biodiversity, embodied carbon, lower noise levels, waste, water and also benefits relating to adaptation. It is expected that Westside DZ will act as a demonstrator area with potential to roll-out the initiatives to other parts of the city.

The Council will also prepare an Energy Master Plan for Galway City (in addition to this EMP focussed on Westside and the GEC SEC area). The City-Wide EMP will provide a register of opportunities for decarbonising projects similar is type (but not in scale) to those outlined here. These will also include energy retrofitting of residential and non-residential buildings, a roadmap for electrification of the heat and transport systems and the identification of viable renewable energy and energy storage projects to target opportunities to achieve the 51% reduction in greenhouse gas emissions required nationally by 2030.

We indicate the areas that make up Westside DZ as *(WDZ)* in all tables and figures.

We will align this EMP closely with the overall aims of the City's.

3.3.2 GCDP Building Efficiency Policy

New buildings are required to be nearly Zero Energy Buildings (nZEB) standard through the transposition of the European Energy Performance of Buildings Directive (EPBD) and Part L of the Building Regulations[4]. The council development plan recognises that the EPBD also requires that energy required by the building to be met by a significant extent by energy from renewable sources produced on-site or nearby and is applicable to buildings undergoing a renovation of in excess of 25% of the building envelope. The Council encourages the design of high energy performance buildings through the siting, layout and design of new developments to make best use of renewable and low carbon energy opportunities. The Council also supports the retrofit and reuse of existing buildings.

Table 1: GCDP Building Efficiency Policies

Policy in Development Plan[5]
1. Increase the energy performance of new buildings in the city by encouraging energy efficiency and energy conservation in the siting, layout, design, and construction of development.
2. Encourage new development to limit greenhouse gas (GHG) emissions and make use of opportunities for renewable and low carbon energy including through design, layout, orientation, and construction practices.
3. Encourage high standards of energy conservation and improved energy performance in all existing and planned local authority housing and include for a deep retrofit programme of works (currently under the Energy Efficiency Retrofit Programme).
4. Liaise with the SEAI and other agencies to develop standards, procedures, and targets for energy conservation in the Council's housing stock.
5. Support the retrofit and reuse of existing buildings in the interests of sustainability and in line with delivery of the proposed National Aggregated Model of Retrofitting.
6. Promote energy efficiency and sustainability in both existing and new buildings and support the implementation of the EU Energy Performance in Buildings Directive and the Building Energy Rating Certification (BER).
7. Support flexibility, accessibility, and adaptability in terms of layout and design of new housing.

3.3.3 Renewable Energy in GCDP

The Development Plan supports the increase in use of renewable energy and development of renewable energy infrastructure and initiatives to provide alternatives to fossil fuels. Sources of renewable energy relevant to the SEC area that are identified in the plan include solar photovoltaic (PV) and hydroelectric power.

[4] https://www.seai.ie/home-energy/building-energy-rating-ber/support-for-ber-assessors/technical-support/domestic-ber/building-regulations-and-standards/

[5] https://www.galwaycity.ie/gccfiles/?r=/download&path=L0RlcGFydG1lbnRzL1BsYW5uaW5nL0RldmVsb3BtZW50IFBsYW4vMjAyMy0yMDI5L01pbmlzdGVyaWFsIERpcmVjdGlvbi9Db21iaW5lZCBJbnRlcmltIEdhbHdheSBDaXR5IERldmVsb3BtZW50IFBsYW4gMjAyMy0yMDI5IFVwZGF0ZWQucGRm page 56.

Table 2: GCDP Renewable Energy Policies addressed in this report.

	Relevant section in this EMP
1. Promote and facilitate the development of renewable sources of energy within the city, and support national initiatives, which offer sustainable alternatives to dependency on fossil fuels and a means of reducing greenhouse gas emissions, subject to the avoidance of unduly negative visual and environmental impacts or impacts on residential amenity.	Section 6.5.2
2. Support and work in partnership with SEAI, local Sustainable Energy Communities and relevant stakeholders in the development of energy efficient and renewable energy projects and investigate the potential for the use of emerging renewable technologies in the city.	Section 6
3. Ensure that the development of renewable energy and its associated infrastructure avoids negative impacts on European sites and adhere to the requirements of Article 6 of the Habitats Directive (92/43EEC).	Section 6.5.2
4. Promote small scale, on-site energy development, where energy generated is primarily required to meet the needs of households, communities, and businesses to reduce their carbon emissions. Examples could include micro wind/solar energy generation, low carbon district heating, waste heating recovery and utilisation, geothermal and air to water energy technologies.	Section 6.1.4.2
5. Support transmission network integration requirements facilitating linkages of renewable energy proposals to the electricity and gas transmission grid, in a sustainable and timely manner, subject to proper planning and environmental considerations.	Not addressed in this report
6. Support the development of appropriate land-based infrastructure at suitable locations in the city to support off- shore renewable energy production subject to adequate visual, environmental and ecological protection.	Not addressed in this report due to SEC location

There are a wide range of sustainability and energy efficiency proposals in the GCDP which we will refer directly to as appropriate in relation to each of the opportunities in Registry of Opportunities Section 6.

4 SEC area Context

4.1 Geography

The SEC is a combination of Urban and Sub-urban settlements making up part of Galway City in the West of Ireland. Figure 2 shows the SEC broken down into its constituent Electoral Districts (EDs). In effect the SEC occupies the areas of two Electoral Wards (11 EDs), Galway Central and Galway City West.

Figure 2: SEC Area Map

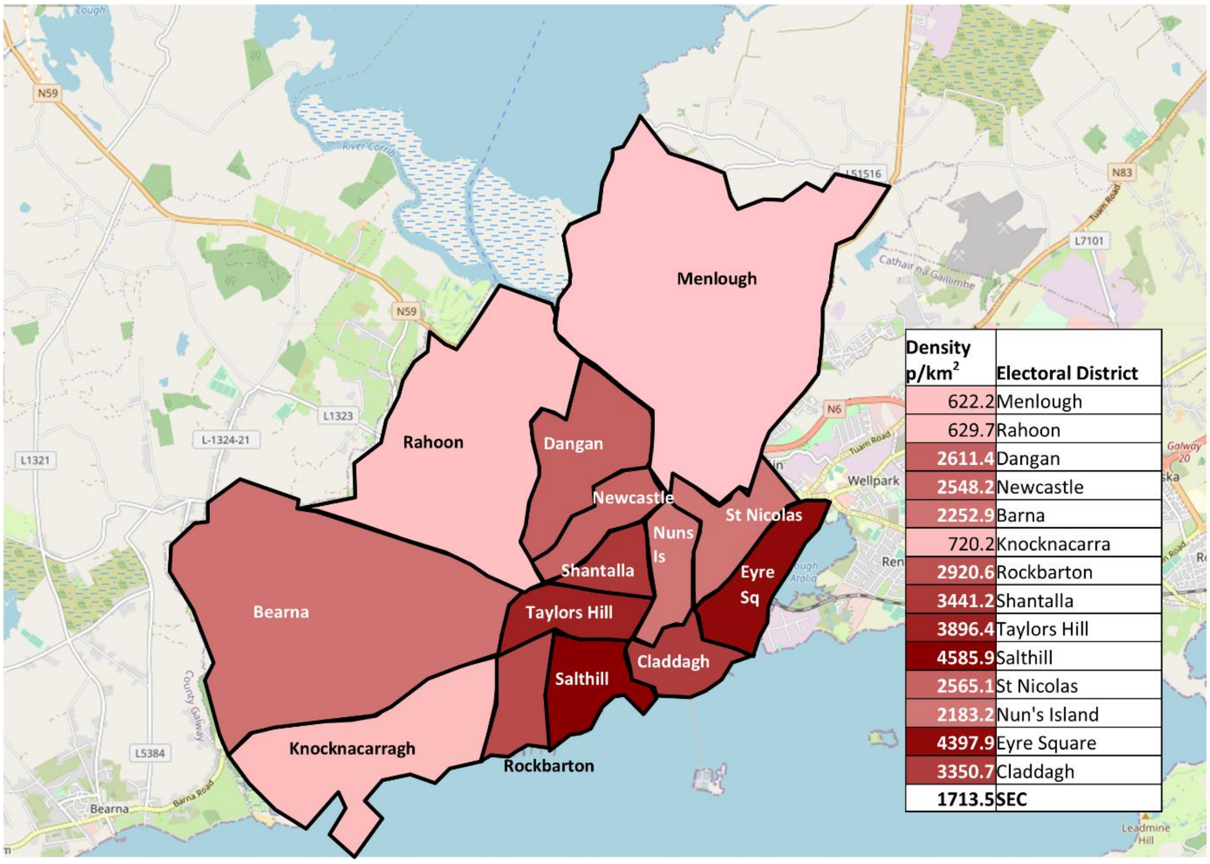
The area of the SEC is 30.39 km2. It is bound on to the South by the coast of Galway Bay, to the north by Lough Corrib, to the West by the city's rural hinterlands and the N84 and Lough Atalia. The area is densely populated 1,714 people per square kilometre (p/km^2). For comparison the national population density is 68.7 p/km^2, and Dublin County is 1459 p/km^2. There is extensive undeveloped green space in Menlough and to the North West of Rahoon as well as the south coast between Salthill and Barna.

4.2 Demography

The population of the area in the CSO 2016[6] census was 52,073. It was not evenly distributed however, as seen in Figure 3 with Salthill and Eyre Square most densely

[6] The EMP is required to use 2016 data as the 2022 census has not been published to the requisite detail.

populated (over 4,300 p/km2) and Menlough and Rahoon the least densely populated (less than 630 p/km2). This uneven spread is probably as much related to the protection of agricultural land in Menlough and Rahoon which restricts building development as it is to the expected density of the urban core of the city. We note that the GCDP does not envisage rezoning[7] much of this agricultural land.

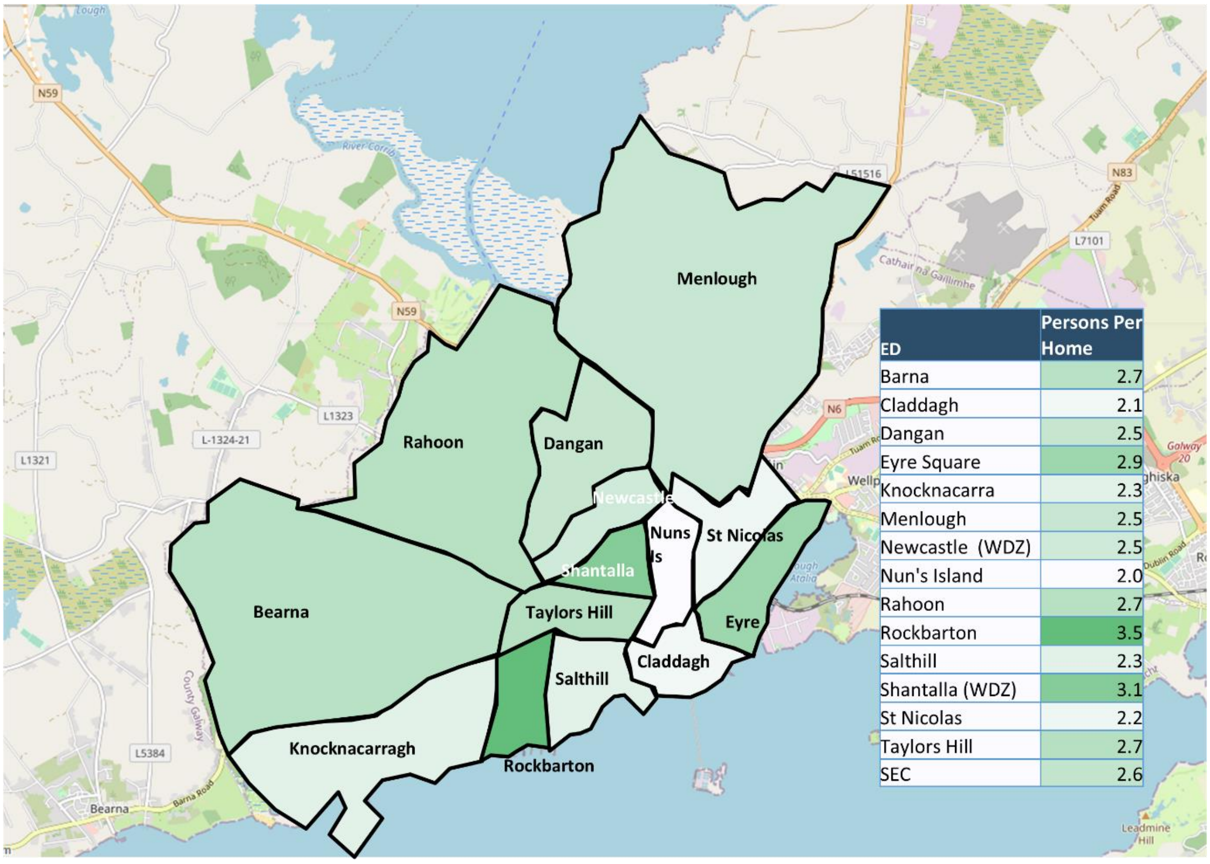


Density p/km^2	Electoral District
622.2	Menlough
629.7	Rahoon
2611.4	Dangan
2548.2	Newcastle
2252.9	Barna
720.2	Knocknacarra
2920.6	Rockbarton
3441.2	Shantalla
3896.4	Taylors Hill
4585.9	Salthill
2565.1	St Nicolas
2183.2	Nun's Island
4397.9	Eyre Square
3350.7	Claddagh
1713.5	SEC

Figure 3: Population Density by ED

We also examined the number of persons per home as it is relevant to the energy use of the homes which is central to the Baseline Energy Use (BEU) discussed in Section 5. As Figure 4 shows, the area with the highest number of persons per home is Rockbarton (34% above the mean)[8] while Nuns' Island has the fewest persons per home (2.0 or 21.7% below the mean). This is probably as it is an area with many flats and apartments in converted buildings. For the Westside DZ, Shantalla with 3.1 persons per home is 22.3% above the mean and Newcastle with 2.5 persons per home is 5.8% below the average occupancy rate per household. This spread in the WDZ is not particularly remarkable.

[7] See zoning map here: https://www.galwaycity.ie/gccfiles/?r=/download&path=L0RlcGFydG1lbnRzL1BsYW5uaW5nL0RldmVsb3BtZW50IFBsYW4vMjAyMy0yMDI5L01pbmlzdGVyaWFsIERpcmVjdGlvbi9NYXAgQTEucGRm
[8] Full data given in Appendix Section 8.8 Table 25



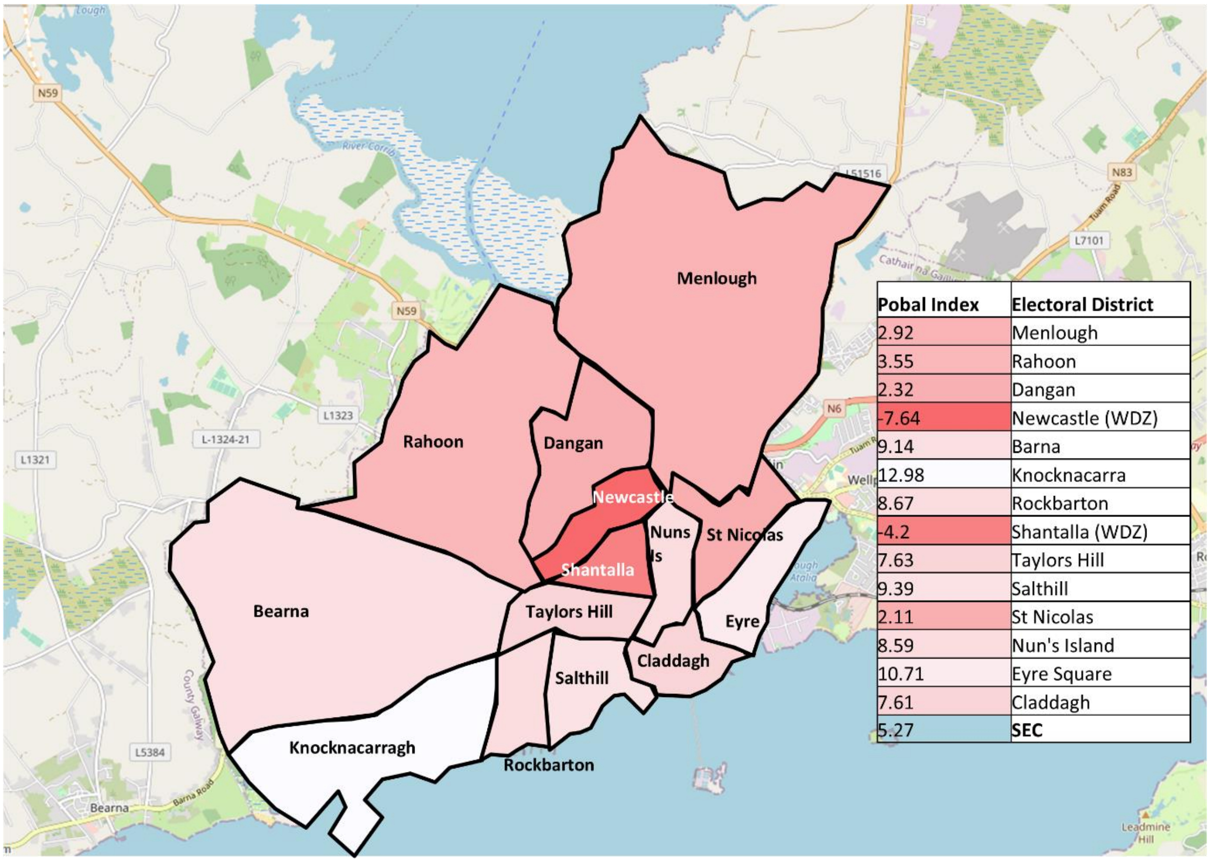
ED	Persons Per Home
Barna	2.7
Claddagh	2.1
Dangan	2.5
Eyre Square	2.9
Knocknacarra	2.3
Menlough	2.5
Newcastle (WDZ)	2.5
Nun's Island	2.0
Rahoon	2.7
Rockbarton	3.5
Salthill	2.3
Shantalla (WDZ)	3.1
St Nicolas	2.2
Taylors Hill	2.7
SEC	2.6

Figure 4: Persons per home by ED

4.3 Social Balance

There is a variance across the SEC area in relation to economic advantage. According to Pobal's social disadvantage metric[9], which rates communities across a number of indices to measure levels of socio-economic disadvantage, there is a spread of levels of socio-economic advantage ranging from Knocknacarragh at 12.98 to Newcastle at -7.64. It should be noted that Newcastle is in the WDZ which will affect the recommendations in the register of opportunities in Section 6. Efficiency measures which can be co-financed by individual property owners through the SEAI 'one-stop-shop' system (Section 6.1.7) will not always be applicable to areas of economic disadvantage where other strategies will need to be adopted.

[9] https://maps.pobal.ie/WebApps/DeprivationIndices/index.html



Pobal Index	Electoral District
2.92	Menlough
3.55	Rahoon
2.32	Dangan
-7.64	Newcastle (WDZ)
9.14	Barna
12.98	Knocknacarra
8.67	Rockbarton
-4.2	Shantalla (WDZ)
7.63	Taylors Hill
9.39	Salthill
2.11	St Nicolas
8.59	Nun's Island
10.71	Eyre Square
7.61	Claddagh
5.27	**SEC**

Figure 5: EDs within the SEC according to Pobal's Deprivation Index

5 Baseline Energy Usage

The Baseline Energy Usage (BEU) for the SEC Area incorporates the main sectors of the local economy, such as residential, non-residential (including private tertiary, public, and industrial), local authority, and transport. To create the energy usage profile for each sector, we utilized detailed data that accurately represents the local conditions as much as possible. In cases where localized data was lacking, we utilized national energy usage statistics provided by SEAI and CSO for the respective sectors. Additionally, we incorporated socio-economic multipliers that consider the scale of local sectorial activity. We look first at domestic energy use in the home and in transport before going on to look at other sectors. We do not examine the energy use of the University of Galway Campus, which is itself an SEC, but we do examine that of the residences and SMEs in Nuns' Island.

5.1 Domestic

This refers to the energy used by individuals in the home and in their own personal transportation. It is different to non-domestic use which is by businesses, schools, public bodies, etc.

5.1.1 Breakdown and Distribution of Residence Types

The SEC area as a whole is predominantly comprised of houses (14,245) as opposed to apartment dwellings (4,384). The housing stock is of mixed in age with 42% of homes built between 1980 and 2000 and with 34% built pre-1980. By far the most common fuel used in home heating is oil (51.1%) followed by electricity (22.6%) and natural gas (13.4%). There is wide variance across the SEC area, however.

When we look at the information on housing by Electoral Divisions, we see from Figure 6 that Barna is the area of most rapid growth (proportion of houses built since 1980). While this is unsurprising given the pattern of outward expansion into the suburbs of most Irish cities, the degree to which housing in the area has shifted to Barna is interesting, and likely a factor of the relative availability of undeveloped land in a scenic location with access to the sea.

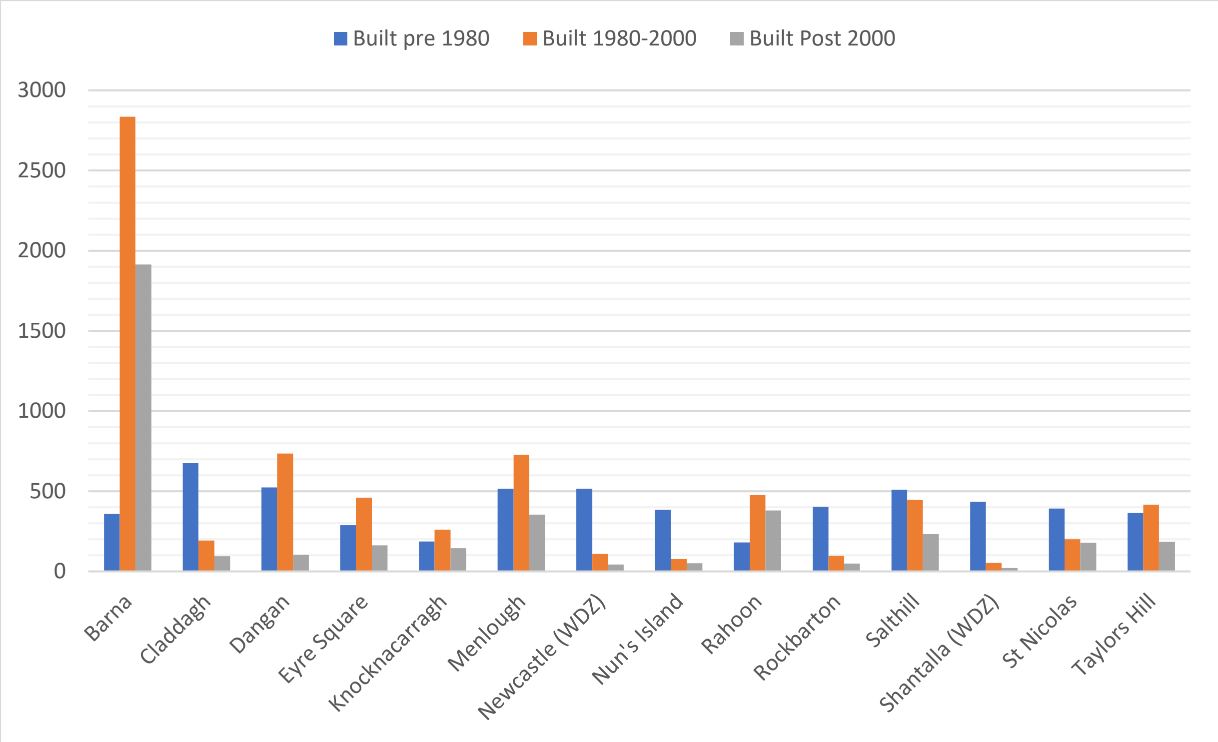


Figure 6: Houses in Electoral Districts By Construction Period

The age of the homes in the SEC may have significance in relation to their energy use, both in degree and in type of fuel used.

The majority homes of the SEC as are we have seen mostly individual units (76.5%) rather than apartments and flats (23.5%). This is in keeping with trends elsewhere in Irish cities. However, as would be expected, this predominance of house-as-home is not evenly spread throughout the SEC area. In some parts of the city (the older parishes) multi-home units are in the majority. For example, in Eyre Square 58.6% of the homes are flats or apartments. St Nicholas, Salthill, Claddagh and Nuns' Island can all be considered to have significant levels of apartment homes. This will require specific recommendations in relation to energy saving opportunities, as retrofit measures for apartments are very different for those for houses. We address these in Section 6.

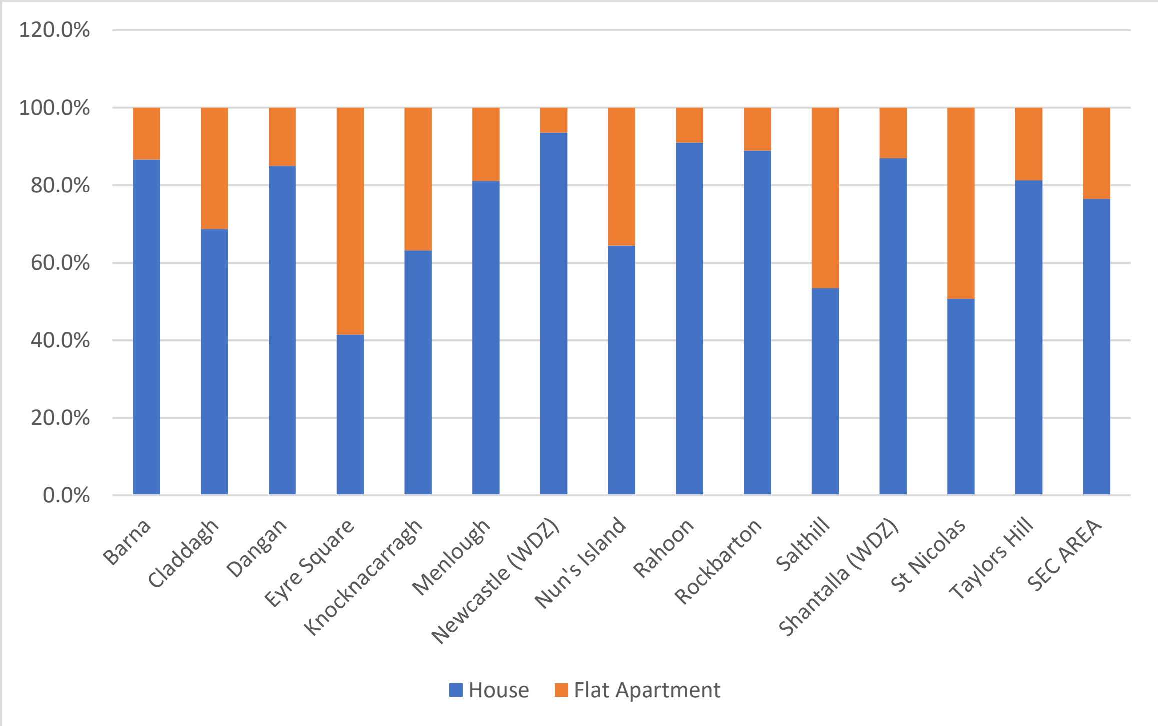


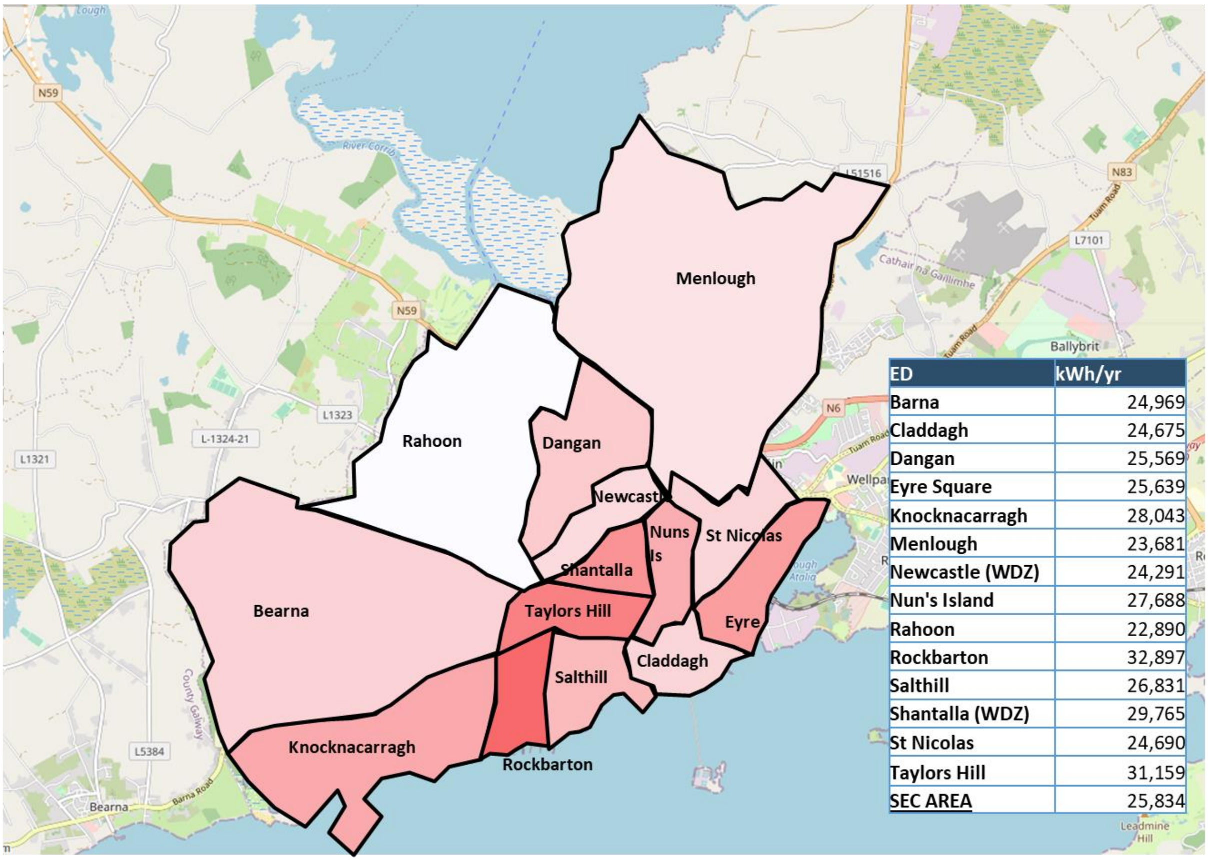
Figure 7: Apartments v Homes by Electoral Division

5.1.2 Home Energy Use

We adopted a number of approaches to achieve an estimation of the home energy use baseline for the SEC. We discuss our methodology and approach in Appendix Section 8.7.1.

We found that across the EDs there was an estimated 524,124 MWh of energy consumed between space and water heating, lighting, and appliances. Figure 8 shows that overall SEC area homes at 25,834 kWh/yr are above the National Average of 20,424 kWh/yr energy consumed per home[10]. Where we compare the average energy consumption across each Electoral Division in the SEC area, we notice a spread of energy consumption around the mean of 25,834 kWh/yr from a low in Rahoon at 88.6% of the mean to a high of Rockbarton at 127.3% of the mean.

[10] https://www.seai.ie/data-and-insights/seai-statistics/key-statistics/residential/



ED	kWh/yr
Barna	24,969
Claddagh	24,675
Dangan	25,569
Eyre Square	25,639
Knocknacarragh	28,043
Menlough	23,681
Newcastle (WDZ)	24,291
Nun's Island	27,688
Rahoon	22,890
Rockbarton	32,897
Salthill	26,831
Shantalla (WDZ)	29,765
St Nicolas	24,690
Taylors Hill	31,159
SEC AREA	25,834

Figure 8: Average kWh/yr Consumed by Homes in Electoral Divisions

5.1.3 Energy Use by Fuel Type in the home

CSO data provides a breakdown of the fuels used in home heating for each Electoral Division and thus for the SEC area as a whole. This is shown in Figure 9 below. It is clear that for the SEC home heating oil is the most common fuel, followed by electricity. Natural Gas is indicated as 6%, but this comes with a caveat[11]. Other is predominantly solid fuel in the form of coal and peat.

There is a wide variance across the Electoral Divisions. Oil use is highest as a proportion of all fuels in the newer areas with a more distributed settlement pattern. Close to the traditional city centre, electricity is more commonly used. Natural gas is not widely used at all – this despite the fact that it is a relatively cheap heating fuel and that it is less intensive in carbon emissions: the gas network does not cover the whole SEC area. This means that the recommendations in Section 6 will predominantly compare renewable options with home heating oil on a cost benefit basis.

[11] It is a feature of the CSO returns that some residents say they use Natural Gas even where this is not available. We assume that they intend to state LPG in gas cylinders.

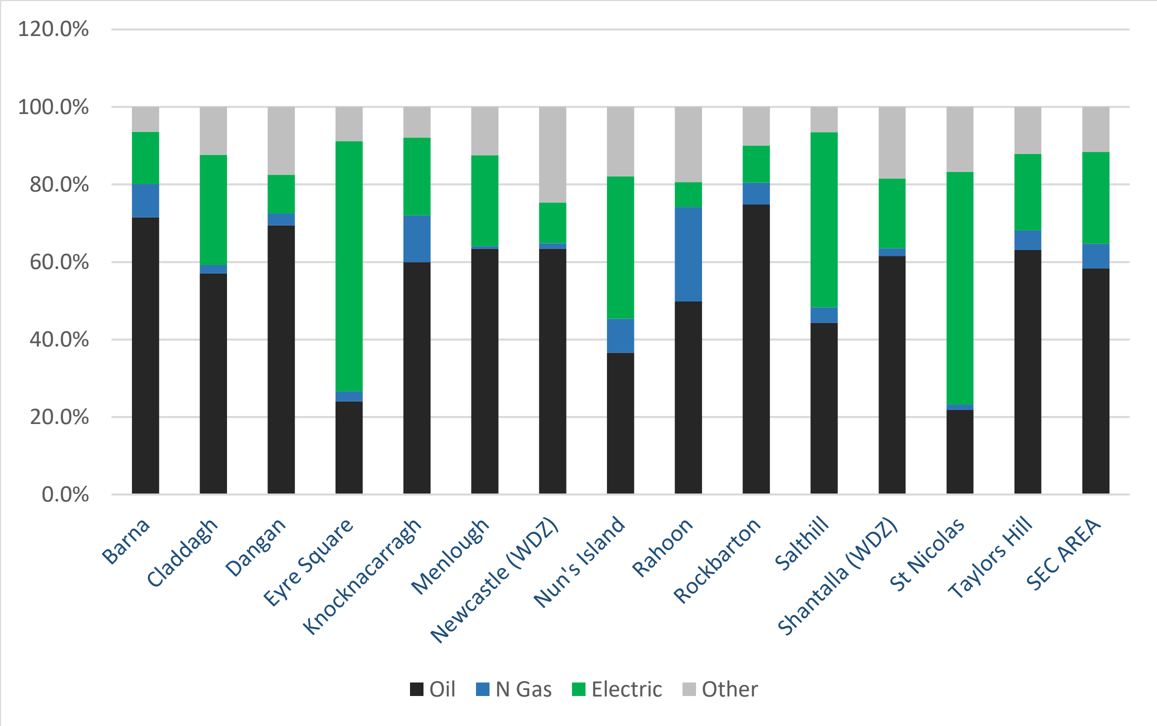


Figure 9: Home heating by fuel type

5.1.4 Total Energy Use in the home

We used a combination of the CSO data on home heating fuel with the results of home energy use for hot water and space heating and electrical use from the SEAI BER data (see methodology Appendix Section **Error! Reference source not found.**) to arrive at an e stimation of the fuel types used in the SEC.

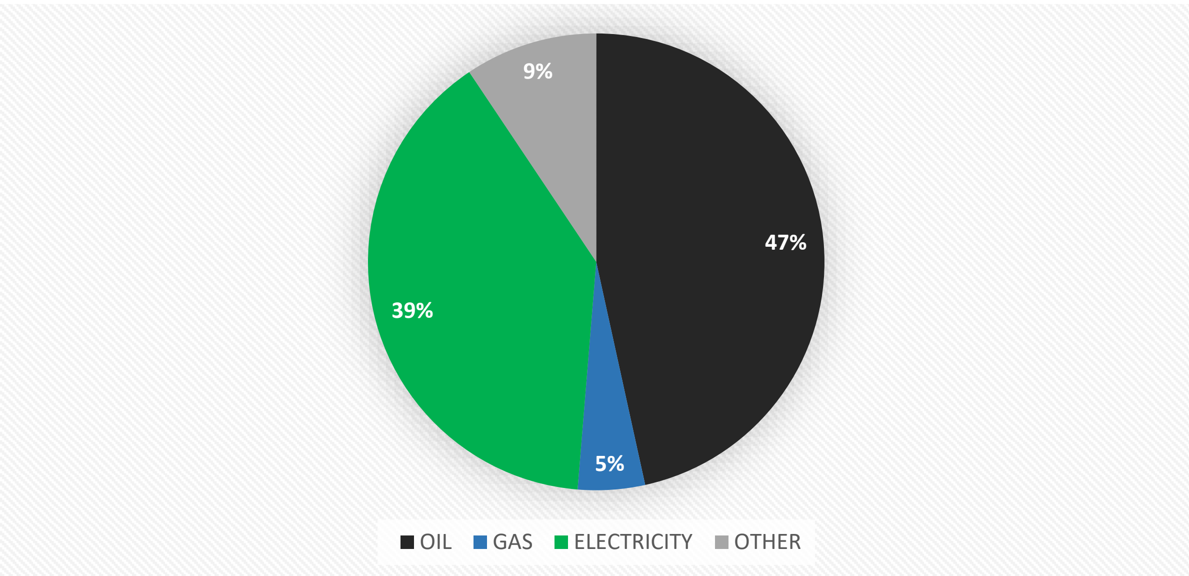


Figure 10: Fuel Use by type SEC Area

As we can see the fuel use is dominated by home heating oil and electricity. In the case of home heating oil this is due to its widespread use in central heating. Electricity use stems from space heating in some homes (particularly in the city centre), secondary water heating in most homes (the 'immersion') and lighting and appliances in all homes, and cooking in the vast majority of homes. We address costs and emissions below.

Broken down by Electoral Division in Table 3. we see that Barna has the highest overall energy use by far (given that it is the most populated ED this is unsurprising. Its relatively less dense settlement and building pattern does provide for micro-generation at the home level as will be seen in Section 6.1.4.2.

Table 3: Fuel Use by Electoral Division in kWh/yr

ED	OIL	GAS	ELECTRICITY (Heat)	OTHER	Total
Barna	80,927,980	9,684,925	44,449,792	7,310,157	142,372,855
Claddagh	13,819,223	512,649	12,612,371	2,986,735	29,930,978
Dangan	23,131,387	1,035,405	11,540,851	5,815,892	41,523,534
Eyre Square	7,195,620	770,959	25,537,679	2,646,960	36,151,218
Knocknacarragh	8,932,558	1,791,420	6,466,205	1,177,920	18,368,103
Menlough	24,189,744	236,312	18,709,894	4,747,721	47,883,671
Newcastle (WDZ)	9,458,441	209,258	5,377,372	3,682,933	18,728,003
Nun's Island	6,135,137	1,476,506	9,430,376	3,003,926	20,045,944
Rahoon	9,654,765	4,713,900	8,177,809	3,753,661	26,300,133
Rockbarton	12,328,115	918,347	5,047,141	1,641,893	19,935,497
Salthill	15,685,844	1,421,201	23,373,140	2,316,031	42,796,215
Shantalla (WDZ)	9,350,465	303,407	5,659,729	2,813,414	18,127,015
St Nicolas	4,933,545	322,292	18,208,878	3,793,127	27,257,842
Taylors Hill	18,141,041	1,456,781	11,310,789	3,490,776	34,399,387
SEC AREA	**243,883,866**	**24,853,360**	**205,902,024**	**49,181,146**	**523,820,396**

5.1.5 Carbon emissions from home energy.

We are able to calculate the emissions from home energy use by combining the total energy use in the SEC area in kWh/yr with data for Carbon emissions for each type of fuel in grammes of carbon dioxide per kilowatt hour (gCO2/kWh) We use the emissions values published by the SEAI[12].

We found (see Table 4) that domestic energy use in the homes of the SEC area as a whole is responsible for the emission of 157,205 tonnes of carbon dioxide per year. To put this level of emissions in context, for the SEC area, this level of carbon emissions represents the equivalent amount of CO2 that is offset by 11,228,928 10-year-old pine trees over a year.[13]

[12] https://www.seai.ie/data-and-insights/seai-statistics/conversion-factors/

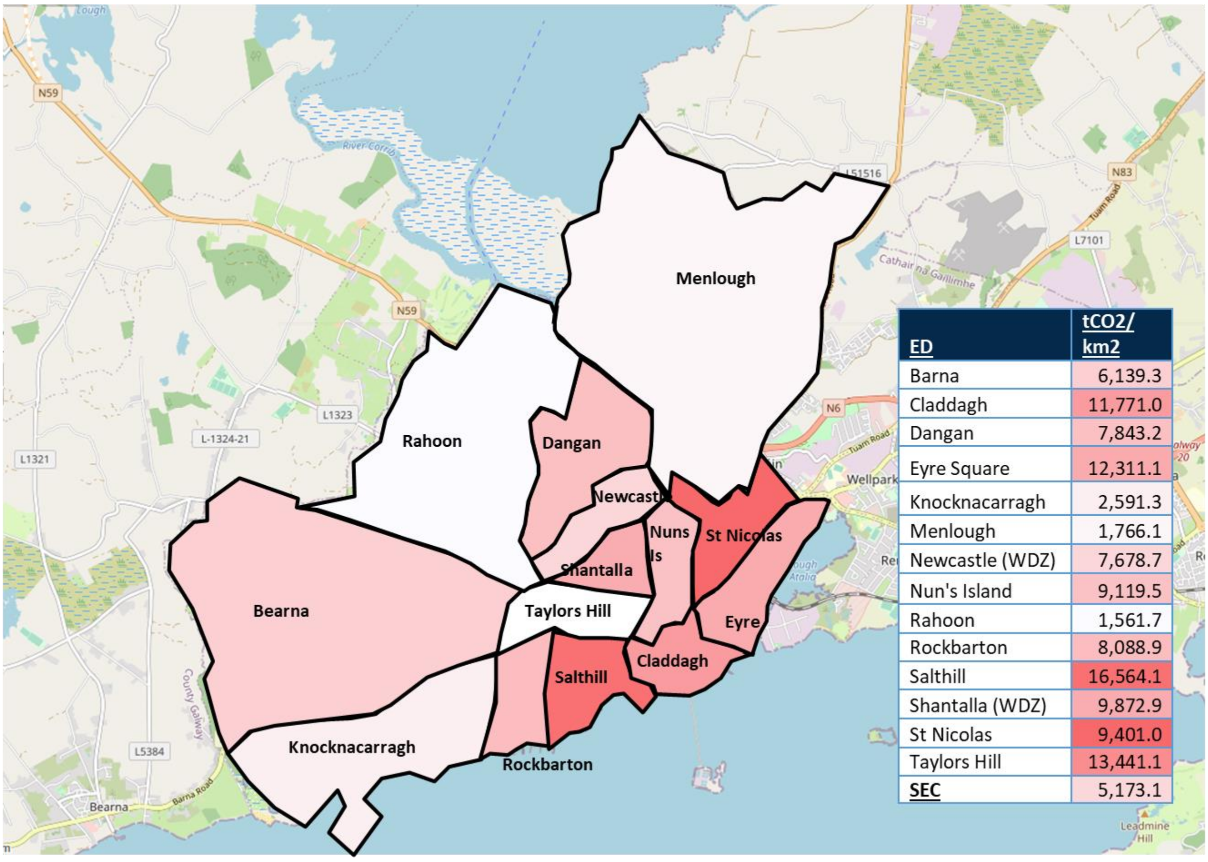
[13] A mature pine tree will sequester 14kg per year. The more mature tree is larger and will sequester more carbon than a young tree. https://www.treecouncil.ie/carbon-footprint

Table 4: Emissions from home energy use in SEC area in tonnes CO2 per year by ED

	tCO2					
ED	OIL	GAS	ELECTRICITY	OTHER	Total	Var above mean
Barna	22,142	1,965	14,686	2,587	41,380	119%
Claddagh	3,781	104	4,167	1,057	9,109	228%
Dangan	6,329	210	3,813	2,058	12,410	152%
Eyre Square	1,969	156	8,438	937	11,500	238%
Knocknacarragh	2,444	363	2,136	417	5,361	50%
Menlough	6,618	48	6,182	1,680	14,528	34%
Newcastle (WDZ)	2,588	42	1,777	1,303	5,710	148%
Nun's Island	1,679	300	3,116	1,063	6,157	176%
Rahoon	2,642	956	2,702	1,328	7,628	30%
Rockbarton	3,373	186	1,668	581	5,808	156%
Salthill	4,292	288	7,722	820	13,122	320%
Shantalla (WDZ)	2,558	62	1,870	996	5,485	191%
St Nicolas	1,350	65	6,016	1,342	8,774	182%
Taylors Hill	4,963	296	3,737	1,235	10,231	260%
SEC	66,727	5,043	68,030	17,405	157,205	

We show the level of emissions across the EDs in tonnes CO2 per km2 per year in Figure 11 which indicates Barna which is the highest emitting ED in total, is just 19% above the SEC average for the SEC as a whole[14]. On the other hand, the more densely populated Salthill (320% of mean) understandably has more emissions per square km. This will present challenges to overcome in the Register of Opportunities as there is an issue over restricted space for renewable energy sources to help reduce emissions. The WDZ EDs are above the SEC average in this measure with Newcastle +46% and Shantalla +88%.

[14] See Appendix Section 8.8 Table 26



ED	tCO2/ km2
Barna	6,139.3
Claddagh	11,771.0
Dangan	7,843.2
Eyre Square	12,311.1
Knocknacarragh	2,591.3
Menlough	1,766.1
Newcastle (WDZ)	7,678.7
Nun's Island	9,119.5
Rahoon	1,561.7
Rockbarton	8,088.9
Salthill	16,564.1
Shantalla (WDZ)	9,872.9
St Nicolas	9,401.0
Taylors Hill	13,441.1
SEC	5,173.1

Figure 11: Electoral Divisions by tonnes CO2 emissions per km2

5.1.6 Energy Use Cost

The SEC is estimated to spend a total of €97,673,042 on home energy (see Appendix Section 8.8 Table 27).

This would amount to €4,814.33 in total per household. This is more than the typical energy bill quoted elsewhere owing to a number of factors. The BER energy rating system does not directly reflect the energy use practice of individual householder who may choose to under (more usually) or overheat their home. The typical national figures that are often referenced relate to Natural Gas as the primary space and water heating source. Natural Gas has traditionally been a relatively cheap form of heating energy (currently it is at €0.15/kWh) For the majority of the homes in the SEC area Gas connections to the mains are not possible at this time. Therefore, more expensive and or less efficient heating fuels are used.

Solid fuel heating both drastically reduces a home's airtightness while at the same time delivering very poor typical efficiency - 20-30% for open fires. This means that to achieve the same level of delivered energy as a 1,000W electric room heater (costing €0.29 per hour to run) a fireplace will burn 3,000W per hour (costing €0.3585/hr) of fuel.

5.1.7 Energy in travel

There are a broad range of methods of travel available in the SEC area. It is serviced by public bus within the SEC and there is an intercity train available from the station at Eyre Square.

In this section we look at the domestic travel methods – namely walking, cycling and cars, but more specifically cars. Walking and Cycling produce no emissions and are largely free. We also discuss cycling in some detail in Section 6.2.2. We calculate emissions from the public bus service in Section 5.2.4.1**Error! Reference source not found.**. We will take note of e missions *avoided* by cycling and walking here, however.

We calculated (Table 5) from CSO 2016 and geographical data that there is a similar density of cars per km2 in the SEC as in Dublin County. In fact, a mix of dense urban centre, suburbs and some sparsely populated areas occurs in both Dublin County and the SEC area.

It is not realistic to see the SEC area driving patterns as being the same as for the rest of the county which is not densely populated at all and where journey distances will certainly be longer than in the SEC.

Table 5: Car Densities Compared[15]

Area	Area km2	Cars per km2
SEC	30	624
Dublin	971	579
Galway County	6,151	19.8
Ireland	70,273	32

Using this we can extrapolate the number and type of car fuel types in the SEC. Table 6 shows this broken down into Electoral Division.

[15] Drawn from https://statbank.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?maintable=THA17&PLanguage=0

Table 6: Car by Fuel Type per ED

No of Cars	Total	Diesel	Petrol
Barna	5,516	2,391	2,641
Claddagh	1134	492	543
Dangan	1512	655	724
Eyre Square	1269	550	608
Knocknacarragh	617	267	295
Menlough	1823	790	873
Newcastle (WDZ)	713	309	341
Nun's Island	659	286	316
Rahoon	1110	481	531
Rockbarton	592	257	283
Salthill	1450	629	694
Shantalla (WDZ)	563	244	270
St Nicolas	962	417	461
Taylors Hill	1046	453	501
SEC AREA	18,966	8,222	7,005

Diesel engines are favoured for their efficiency over distances, and CSO National Transport Omnibus found that diesel drivers (at an average of 19,681km/yr) usually drive further distances than petrol drivers (at an average of 12,113 km/yr)[16]

Thus, we can arrive at a solid estimation of kms driven, energy related carbon emissions, and costs from private domestic transport in the SEC area which we show in Table 7.

[16] https://statbank.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?maintable=THA17&PLanguage=0

Table 7: Cost and Emissions for SEC area Private Car Use[17]

Cars	Total Cost €/yr	Total Emissions tonnes CO2/yr
Barna	€6,326,595	11,982
Claddagh	€1,300,645	2,463
Dangan	€1,734,194	3,284
Eyre Square	€1,455,484	2,757
Knocknacarragh	€707,670	1,340
Menlough	€2,090,896	3,960
Newcastle (WDZ)	€817,778	1,549
Nun's Island	€755,842	1,432
Rahoon	€1,273,118	2,411
Rockbarton	€678,996	1,286
Salthill	€1,663,083	3,150
Shantalla (WDZ)	€645,735	1,223
St Nicolas	€1,103,369	2,090
Taylors Hill	€1,199,713	2,272
SEC AREA	€19,503,105	41,200

Private car related emissions in the SEC are estimated at 41,200 tonnes CO2/yr. This would need 2,928,571 trees to offset this amount of CO2 over the year (which does not take into account NOx from petrol that are very harmful to human health).

5.1.8 Total Baseline Energy Use Domestic Sector

We are now in a position to measure the total energy use for the residential sector in the SEC area.

We can see from Table 8[18] the SEC spends €117,176,147 on 642,787 MWh of energy per annum. This would generate 198,404 tonnes of CO2 in emissions: needing 14,171,714 trees to offset.

[17] Full data and calculations in Appendix Section 8.8 Table 29
[18] Full breakdown shown in Appendix Section

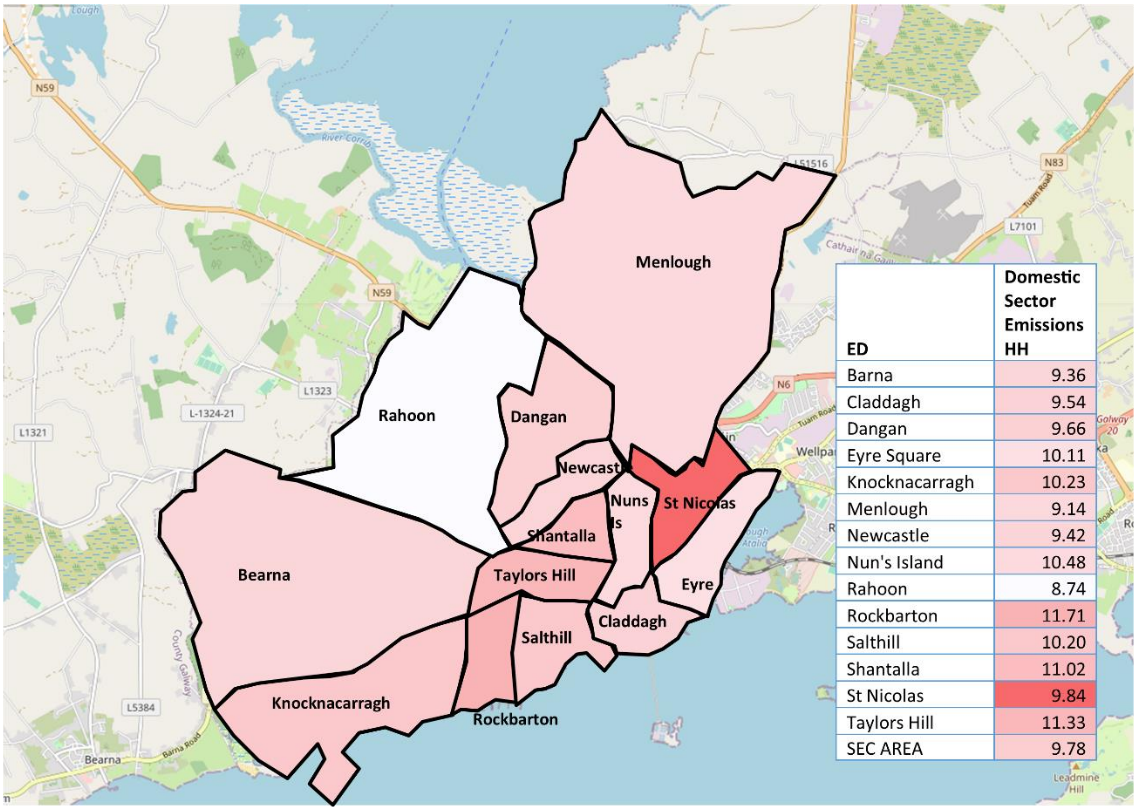
Table 8: Total Domestic Energy Use, Emissions and Cost by ED

ED	Domestic Sector Energy MWh	Domestic Sector Emissions t CO2	Domestic Sector Costs €
Barna	180,402	53,363	€30,839,763
Claddagh	37,749	11,572	€6,999,588
Dangan	51,948	15,695	€8,575,073
Eyre Square	44,900	14,256	€10,227,478
Knocknacarragh	22,622	6,701	€4,029,431
Menlough	60,452	18,488	€10,913,730
Newcastle **(WDZ)**	23,644	7,259	€3,932,084
Nun's Island	24,589	7,589	€4,809,426
Rahoon	33,953	10,040	€5,939,432
Rockbarton	24,017	7,094	€3,881,720
Salthill	52,793	16,272	€10,804,898
Shantalla **(WDZ)**	22,009	6,708	€3,741,916
St Nicolas	33,890	10,864	€7,528,612
Taylors Hill	41,611	12,504	€7,203,011
SEC AREA	**642,787**	**198,404**	**€117,176,147**

In terms of emissions Figure 12 shows the level of emissions per household (HH) by Electoral Division. It ranges from mean of 9.88 for the SEC as a whole to a high of 16.61 tCO2 per HH in St Nicolas' (168% of average) to a low of 6.75 tCO2 per HH in Rahoon (68% of mean).

We surmise that this is due to the fact that Rahoon had the highest proportion of BER A2 rated homes at 9.7% of all BER homes (the average for the SEC was 2.2%).

The Westside DZ Electoral Districts performed spread across the mean in terms of energy costs as well as tonnes CO2 in annual emissions. Newcastle was 95.3% of the average in terms of tCO2 and 86.9% of the average annual energy costs per annum, while Shantalla was 111.5% of the average in terms of tCO2 and 104.7% of the average annual energy costs per annum.



ED	Domestic Sector Emissions HH
Barna	9.36
Claddagh	9.54
Dangan	9.66
Eyre Square	10.11
Knocknacarragh	10.23
Menlough	9.14
Newcastle	9.42
Nun's Island	10.48
Rahoon	8.74
Rockbarton	11.71
Salthill	10.20
Shantalla	11.02
St Nicolas	9.84
Taylors Hill	11.33
SEC AREA	9.78

Figure 12: Emissions per household for EDs in tCO2

5.1.9 Sustainability of Domestic Energy Sector

The data indicates that the SEC area produces more CO2 emissions than it can offset. The carbon offset footprint of the SEC area would require an area of 7,873 hectares (78.73 km2) of tree planting. The SEC is 30.39 km2 in area. Therefore, the area required for planting is 259% the area of the SEC.

The breakdown of fuel types is shown in Figure 13 showing that at present almost all of the energy consumed comes directly from fossil fuels. There is an imperative to reduce energy use as much as possible before looking to replace the fuels used by electricity.

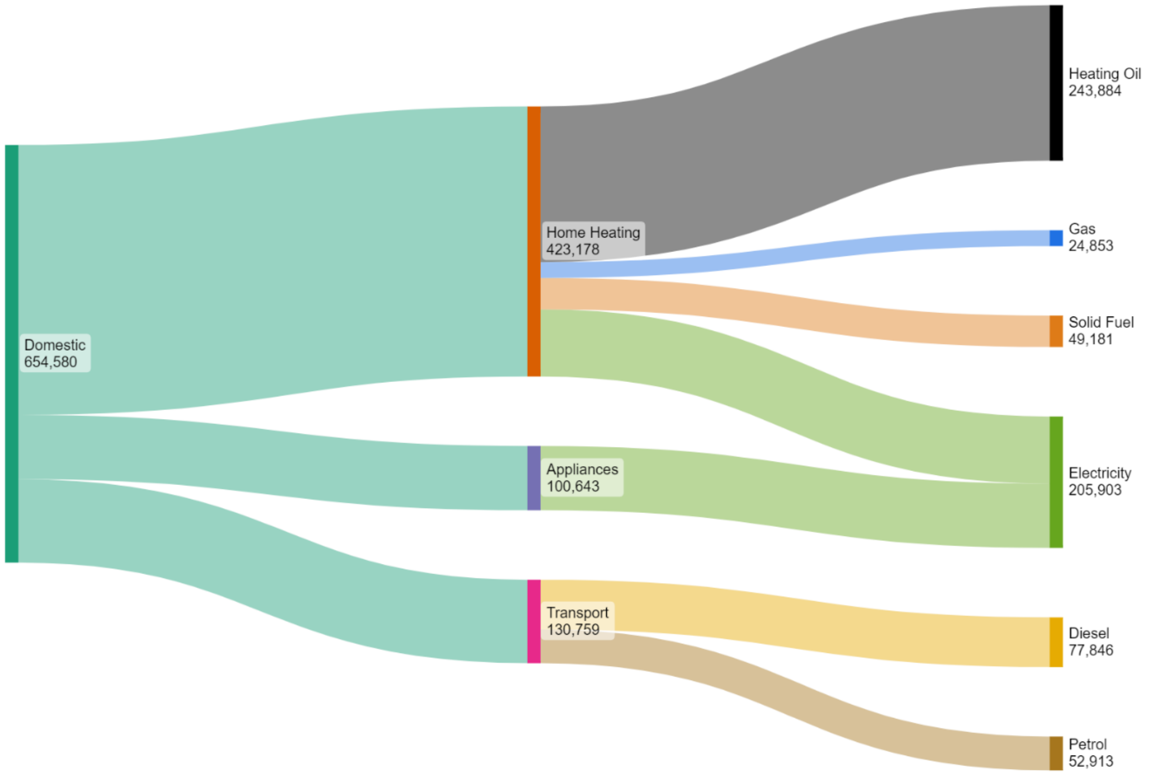


Figure 13: Sankey Graph of Domestic Energy Use by Fuel Type[19]

[19] Sankey Graphs were built using [Sankeymatic]

5.2 Non-Domestic Energy Use and Emissions

Non-domestic premises includes businesses of all sizes, community premises such as centres and sports clubs, as well as schools, and public buildings. We examine their considerable contribution to the energy use of the SEC area.

5.2.1 Breakdown of Business Types

The CSO classifies business types in their BER statistics. We used these classifications to identify the number of businesses in the SEC area using Geocode data.

Table 9: Businesses in SEC area by CSO type

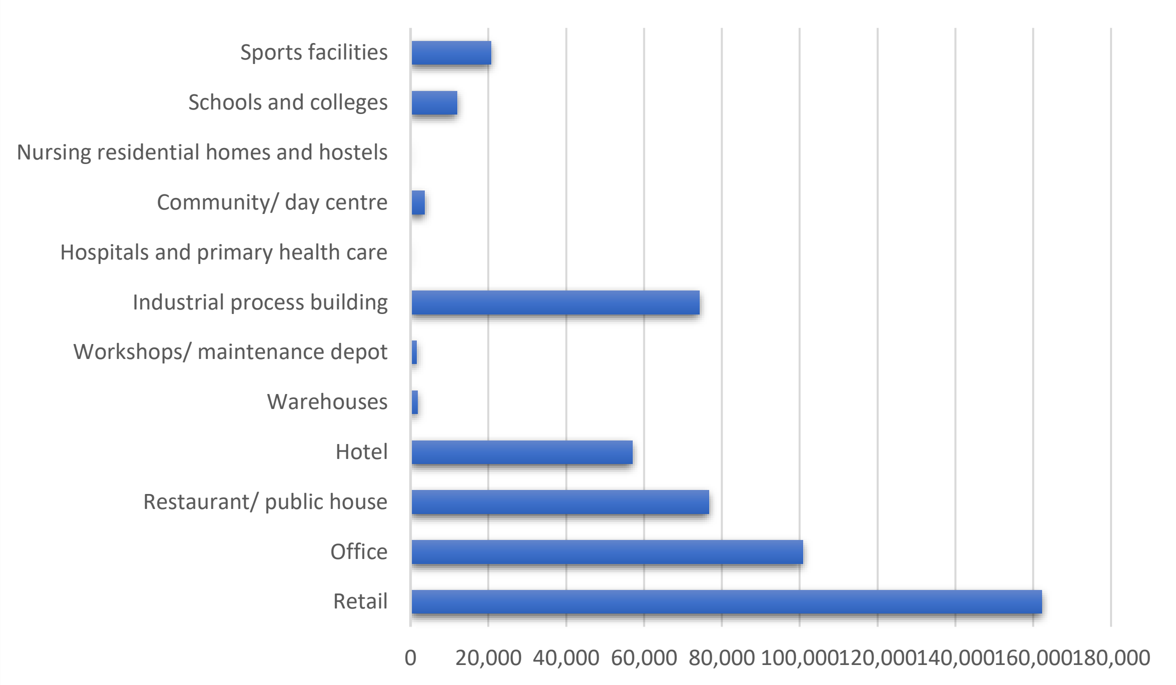
CSO Class	Number in SEC area
Retail	536
Office	465
Restaurant/ public house	313
Hotel	29
Warehouses	4
Workshops/ maintenance depot	7
Industrial process building	27
Community/ day centre	19
Nursing residential homes	0
Schools and colleges	36
Sports facilities	43

5.2.2 Energy Use

CSO publishes data on building energy use per m2 for each class of business as well as average building areas for each business type. This enables us to estimate the overall energy use for the SEC area's businesses.

There are an estimated 510,475 MWh of energy used in business premises in the SEC area (i.e., this excludes transport).

Table 10: Energy Use in Business in SEC area in MWh



See Appendix Section 8.8 Table 32 for detailed figures.

5.2.3 Non-Domestic Energy Use in Premises by Fuel Type

Different businesses use different forms of energy to meet their specific energy requirements. Combining data from the CSO on fuel use in Galway City[20] across the categories above, we can calculate this varying fuel source type across the categories of businesses in the SEC area.

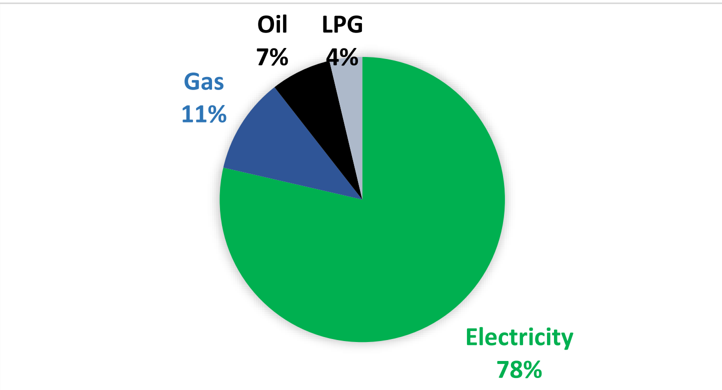


Figure 14: Non-Domestic Energy Use by Fuel

Table 11: Non-Domestic Energy Use by Fuel and CO2 emissions

Fuel	MWh/yr	tCO2
Electricity	401,211	139,621
Gas	55,385	10,246
Oil	34,966	9,091
LPG	18,913	4,161
Total	**512,642**	**163,120**

The contrast between non-Domestic energy use (not in travel) and that of domestic use is very clear in the greater use of electricity as a power source in the non-Domestic context.

[20] https://www.cso.ie/en/releasesandpublications/ep/p-ndber/non-domesticbuildingenergyratingsquarter32022/

Figure 10 above showed that oil provided 47% of the domestic energy demand and electricity 39%. This relatively high electrical demand in the non-Domestic sector in the SEC area (81%) will call for specific measures to be addressed in the Register of Opportunities specific to the commercial and community sector in Section 6.3 below.

In terms of emissions, the total for the non-Domestic sector (excluding transport) is 163,120 tonnes of CO2 or 83% of the domestic energy demand. This suggests that the homeowners' energy use is very significant in terms of emissions and needs to be addressed in tandem with that of the commercial and community sectors.

5.2.4 Energy in non-domestic transport

5.2.4.1 Bus Services

There are a number of bus services serving the SEC, run by City Direct and Bus Éireann. We have calculated their distance travelled at 1,077,896 km diesel use of 495,832 Liters and emissions of 1,309 tCO2 based on 2019 values.

We note that Bus Éireann has since then deployed Hybrid buses over its entire Galway fleet[21]. This has had significant reduction of on the consumption of diesel and the emissions of the Bus Eireann run routes (70% of distance travelled and thus emissions). Bus Eireann has said that it has achieved 415,000 zero emission kms between Galway (40 buses) and Limerick (21 buses). This would suggest on the face of it that 273,900 of these are on the Galway routes which would mean a possible avoidance of 333 tonnes of CO2 from the Galway routes (a 25% reduction on the 2019 figure)

5.2.4.2 HGVs, PSVs, Tractors and Machines

From a combination of CSO census and transport omnibus data (2019) we have estimate the amount of diesel consumed in the SEC area by goods vehicles (accounting for varying size of goods vehicles), tractors, machines and small PSVs (Table 12)

Table 12: Non-Domestic Transport Fuel Use (excluding buses)[22]

	Goods vehicles	Tractors and machinery	Small PSVs[23]	All Transport
SEC	4,130	1,097	197	5,423
Average km	-	17,066	40,504	-
Total km	91,355,658	18,713,901	7,962,506	118,032,066
L/100km	-	12	6	-
Total Liters	14,413,971	2,245,668	477,750	17,137,389
Total MWh	144,140	22,457	4,778	171,374
Total CO2	33,296	5,187	1,104	39,587

[21] https://buseireann.ie/pdf/1681208987-ANNUAL-SUSTAINABILITY-REPORT-2022.pdf
[22] See Appendix Section 8.8 Table 35: Goods Vehicles Calculations for calculations.
[23] Taxis and minibuses

Certain forms of commercial transport are readily open to electrification (thus being zero emission). It is very feasible today to use an EV for small PSVs (taxis, minibuses). Bus Éireann has also shown that plug in hybrid buses function well in the SEC area. This means that today 6% of the calculated emissions for 2019 in the SEC's commercial transport sector are open to electrification (including hybrid buses). This does leave a large amount of emission not immediately and seamlessly open to electrification. We will discuss this in the Register of Opportunities in Section 5.2.4.2.

5.2.5 Total Energy Use Non-Domestic Sector SEC Area

We can now state the estimated non-domestic energy use for the SEC area. This is 686,807 MWh energy per year (Figure 15). This reflects an energy consumption of 13.2 MWh per person per year (MWh/pp/yr) for the SEC area. This is close to the national average of 15.6 MWh/pp/yr[24]. It is 191.6% the MWh/pp/yr for Galway County, but this is unsurprising as the SEC is a services (Retail and Offices) hub for the County and the City. Thus there is a relatively high level of electricity use in the retail, food and accommodation, and services sectors in the SEC. The level of tourism and the presence of the retail service hubs of St Nicholas, Eyre square and Westside Shopping centre are clearly significant.

[24] See Appendix Table 37

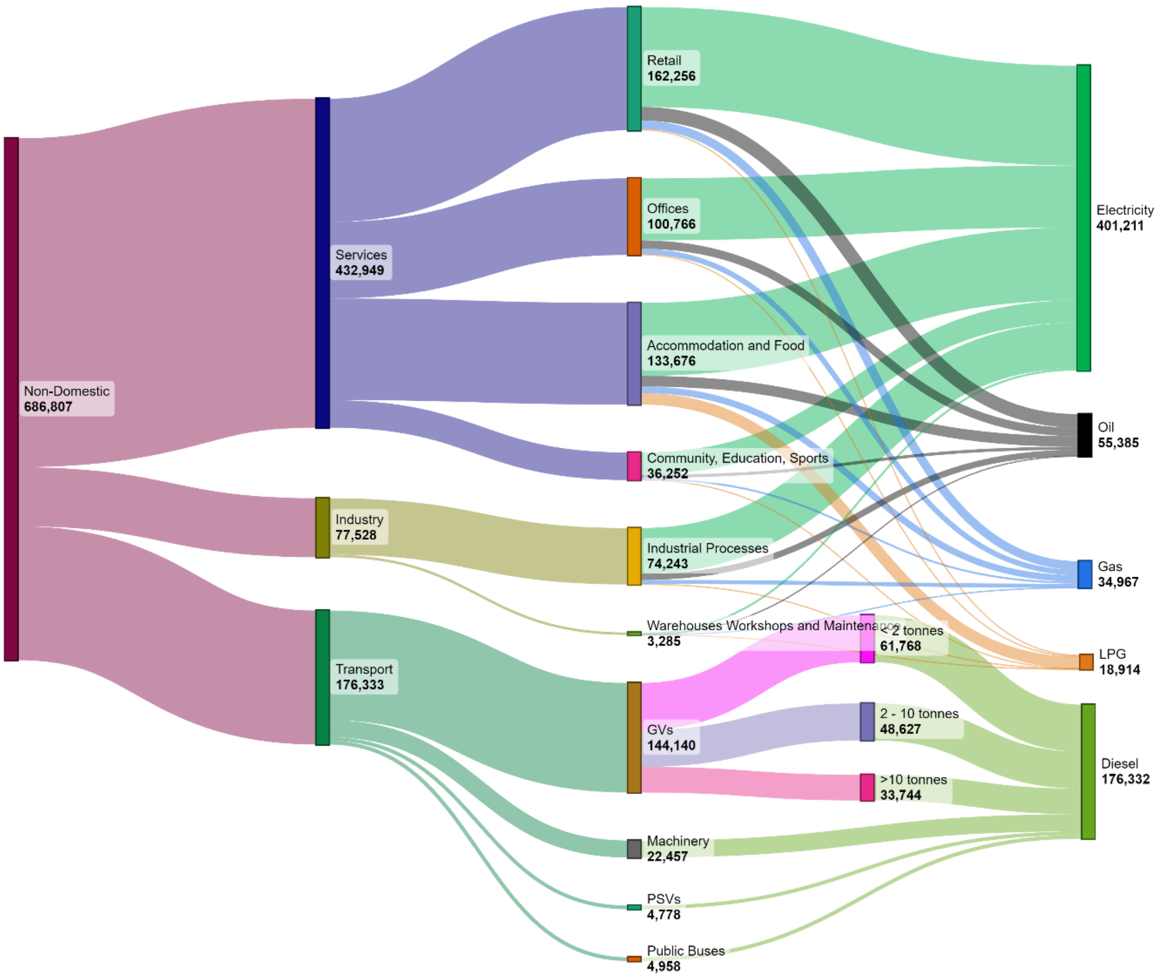


Figure 15: Sankey Graph of Non-Domestic Fuel Use by Sector

5.2.5.1 Non-Domestic Carbon Emissions

As we can see from Figure 16 the majority of commercial/community CO2 emissions come from electricity. This is due to two factors: firstly, the SEC area's retail and services businesses use more electricity than other forms of energy. Lighting, equipment, and refrigeration in services use large amounts of electricity. There is a relatively high carbon intensity of Ireland's electricity (330.4 kg CO2/MWh). Some of the electricity use is open to decarbonisation but opportunities are site specific. We discuss these opportunities in Section 6.3.

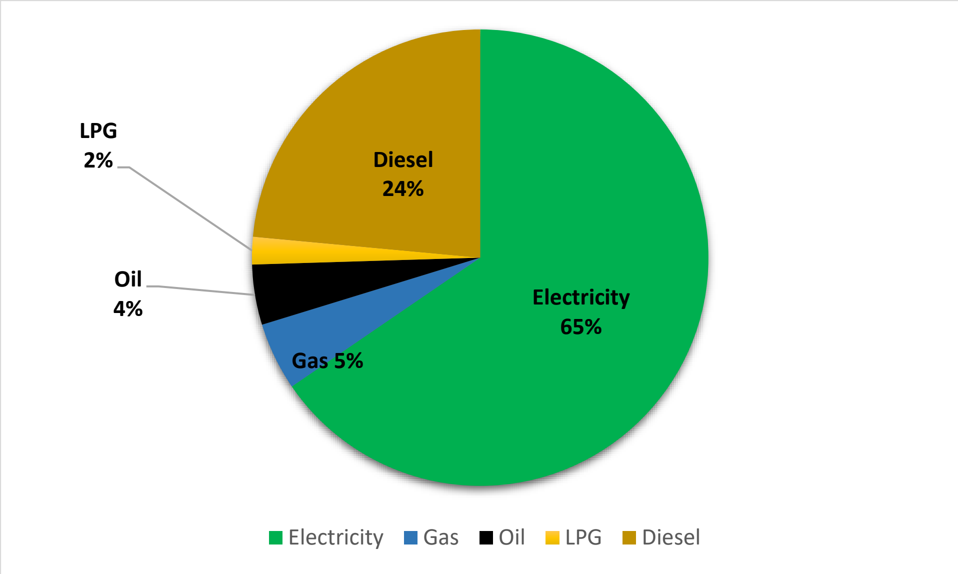


Figure 16: Non-Domestic Energy CO2 Emissions

5.3 Aggregated Energy Use by Energy Source

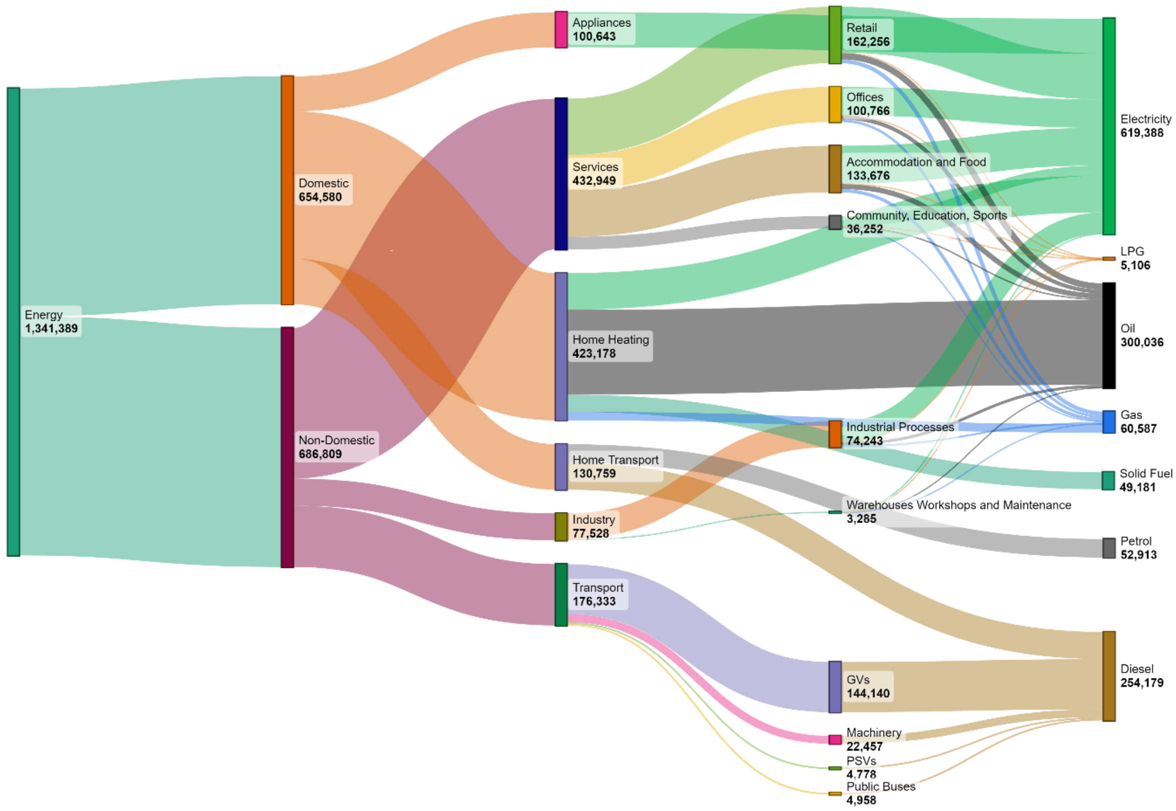


Figure 17: Sankey Graph Showing Breakdown of Fuels Across All Sectors

Across all sectors Figure 17 shows that Electricity is the greatest energy source (42.6%). Achieving efficiencies in electricity will not be straightforward: most modern electrical appliances are generally high efficiency as standard. Most homes and businesses have already switched to energy efficient lighting also. Electrical heating can be made more efficient using retrofits, but the highest electrical energy use for heating in the SEC is in the EDs of Eyre Square 64% and St Nicholas 60% (see Figure 9 above). These are areas of historic urbanisation with many of the buildings of heritage significance. They are also often multi-occupancy. All these facts will make retrofitting efficiencies reducing electricity use difficult to achieve. The density of building and limited suitable roof-space in these areas will reduce the opportunities for PV deployment. This means that some of the largest domestic grid electricity uses in the SEC are not amenable to direct reduction and replacement at the local level – which is probably a swiftly achievable decarbonisation opportunity in other SECs. The cost and carbon intensity of electricity is a national level issue. There will certainly be a rapid reduction in the carbon intensity of grid electricity here with the role out of grid scale PV and offshore electricity which is targeted to be 80% of all electricity by 2030 in the National Development Plan 2021-2030[25]. Notwithstanding recent developments[26], we can be sure that there will be a reduction over time from the current carbon intensity of Irish grid electricity which is currently 0.3304 kg CO_2/kWh. This is 118% of that of oil and 139.6% that of natural gas in the home). As large-scale renewable projects come onstream – in particular offshore wind, this will have the effect of largely decarbonising the electricity used in the SEC.

With great advances made in photovoltaic (PV) technology, government policy, and system economics[27], there will also be opportunities to produce renewable electricity at the local SEC level. These opportunities will be more suited to certain building contexts. Space, orientation, building ownership patterns, and energy use will be critical to the feasibility of PV deployments. We provide an estimate of PV potential to reduce grid electricity use in Sections 6.1.4.2 and 6.5.2.

Home heating oil for the large residential sector in the SEC is also significant and represents 20.8% of the areas total energy use. It is concentrated in use at the domestic level (87% of all heating oil use). It does present a strong opportunity for energy use and emissions reduction as the required interventions are technically well proven. These measures are initially costly, but they are well supported by grants, they have clearly defined payback periods, and they provide comfort and health benefits beyond the positive sustainability impacts. The recommendations to reduce the 6% of the SEC's energy in the form of gas will be the same as those for oil.

[25] Department of Public Expenditure, 2021, National Development Plan 2021-2030 https://www.gov.ie/en/publication/774e2-national-development-plan-2021-2030/
[26] https://www.irishtimes.com/environment/climate-crisis/2023/06/07/esb-switch-from-coal-to-oil-at-moneypoint-power-plant-will-drive-up-emissions-environmental-group-warns/ (subscription required)
[27] These are discussed throughout the document below.

The diesel use of 254, 179MWh (18.9% of the total) in the SEC that we see in Figure 17 is from goods vehicles, at 69.4%, and domestic vehicles, 30.6%. It will be possible to decarbonise the domestic portion with a switch towards battery electric vehicles. Advances in efficiency, cost reduction and most of all range, have been made to make this a firmly feasible option. Increased public transport use as facilities improve as directed by government policy use[28] will also assist in this.

The diesel use of goods vehicles will be harder to reduce under current technology conditions (although the this will develop in the next few years). Electric Goods Vehicles (GVs) under 2 tonne weight are on the market and so with supports and in the right conditions, the 42.9% of the diesel use they represent can be decarbonised in the short to medium term.

GVs above this weight are not readily on the market. There are a number of technologies that are in development fuel cell vehicles (FCVs) that use hydrogen as their energy storage are in development and Galway University and the wider community are involved in significant demonstration projects at an EU level that seek to address this[29]. This portion of the overall diesel use (58.1%) and the fossil fuel use of the SEC as a whole (6.1%) will be difficult to decarbonise in the medium-term, however.

The petrol use for private cars is a relatively small portion of the SEC's energy use (3.9%). It can be readily reduced using EVs. While the carbon intensity of grid electricity at 330.4g CO2/kWh as noted above is higher than that of petrol at 251.9g CO2/kWh, Internal Combustion Engines (ICEs) have an average efficiency of only 30%. This means that a petrol engine produces 831.27g CO2 per kWh delivered. The petrol vehicle also produces this CO2 and other particulate pollution at street level in densely populated areas. The recommendations in Section 6.2 will discuss costs, benefits, and potential synergies in EV adoption.

Solid fuel use makes up a relatively minor component of the SEC's energy use (3.7%) it is almost the same as that of petrol cars. The good news is that solid fuel reduction and replacement measures are much cheaper and more easily achieved than BEV adoption. Replacing fireplaces with stoves is cheap and will achieve considerable energy savings straight away.

[28] Climate Action Plan 2021, p148, envisages a 500,000 increase in non-car journeys https://www.gov.ie/pdf/?file=https://assets.gov.ie/224574/be2fecb2-2fb7-450e-9f5f-24204c9c9fbf.pdf#page=null
[29] For example Galway Hydrogen Valley and GH2 projects.

5.4 Carbon emissions

The non-domestic sector accounts for slightly more of the emissions of the SEC (52%) than the domestic sector (48%). Most of this comes from the electricity that is used. As stated before, the Irish electricity system is carbon intensive. We still have coal burning at Moneypoint Power Station. It is expected that as Ireland moves towards achieving its 2030 target of producing up to 80% of our electricity from renewables (overall, during 2022, gas generated 48% of the total electricity used in Ireland, with wind energy contributing 34% and coal providing 9%).

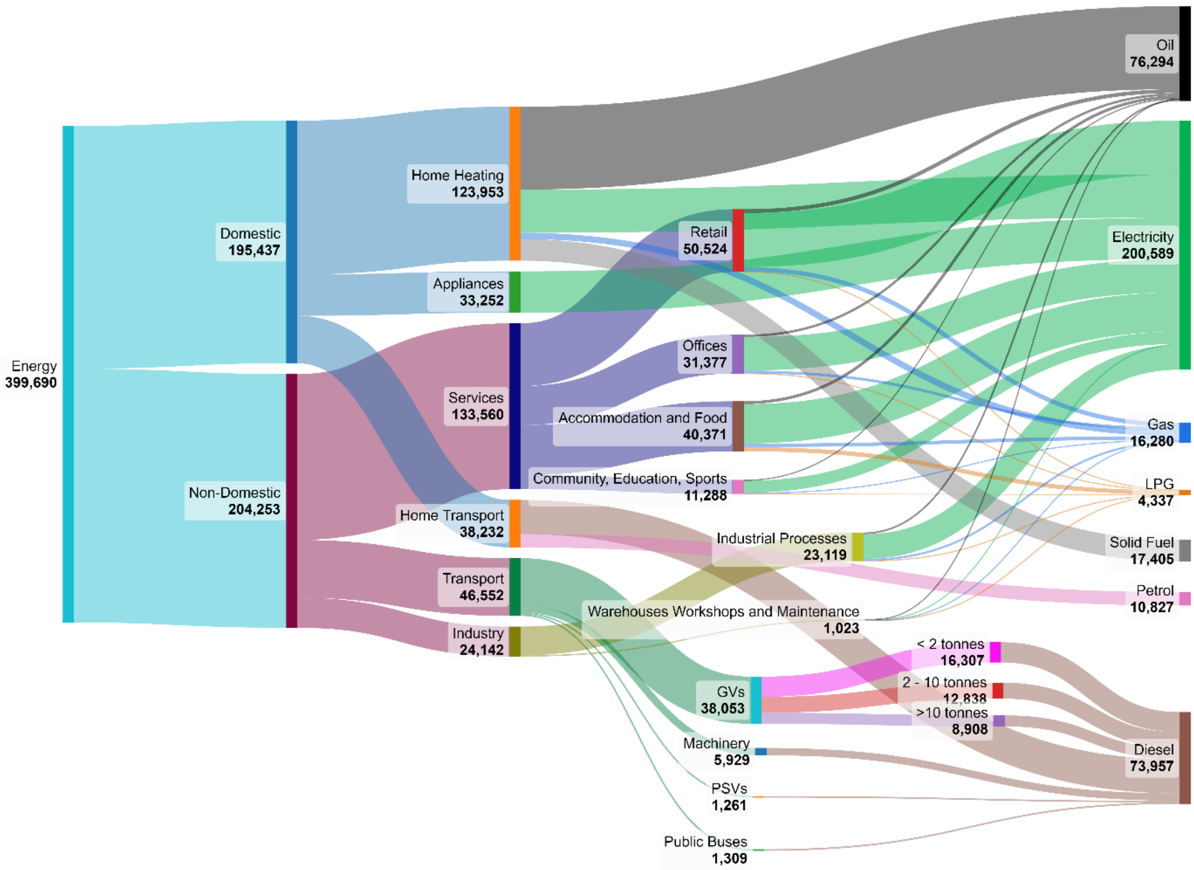


Figure 18: Total SEC CO2 Emissions by Sector t CO2

We can expect that decarbonisation of the Irish electricity supply will have significant beneficial effects on the SECs carbon emissions from electricity. In calculations we retain the electricity carbon intensity values of 2019, but in our recommendations, we stress the overall benefits of moving in as far as possible towards switching from fossil fuels to electricity in most situations.

5.5 Costs

Costs of energy usage in the SEC are broadly aligned between the residential and the non-residential sectors. Indeed, costs of transport are also aligned in both sectors (Figure 19)

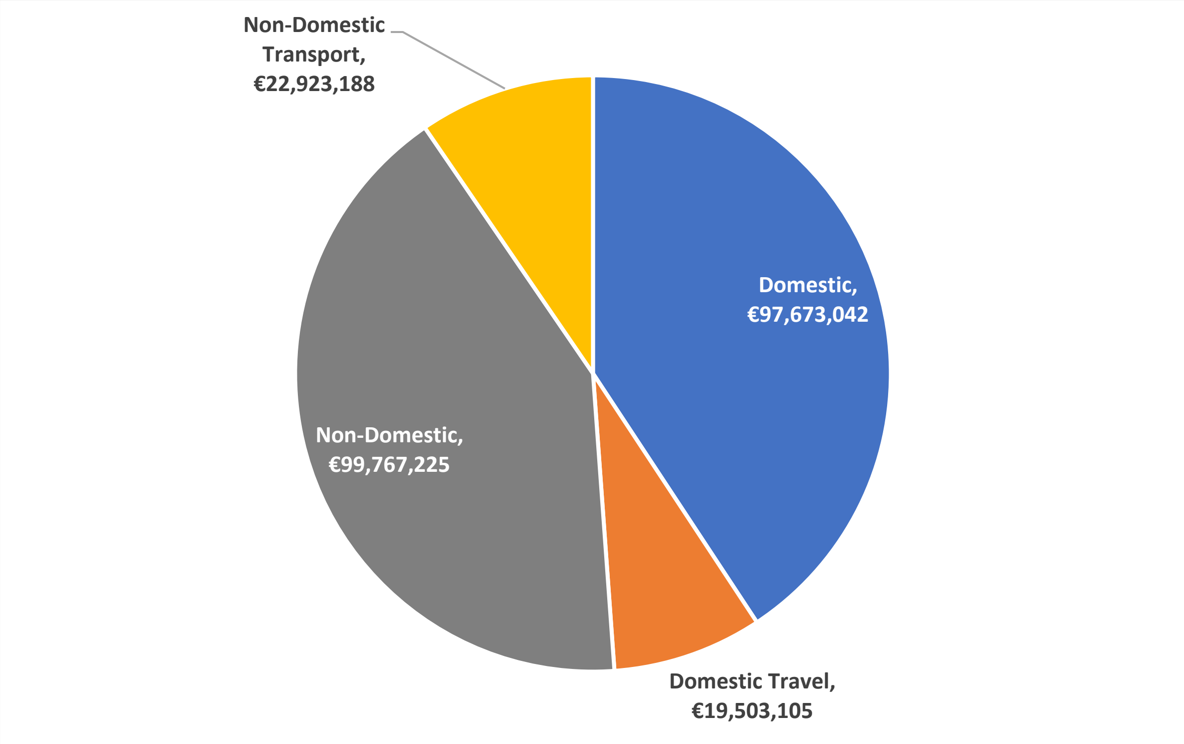


Figure 19: SEC Energy Costs by Sector €

The energy source spend is heavily weighted towards electricity (and this is using 2019 benchmark values). Diesel is the second largest source of energy costs – the majority of these will be in long distance HGV use, with light goods vehicles also contributing. Heating oil, which is a very avoidable cost when the correct building efficiency measures are taken, cost the SEC an estimated €32m. Most of this falls on the domestic sector where it represents an after tax expenditure. We focus many of our recommendations in Section 6 on reducing this cost.

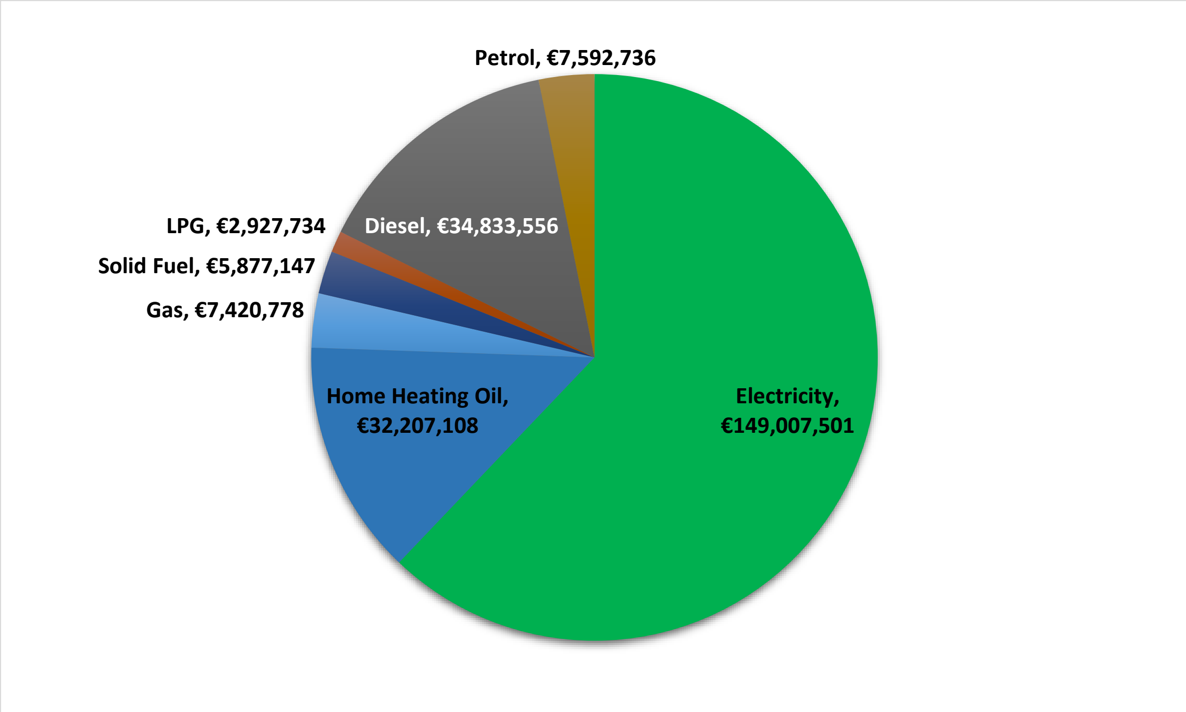


Figure 20: SEC Spend on Fuel by Type €

6 Registry of Opportunities

This is an assessment of the means by which the SEC can achieve efficiencies to reduce energy demand as well as take up renewable energy generation opportunities. These opportunities are summarised in Section 7.1.

6.1 Domestic Level Retrofits

We lay out a range of opportunities for homeowners and community residents to demonstrate how they can increase their levels of sustainability: by improving the degree of energy efficiency of their homes, assisting transport choices that will be less carbon intensive as well as simple behavioural changes that can reduce their imported fossil fuel dependency. We will also discuss how they can engage in micro-generation at the home level.

6.1.1 Behaviour change efficiencies

While we are all aware of the scale of the environmental challenge that faces our communities, it is critical that we as citizens are also aware of our own role in addressing that challenge. Research shows that what we do at home can help guide us to taking bigger, more noticeable community actions:

> *Individual behaviour creates the foundation for action in social, economic, and environmental sustainability, and potentially guides our ability to work with one another to make life-affirming decisions. In short, it is a matter of aligning our day-to-day behaviours with our well-stated values that will result in greater sustainable community action.*

Pappas & Pappas (2014)[30]

We present a list in Appendix, Section 8.1, of some quite simple actions that the homeowner can take to reduce the level of energy use in their own home with just behaviour changes. We summarise the highlights here:

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[30] https://files.eric.ed.gov/fulltext/EJ1060565.pdf

Cost reduction measures:
- Change your energy provider.
- Consume less electricity and bottled gas, and more oil to heat your home and water.
- Consider switching to smart or night meters: but be aware this should be accompanied by only using immersion, washing machines and dryers between 11pm and 7 am.

Home Improvement Measures:
- Track down and eliminate draughts: check windows, external doors, vents, floor spaces, fireplaces, and stoves.
- Install a stove instead of an open fireplace.
- Check insulation levels in attic, basement, walls (including the meter box), and floor spaces.
- Check your boiler and stove is serviced.

Energy Reduction Measures:
- Switch to more efficient appliances and lower temperature settings
- Don’t use standby on devices and turn off lights when possible.

6.1.2 BER

Achieving energy efficiencies through building upgrades and behaviour change are the key to reducing the cost of energy and the carbon emissions in this sector.

We identified opportunities for efficiencies in the homes of the SEC by conducting BER surveys of homes to establish levels of efficiency and across the domestic built environment and then providing each sampled home with a roadmap of measures to move them from their base level efficiency to B2 minimum.

6.1.3 Sample Homes

We advertised for SEC residents to volunteer for a free BER and Home Energy Upgrade report through advertisements in the Galway Advertiser. We recruited 21 homes whose homes were surveyed by SEAI registered BER assessors. The assessors provided home owners with a set of recommended upgrades which could be carried out to improve the energy efficiency and comfort of their homes. A sample of such a report (which is found in the accompanying Register of Opportunities Document which is a live excel report to which other homes can be added) is shown below (Table 13). In the sample, the BER Assessor identifies 8 measures which, when completed in order, will bring the home’s BER from an F-rating with potential energy costs of €6,410.45[31] per year to an A2-rating with potential energy costs of €1,071.47. This is a potential 83% reduction of energy costs. The report also indicates the reduction of carbon emissions achievable. In this case, post works the CO2

[31] BER is a hypothesized energy consumption for the dwelling and does not reflect he actual energy bill – simply what the bill would be were the owner to heat the building to normal levels. It is quite possible the occupants due to economic pressures may underheat their homes.

emissions of the home would be reduced by 88%, or 9.66 tonnes which is the equivalent of carbon sequestered by 609 mature trees annually.

We produced 21 such reports each representing a home type in the SEC area. These are included in the RoO.

Supported by

Table 13: Sample Energy Upgrade Report

	Total Building Area (m2):	**116.85**				**Dwelling Type**	**Detached Home – 2002 –Cavity Block**				
	Existing Heating System	**Cost when surveyed**		**Co2 Emissions**							**F**
	Heating Oil	0.139	€/kWh	0.257	Kg CO2/kWh						
	Element	BER Rating	Energy Value	Co2 Emissions	Potential Energy Savings	Total Annual Space Heating	Space Heating in Kw/hour	Heat Loss Indicator	Space Heating costs per year	Carbon Emissions	
			(kWh/m2/yr)	KgCO2/m2/yr)	€	kWh/yr		(HLI) w/km2			
	Dwelling Current Condition	**F**	**394.68**	**101.43276**	**€4,468.54**	**46,118**	**24.02**	**4.97**	€6,410.45	**11,852.42**	
	Element	BER Rating	Energy Value	Co2 Emissions	% Energy Saving	Total Annual Space Heating	Energy Requirement per hour for space Heating	Heat Loss Indicator	Space Heating Cost per year	Overall Carbon Emission KgCo2/Year	
			(kWh/m2/yr)	KgCO2/m2/yr)	%	kWh/yr	Kwh/Hour	(HLI)	€	KgCO2/year	
1	Upgrade Existing Windows to Achieve Minimum U-Value of ≤0.73 W/m²K	E2	363.39	93.4	**7.93**	42,462	**22.12**	3.91	€5,902.23	10,913	
2	Upgrade Original Walls to Achieve Minimum U-Value of ≤0.20 W/ m²/K	D2	285.5	73.4	**27.66**	33,361	**17.38**	3.25	€4,637.13	8,574	
3	Upgrade Original Wall Exposed to Garage to Achieve Minimum U-Value of ≤0.21 W/m² K	D2	270.59	69.5	**3.78**	31,618	**16.47**	2.8	€3,794.21	8,126	
4	Upgrade Extension Wall to Achieve Minimum U-value of ≤0.31 W/m²K	D2	265.26	68.2	**1.35**	30,996	**16.14**	2.2	€3,719.48	7,966	
5	Install 400mm Insulation on Flat Ceiling	D1	244.02	62.7	**5.38**	28,514	**14.85**	2.17	€3,421.65	7,328	
6	Improve Building Airtightness to Achieve ≤ 5m³/hr/m2 & Block Existing Chimney	C3	224.59	57.7	**4.92**	26,243	**13.67**	1.99	€3,149.20	6,745	
7	Install Air To Water Heat Pump (HP) - Upgrade Heating Controls & Hot Water to Full Time & Temperature Control	B1	75.54	19.4	**37.76**	8,827	**4.60**	1.99	€1,941.91	2,269	
8	Install 2kW Photovoltaic system	A2	41.68	10.7	**8.58**	4,870	**2.54**	1.99	€1,071.47	1,252	
	* The Heat pump used in this Assessment is a Mitsubishi 6.00 Kw - The Heap Pump installed MUST be specified by the Installer and/or Manufacturer. A Heat Loss Indicator of <2.0 is required										**A2**
									Carbon Dioxide Savings per year	**9.66**	**Tonnes**
									Equivalent Planted Trees	**690**	**Trees**

6.1.4 Typical Retrofit Measures

The recommended works are based on a fabric first approach. That is, improve the energy efficiency of the building by sealing off drafts and increasing insulation. It is typical in an energy upgrade to exchange stoves for fireplaces or to block up the chimney altogether. These measures have the immediate benefit of sealing off a major source of drafts. Improving seals to doors and windows is also an excellent first step. Insulation should be installed from the top of the house downwards. Felt or fiberglass insulation should be laid in two layers with opposite direction. If using fibrous insulation, do not store items on the insulation that would compress it. If you use the attic for storage, you should probably use in-rafter insulation.

Flat roofs can be insulated with purpose manufactured insulation boards. These are typically thicker than 150mm, the key is to achieve a thermal value (U-values) of 0.16 W/m2K for ceiling level insulation or 0.20 W/m2K for rafter insulation. Insulation should be installed by a professional who will guarantee that there will be no gaps between insulation material joins.

Many homes built pre 2007 will probably need external insulation. Nearly all in our sample of 21 homes did. This can be costly but will refresh and future-proof the home for years to come adding to its value as well as saving energy, money and reducing carbon emissions.

Windows and doors upgrading were recommended in most of our audits. Again, these are costly but are often necessary to reduce drafts and loss of heat from thin glazing. It would be essential that you discuss whether you need to upgrade windows to achieve the necessary fabric level.

A reduction in what is known as the 'Heat Loss Indicator' (HLI) is required. This is a measurement of airtightness. In all but exceptional circumstances, an HLI of less than 2 is needed before a heat pump can be installed.

6.1.4.1 Heat Pumps

We recommend a switch to air-source to-water heat pumps (ASHP)(explained more fully in Appendix Section 8.6.1) in all retrofitting projects. This will reduce the amount of energy required to heat the home. Heat pumps have an efficiency of 3:1 which means that for every kWh of electricity is put into the system, 3kWh of heat are produced. Heat pump technology is now very advanced and reliable. There are well over 55,000 heat pumps installed in Irish homes, and the Climate Action Plan outlines plans for 400,000 heat pumps in existing Irish homes by 2030. As a solution to the country's heating needs, heat pumps, in particular ASHPs are a recommended route. They are particularly recommended in areas where there is no gas grid. The economics of the ASHP are very favourable in comparison to an oil alternative.

The cost of installing a heat pump varies from home to home quite considerably. We have done assessments of typical costs however and on the homes in our survey, the typical cost was €12,500. However, an Apartment can qualify for a €4,500 grant from the SEAI and a

Semi-Detached/End of Terrace/Detached/Mid Terrace house a grant of €6,500 towards the cost of an ASHP.

6.1.4.2 Domestic PV

In many of the Upgrade reports, we were able to recommend domestic PV installations (after fabric and heating system upgrades are completed). This will have the benefit of reducing the amount of electricity the home will consume after the heat pump insulation. It will also decarbonise the electricity consumed by the home. The current carbon intensity of electricity in Ireland is 330.4g CO2/kWh (more than home heating oil), though this will change as more grid scale PV and offshore wind comes into operation.

A domestic solar PV system consists of a number of solar panels mounted to your roof (or in your garden or adjacent field) and connected into the electrical loads within your building. PV systems are rated in kilowatts power (kWp[32]). A 2kWp solar PV system would require 5X400W solar panels on a roof, approximately 10m^2 in area.

Summary

Provided inputs:	
Location [Lat/Lon]:	53.275,-9.069
Horizon:	Calculated
Database used:	PVGIS-SARAH2
PV technology:	Crystalline silicon
PV installed [kWp]:	2
System loss [%]:	14
Simulation outputs:	
Slope angle [°]:	35
Azimuth angle [°]:	0
Yearly PV energy production [kWh]:	1814.98
Yearly in-plane irradiation [kWh/m^2]:	1117.33
Year-to-year variability [kWh]:	77.29
Changes in output due to:	
Angle of incidence [%]:	-3.18
Spectral effects [%]:	1.82
Temperature and low irradiance [%]:	-4.2
Total loss [%]:	-18.78

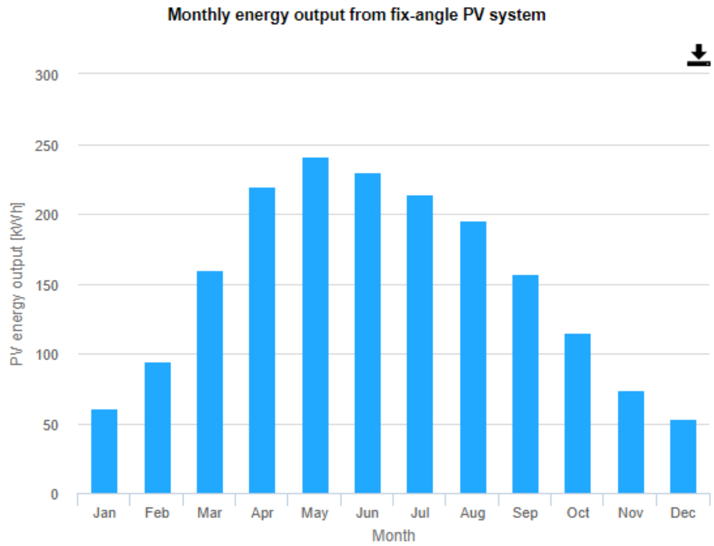


Figure 21: PV output from 2kWp Installation in Shantalla, Galway

A roof mounted 2kWp PV system on a south facing roof in Shantalla will produce 1,815 kWh per year. The average B2 house in Shantalla (in the WDZ) consumes 4,737 kWh of electrical power in a year for lighting, appliances and cooking[33].

Since a consumer today pays approximately €0.433 per kWh to their electricity provider, a 2kWp PV panel (if the home is occupied during the day and 50% of the electricity is consumed in the home) will save the homeowner €392.94 per year. There would also be an

[32] kilowatt peak power: a system that delivers one kilowatt. Over one hour at *maximum* output it will produce 1 kWh

[33] Though not at the times shown in Figure 21 – PV output is highest in the daytime during summer. Electricity consumption is typically highest at night during the winter.

additional payment from the Clean Export Guarantee (CEG) (of approximately €190.57 per year in this case) On an installation costing €5,000, this would achieve a simple payback of 5.4 years if the installation qualified for a grant.

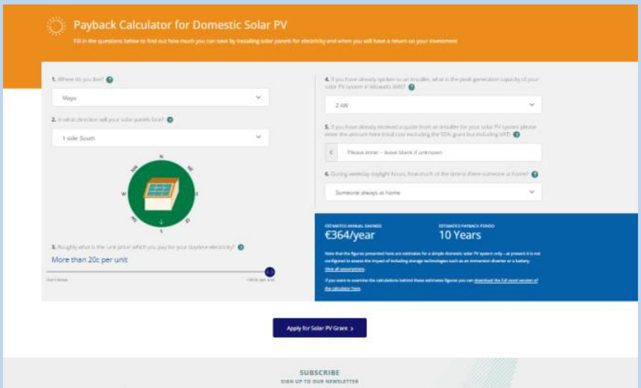
There is a significant grant incentive available from the SEAI for PV installation for homeowners. The full details are available[34] at this link.

Table 14; SEAI PV Grants for Homeowners

Value	Example
€900 per kWp up to 2kWp	€1800 for 2kWp solar panels
€300 for every additional kWp up to 4kWp	€2100 for 3kWp solar panels
Total Solar PV grant capped at €2400	**€2400 for 4kWp solar panels**

Excess electricity produced can also be stored in a hot water immersion tank or in a battery. The water tank should be well insulated and with a capacity of more than 250 litres – it can be installed at the same time as the PV. Batteries are most suitable for systems greater than 5 kWp and can cost up to €10,000. We do not emphasize their use in this report owing to the generally smaller PV installations we predict will be the norm here. Excess electricity can also be used to power a BEV that is parked during the day at the home. The CEG exports from the house into the electrical network on the road outside your home for an average price in 2023 of €0.21 per kWh. The best solution is to manage your electricity consumption (for example diverting power to the hot water tank, using the washing machine and dishwasher) to match the best PV generation times i.e., daytime.

[34] https://www.seai.ie/grants/home-energy-grants/solar-electricity-grant/



The SEAI has a useful Calculator that shows payback period for typical installations, customisable by county, size of system and retail price of electricity. It is available at this LINK

Economics of a 2kWp East-Facing System in Galway

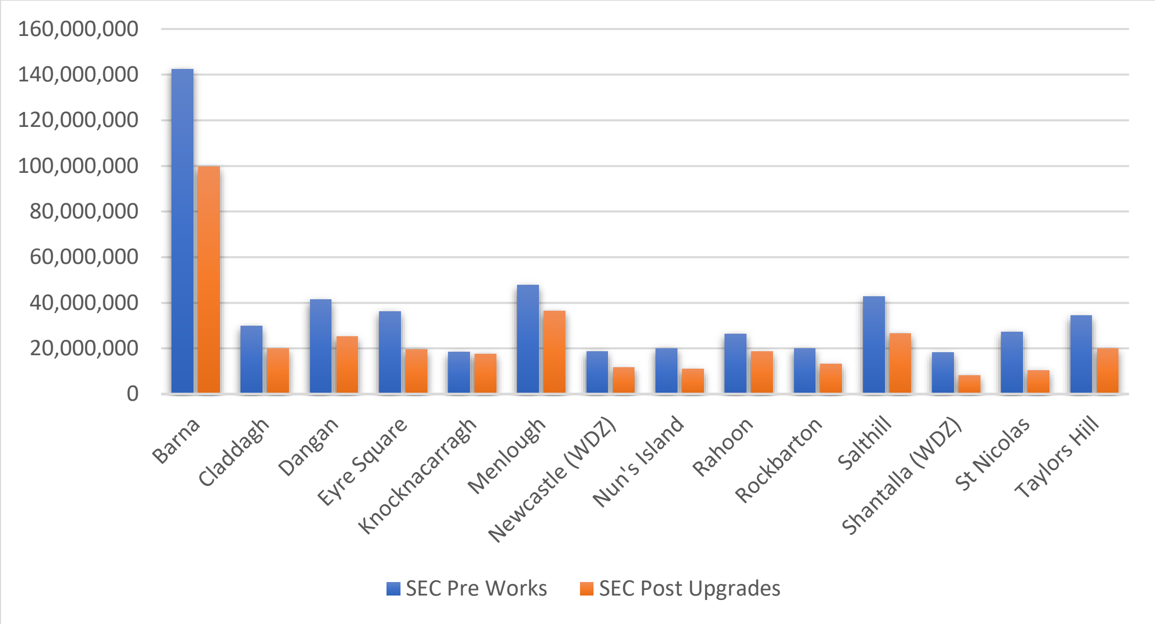
System Cost (with grant)	Annual Savings	Payback Period
€3200	€526/year*	6 Years

*It is not assumed that the homeowner will consume all the electricity. This is based on a cost of €0.43/kWh unit electricity – Electric Ireland's 24hr price 12.07.23.

6.1.5 Community Level Impacts of Measures

If we assume that the homes in the SEC upgrade from their current level to a minimum B3, we can make predictions on the effect this would have on the SEC's energy consumption and carbon emissions. We do not expect homes from B3-A1 to require retrofitting.

If all SEC homes were B3 or above (see Appendix Section 8.8 Table 38) we can expect a considerable energy saving dividend of approximately 185,678 MWh and home energy related emissions reductions of 50,801 tonnes of CO_2. The home energy use in the SEC would be reduced by 35%. However, some of this will be transformed from bought-in grid electricity to domestic-scale PV.



76% of the homes across the SEC are houses, with 24% apartments. If we assume that of these 70% will be able to accommodate 2kWp PV (all of the homes in our survey could whether they were detached, semi-d, end of terrace, of mid terrace). This means that of the 4,746 houses, 3,322 will be able to install on average 2kWp. With 50% with south-facing roof space and 50% east-facing roof space this would produce approximately 5,552 MWh of zero carbon electricity. This will save approximately 1,834 tCO2.

The sustainability effect of such carbon reduction will be the equivalent of the amount of carbon sequestered by 131,000 mature conifers.

6.1.5.1 Westside DZ Retrofits

In homes from the two Electoral Districts in the WDZ, there would be an average per home energy use of 14,218 kWh/yr, a reduction of 47%. The carbon emissions post retrofits would be on average 3.39 tCO2 per home/yr with a total reduction of 4,672 tCO2/yr across the DZ. The equivalent of carbon that would be sequestered by 333,714 trees per year: which would take up an area of 222 hectares as indicated below in Figure 22

Figure 22: 222 hectares in relation to Westside DZ area

6.1.6 Costs of measures

Our home surveys costed the retrofits, heating upgrades and PV installations using supplier information at the time the surveys were conducted (mid-2022). There has been construction inflation since then, but we include the 2022 figures here as useful indicators of the average costs of works. We cannot guarantee that these costs will be what a given homeowner will be quoted. The cost of works is site and contractor specific.

Table 15: Survey Homes: Type, Upgrade Cost €, area m2, Cost/m2

Current BER	House Description – Year – Construction Type	Costs	Floor area m2	Cost/m2
C2	Detached Dormer Bungalow – 2003 - Unknown wall construction	€58,864.25	235	€250.49
C2	Detached Home – 2002 –Cavity Block	€59,747.00	238	€251.04
D1	Detached House - 1970 - Cavity wall construction	€74,058.00	239	€309.87
C3	Detached House - 1999 - Timber frame construction	€74,449.00	214	€347.89
C2	Semi-Detached 2-Storey Dwelling– 1985 – Cavity Block	€29,875.47	82	€364.34
D1	Detached House - 1990 - Cavity wall construction	€51,584.00	138	€373.80
C3	Detached Dwelling– 1978 – Cavity Block	€76,905.45	200	€384.53
C3	Detached 2-Storey Dwelling– 1991 – Cavity Block	€124,024.63	318.8	€389.04
C1	Semi Detached Home – 1991 – Cavity Block	€63,610.00	140	€454.36
F	Detached Home – 2002 –Cavity Block	€64,785.80	117	€553.72
D2	Detached Home – 1973 –Cavity Block	€98,378.00	171	€575.31
E2	Detached Dwelling– 1850 – Stone	€116,711.20	201.41	€579.47
E2	Semi Detached Home – 1940 – Mass Concrete	€58,728.69	100	€587.29
D2	Semi Detached Home – 1990	€78,915.45	133	€593.35
E1	Mid Terraced Dwelling – 1932 –Cavity Block	€63,877.80	103	€620.17
D1	Mid Terrace Dwelling – 1973 – Cavity Block	€57,273.65	90	€636.37
E2	Detached Dwelling – 1976 – Unknown	€105,018.76	153	€686.40
C3	End of Terrace – 1984 - Unknown wall construction	€62,566.61	80	€782.08
E2	End of Terrace Dwelling – 1950 – Mass Concrete	€61,337.51	77.68	€789.62
	Median			€553.72

The costs for upgrades in Table 15 **do not include** the SEAI grant deduction. The grants are not paid out as a proportion of the total, rather than as a payment for measures carried out. The grant amounts per measure are listed below.

There is a wide range of costs per square metre the lowest price is 31% the highest, and 45% the median. There does not appear to be any strong correlation between age of build, starting BER, or construction type. We do not propose to draw any strong conclusions for the cost of energy upgrades across the SEC. However, the individual homeowner could benefit from comparing their own home with those surveyed.

6.1.7 Available Supports

Irish homeowners are relatively fortunate in the level of assistance that is available to them for energy efficiency upgrade works. We emphasise the benefits of collectively organised retrofitting works, although there is a guide to other supports in the Appendices.

6.1.7.1 Individual Level Supports

There are three categories of applicants to the SEAI Home Energy Grant Scheme[35] of which this is a brief summary. These are:

- Individual Energy Upgrade Grants towards the cost of various upgrades for a typical family home with SEAI grants
- One Stop Shop Service based on set grants per measure, this can be grant funded by SEAI 45 - 50% of the cost for a typical family home.
- Fully Funded Energy Upgrade for qualifying homeowners in receipt of certain welfare benefits.

These supports are discussed in greater detail in Appendix Section 8.5. There is also a full explanation of the schemes, grants, and levels of funding on the SEAI site here. We noted above that WDZ includes some areas of disadvantage. The individual level supports may not be enough to allow some homeowners to carry out the necessary upgrades. There are improved levels of supports for some qualifying homeowners (Section 6.1.7.3 below)

6.1.7.2 Community Energy Grants

The Community Energy Grants (CEG) scheme is a Sustainable Authority of Ireland (SEAI) scheme to achieve national retrofitting of community and SME buildings and homes. It provides capital grants for energy efficiency projects for communities throughout the country. The criteria for participating in CEG projects are that they must be community orientated with a focus on cross-sectoral approach. This means that they involve homeowners, SMEs and Community Buildings, and have inputs from private citizens, companies, community groups and if possible municipal and corporate bodies.

[35] Available at this link: https://www.seai.ie/grants/home-energy-grants/

There is a mandatory requirement for all projects to support **10 homes** for applications below €1M.

According to the SEAI, successful Community Energy Grant projects demonstrate some or all of the following characteristics.

- Community benefits
- Multiple elements, not a single focus
- Mix of sustainable solutions
- Innovation and project ambition
- Justified energy savings
- An ability to deliver the project

The types of measures that are targeted through the grant program are:

- Building Fabric Upgrades
- Technology and System upgrades
- Integration of renewable energy sources
- Domestic Combined Fabric Upgrade
- Single Building Demonstration projects will be considered under the Communities Grant

The EMP has therefore collected enough information from community buildings and homeowners to potentially bring together an application with a Community Energy Grant application specialist.

Table 17: CEG 2023 Funding Levels.

Non-Residential	
Type	Funding Level
Not for profit/Charities/State Schools with Charity Status*	Up to 50%
Private sector	Up to 30%
Public Sector	Up to 30%

* subject to prior written agreement with the SEAI's communities team

There is no cap or maximum grant amount permitted to homeowners for upgrade grants. The grants have fixed values for each energy upgrade. The total value of the grant depends on the type of house and what energy upgrades are carried out. It is estimated that to bring a standard detached home from an E to a B2 rating, it will cost approximately €45k but would qualify for a grant of €22.5k covering up to 50% of the costs.

6.1.7.3 100% Support Levels.

Some homeowners qualify for 100% grant funding for retrofits. These are homeowners in receipt of certain welfare benefits:

- Fuel Allowance
- Job Seekers Allowance for over six months with a child under seven
- Working Family Payment
- One-Parent Family Payment
- Domiciliary Care Allowance
- Carers Allowance
- Disability Allowance for over six months with a child under seven

We discuss the SEAI homeowner grants for individual homeowner applicants in Appendix Section 8.2.1.1.

A list of Community Energy Grant Project co-coordinators is available here:
https://www.seai.ie/grants/community-grants/project-coordinator/

6.2 Domestic Transport

There are a number of opportunities available to the residents in the SEC areas to increase the sustainability of their transport use.

6.2.1 Context

The National Climate Action Plan[36] states that there will be a 42-50% reduction in emissions from the transport sector by 2030 if Ireland is to meet its Climate targets.

To achieve these reductions, a transition towards more sustainable forms of transport is required, including safe and accessible walking and cycle routes to appropriate public transport links serving the needs of the residents, and the implementation of appropriate infrastructure to support the electrification of private cars.

The Climate Action Plan aims to encourage active travel (walking and cycling), with public transport being encouraged over the private car. The SEC area has real opportunities in these areas which are discussed below.

6.2.1 More Efficient Car Use:

As with individual actions to achieve home energy efficiency, there are actions the citizen can take to reduce the impact of their private car use. These are described in Table 16.

[36] https://www.gov.ie/en/publication/6223e-climate-action-plan-2021/

Table 16: More Efficient Car Use

Reduce the most inefficient journeys by car where possible
Save CO2 and money by sharing journeys on the mainland.
Plan ahead by combining trips (shopping, school runs etc.)
For cars that do not automatically turn off when idling, switch off if you will be stopped for more than 9 seconds
An energy-aware driving style can save 13% on fuel and emissions
Inflate tyres correctly to manufacturer's recommendation
Avoid harsh acceleration or heavy breaking also slowing down in good time saves fuel, smooth style around bends
Cars are parked 95% of the time, do you need a second car?
The sun-roof fully open consumes up to 4% more fuel, half-open - 3%
A roof rack can increase fuel consumption by 40% and a cycle rack with two bicycles by 10% - 15%
Use air-conditioning sparingly – it increases fuel costs
Rear screen heater's increases fuel consumption by 3% - 5%, so switch it off once the window is demisted
Front windows left half open consume more fuel at higher speeds so use the air vents instead
Do not carry unnecessary weights in the boot, clean it out!
The average new car emits 120g of carbon dioxide for every kilometre. SUV's can emit a staggering 330g carbon dioxide per km.
Consider joining a transport sharing group such as https://liftshare.com/uk/search/from/galway-ireland or **start one yourself**. TFI has an introduction as to how to go about this here: https://www.transportforireland.ie/wp-content/uploads/2021/06/Carpool_Guide_2019_compressed.pdf

6.2.2 Active Travel in Galway

The Active Travel/ Galway City Cycle Network includes infrastructure for walking e.g. pedestrian crossings, footpath; and for cycling e.g. cycle paths, cycle lanes, cycle parking. The provision of walking and cycling infrastructure, including the Galway City Cycle Network, is a key objective of Government policy – supporting access and permeability; providing opportunities for active travel and physical activity; and supporting climate action in our city. The Active Travel/ Galway City Cycle Network forms part of the Galway Transport Strategy (GTS), which was developed in partnership by Galway City Council, Galway County Council, and the National Transport Authority.

There has not been the same level of roll-out of cycle lanes in Galway as in other Irish cities. The medieval streetscape seems to have made accommodating cycle lanes in the narrow streets in the city centre problematic. However, even in areas where the roadway is wide, such as in Salthill promenade, lack of public and political support has restricted the installation of segregated cycle lanes.

There are cycle lanes in the Westside DZ, for example of Seamus Quirke Road, but these are not continuous and are fragmented which means that cyclists – especially young or those returning to cycling are nervous using them. This lack of a comprehensive cycle network will make increased cycling difficult. It is beyond the scope of this EMP to make design recommendations for upgraded cycling infrastructure. However, we note there are non-infrastructural interventions which the SEC could carry out that will have the effect of increasing active travel and reducing emissions.

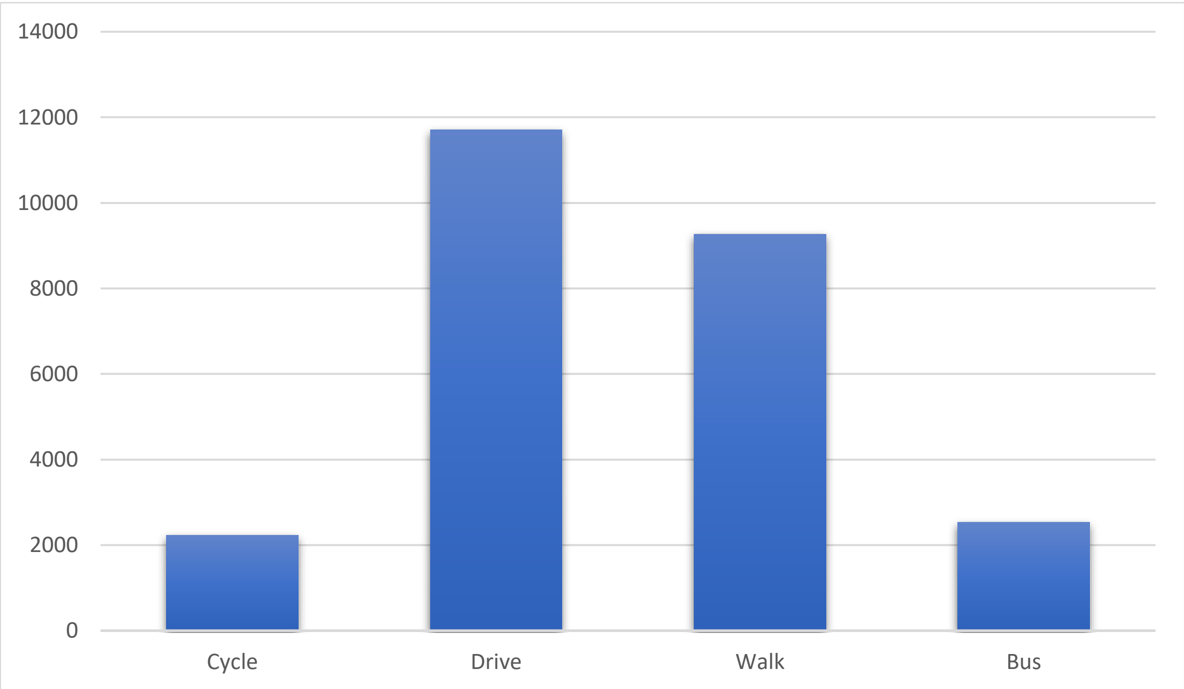


Figure 23: Means of travel to school, college or work

There are a surprising high number of people in the SEC who walk to work. Many of these (some 7,005 people - 40.6% of the area's commuters) live in the historic urban centre. In the Western side of the SEC which includes Barna and Rahoon there is a larger proportion of drivers (41.9%) and only 13.2% of commuters walk.

This should suggest that the more sparsely populated more recently (sub)urbanised areas of the SEC should be amenable to increased cycleways. The Barna to Claddagh roadway is not narrow and could well accommodate a dedicated cycleway – although public consultation will be key to acceptance and political support. Indeed, there a greenway planned for the route in the draft County Development Plan 2023-29.[37]

Reducing car journeys and increased cycling and walking cuts down on energy emissions. Shifting 1,000 people in the western half of the SEC (Knocknacarra, Barna, and Rahoon) from cars to non-motorised transport would remove 201,960 kg CO2 from the SEC roadways. This would be an 8.5% reduction of emissions from car commuting in the SEC.

It should be noted that providing infrastructure alone in the form of cycle lanes will not guarantee to get citizens to switch to cycling. Instead, infrastructure improvement and communication outreach should be combined. Mass marketing is simple, bureaucratically and politically impressive, but usually not very effective: people can resent being lectured at. Instead, peer-to-peer and norm-defining campaigns to specific target groups tend to be more effective. The SEC can therefore offer considerable parallel stimuli to increased active travel to that provide by the City Council on an infrastructural level. We propose partnership approach which recognises the on the ground strengths and citizen expert strengths of the former and the resources, policy authority, and engineering expertise of the latter.[38]

The Meitheal Rothair initiative in Westside should also be recognised as the engine to help drive the change in transport habits. It has the leadership and reputational resources necessary to carry out the identify receptive target groups and can help tailor the message to suit these targets.

As a priority, the SEC should partner with Meitheal Rothair to devise a campaign supported by the City Council to help switch 1,000 residents of Barna and Knocknacarra over three years to cycle commuting. This should be a holistic approach behaviour change approach leveraging norm definition through focussed interpersonal communication work synergising with Coastal Route Greenway planning.

There are a number of resources for cycling behaviour change campaigning. These are provided in the Resources Section 8.5 below.

[37] https://consult.galwaycity.ie/en/consultation/draft-galway-city-development-plan-2023-2029/chapter/volume-2-zoning-maps

[38] Although have to be quick to recognise that there is specialist engineering expertise in this very area on the SEC committee.

6.2.3 Electric Vehicles

The most sustainable car is the one you already own but that's kept parked up. However, cars are considered a standard necessity for modern life. In this section we identify opportunities available for drivers.

Replacement of diesel and petrol cars by Battery Electric Vehicles (EV) is a national policy aim in the medium term. The CAP targets 800,000 zero emission vehicles by 2030. There is even still however some slowness of car owners to buy in to this policy, particularly in the West of Ireland. It is important to note however, that battery range has increased rapidly in the past few years.

Many drivers are not fully aware of their typical driving ranges and see the standard EV range of 250km as not enough. Car use data does not concur.

2019 (i.e. pre-pandemic) car journey data from the CSO[39] shows that 79% of car journeys in Dublin were less than 8kms (we established in Section 4.2 above that the SEC as a densely populated urban area is more akin to Dublin in settlement and distribution patterns than Galway County). The distance from the West of the SEC (Cappagh Road) to the outer eastern limits of the city (roundabout at Oranmore) is 15kms by road and this will be reflected in commuting distances. This is backed up by 2016 Census data: across the SEC, for 72% of commuters, the average journey time is less than 30 minutes: we can assume that with rush hour city traffic this is within a distance of 8-15kms and thus well within the range of EVs. The generally occasional need for drivers to travel further than the standard 250kms range of an EV could be addressed in a variety of means – whether through car share or public transport using park and ride facilities.

It is possible for a person to track their actual travel times and distances over the course of a year using tools such as google timeline. We suggest that this could be promoted at transport workshops to illustrate quite how occasional a >250km car journey is for most people.

There are still state sponsored incentives for drivers wishing to switch to EVs (see Appendix Section 8.3) through the SEAI. The condition that these be new and of eligible make and model means that they start in price at €24,995, for the Fiat 500e, inclusive of the SEAI grant and VRT relief.

There were 2.3m private cars registered in Ireland in 2021. 104,932 new cars were registered in 2021. This indicates an approximate renewal of 5% of private cars per annum in Ireland. The replacement over time of 5% per annum of the ICE vehicle stock with EVs in the SEC area would have a significantly positive effect on emissions and reduced fossil fuel imports. In effect reducing vehicle emissions by 40% in 2030.

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[39] CSO, 2021, Travel Behaviour Trends 2021, https://www.cso.ie/en/releasesandpublications/ep/p-ntstb/travelbehaviourtrends2021/distanceandduration/#:~:text=The%20average%20journey%20distance%20in,the%20same%20period%20in%202019.

6.3 SME Level Efficiencies and Retrofits

There are SEAI supported programs to assist SMEs identify where they can reduce their energy demands and fossil fuel use. These are outlined in Appendix Section 8.4.

We conducted surveys of 9 SME and community buildings in the SEC area. The details of these surveys have been provided to the businesses themselves, but we summarise the central findings in Table 17

Table 17: Sampled Non-Domestic Energy Savings Summary

Type	m2	Potential Savings kWh	Cost Savings	Cost of measures €	Payback (yrs)	CO2 reduction kg
Workshop	232	7,589	€2,542.08	€13,150.00	5.2	2,639
Hotel	9,700	2,012,819	€267,230.00	€940,000.00	3.5	319,477
Café	65	6,385	€2,084.00	€12,550.00	6.0	2,376
Shop	136	4,297	€2,132.00	€3,750.00	1.8	4,297
Restaurant	735	53,926	€20,111.00	€51,900.00	2.6	18,755
Sports Club	675	18,947	€3,489.00	€34,900.00	10.0	4,849
Sports Club	252	15,963	€2,737.00	€26,950.00	9.8	4,548
Shop	8,502	106,984	€36,925.00	€62,500.00	1.7	37,209
School	874	54,145	€7,341.00	€116,800.00	15.9	15,167

As we can see that the payback for nearly all of the SMEs and community organisations was less than 10 years. In the case of the school, the 16-year payback period looks quite long term. However, the measures recommended were primarily fabric improvements to an old, historic building which will improve its thermal efficiency for the next fifty or so years.

There are a great many SMEs in the area that qualify for the SEAIs supports – that is they are independent businesses, or they are public bodies with a floor area less than 500m^2 and spending less than €10,000 per year on energy.

From our buildings survey we have identified that there are approximately 610 SME offices, 313 restaurants and bars, 29 hotels, and 565 retail businesses that would qualify under the SEAI Energy audit scheme. It is recommended that these building owners/managers apply for assistance in a batched process whereby energy efficiencies and sustainability measures can be identified and carried out.

While the examples in our audits showed very significant cost and energy reductions, a more typical energy review can achieve energy savings of 20-30%.

The actions recommended as opportunities are not technically challenging, they are proven measures such as installing the right insulation, replacing oil and gas boilers with heat pumps, and installing correctly sized and sited PV panels, as well as simple, very cheap context specific measures.

Most SMEs receive a grant for energy audits. SEAI's Support Scheme for Energy Audits (SSEA) will offer SMEs a €2,000 voucher towards the cost of a high-quality energy audit. In most cases, this will cover the total cost of the audit. The SSEA is a much more detailed review of your energy use than a domestic level audit. An SSEA runs to 40 plus pages, involves site visits and a close look at energy bills. There is a template for the report here.

6.3.1 Typical efficiency measures

Table 18 shows an extract from an anonymised energy report from one of our participating SMEs. It shows a summary of the measures that are typically recommended.

The SME is at its busiest during the day, and in fact over the summer months. By sizing the PV appropriately, and due to the size of the onsite electricity consumption, the payback for the PV was calculated as extremely favourable. However, although this is the 'big ticket' item, even a cost-free measure such as increasing the MIC[40], provides savings.

Table 18: RoO for SME Example 1 in the SEC

Priority	Opportunity	Capital Cost (€)	Annual Cost Savings (€)	Annual Energy Savings (kWhs)	Annual CO_2 Savings (kg/Year)	Simple Payback Period	BER
	Current		-	-	-	-	D2
1	Increase MIC		686.73	-	-	-	D2
2	Upgrade Lighting & controls	5000	2,228.59	6,187.10	2,152	2.2	C1
3	Install 7-day timer on drinks fridge	500	1,972.10	5,475.00	1,904	0.25	C1
4	Install Night Blinds on refrigerated cabinets	4000	4,417.49	12,264.00	4,265	.9	C1
5	PV Installation	22,400	10,806.00	30,000	10,434	2.07	B3
All	Totals	31,900	20,111.00	53,926	18,755	2.6	B3

[40] See glossary

There are no fabric recommendations in this particular report. The building was found to be in good condition with upgraded glazing already installed. The inspectors found that the BER would be upgradeable to B3 without major building work. Notice that upgrading lighting & controls and installing night blinds on the fridges, despite their technical simplicity and relatively low-cost would provide significant savings (33% of overall energy savings) with a low payback period.

The EMP Registry of Opportunities document provided to the SEC in parallel to this report includes details of energy efficiencies, upgrades, and retrofits that can act as a model for many of the non-domestic buildings in the SEC area. It is proposed that the SEC engage with the relevant groups and stakeholders to hold information workshops that will make the potential savings of energy and carbon emissions reductions apparent.

6.3.2 Summary of available supports for non-domestic energy users.

This section is a brief summary of the supports available to non-domestic building owners and there are more resources in the Appendix.

6.3.2.1 Energy Efficiency Loan Scheme

This supports eligible SMEs to invest in the energy efficiency of their enterprises. Loan amounts from €10,000 to a maximum of €150,000 per borrower, over terms of 1 year up to 10 years.

6.3.2.1 Small businesses

The Energy Efficiency Grant, available through the Local Enterprise Offices, will provide funding to small businesses to invest in more energy efficient technology. It supports the investment in technologies and equipment identified in a Green for Micro Report, GreenStart Report or a SEAI Energy Audit with 50% of eligible costs up to a maximum grant of €5,000. The aim of the scheme is to reduce the impact of enterprises on the environment thereby increasing the agility and resilience of these businesses.

6.3.2.2 Non-Domestic Microgeneration Scheme

The Non-Domestic Microgen Scheme from the SEAI funding ranges from €2,700 to €162,600, to support a wide range of businesses to switch to solar electricity. The scheme provides grant supports for PV installation up to 1,000 kWp (1MWp) capacity. This scheme helps towards the installation of solar PV for business, school, community centres, or other non-profit organisations. PV technology reduces commercial electricity costs and increases security of supply, while enhancing a positive sustainability image. It should be remembered that on site PV generation is carbon neutral while grid electricity has a carbon intensity of 330gCO2/kWh. The scale of installation grant funding is for installation sizes greater than 6 kWp up to 1,000 kWp.

The grant for 6kWp is up to €2,400

There are also additional grant amounts of:

- €300/kWp for each extra kWp installed between 7kWp -20kWp
- €200/kWp for each extra kWp installed between 21kWp- 200kWp
- €150/kWp for each extra kWp installed between 201kWp-1,000kWp

6.3.2.3 EXEED Grant Scheme

The EXEED Grant Scheme - SEAI is designed for organisations who are planning an energy investment project. Grant support of up to €1,000,000 per project is available.

6.3.2.4 Support Scheme for Renewable Heat

The Support Scheme for Renewable Heat - SEAI is open to commercial, industrial, agricultural, district heating, public sector and other non-domestic heat users. The scheme offers 30% of installation costs of selected renewable technologies.

6.3.2.5 Community Grant

The Grants for Sustainable Community Projects - SEAI support energy efficiency community projects through capital funding, partnerships, and technical support with grant supports up to €5,000,000. The scheme empowers Businesses, Public Sector Organisations, Communities, Housing Associations and Local Authorities to lead deep energy efficient upgrades on the buildings.

6.3.2.6 Accelerated Capital Allowance

The Accelerated Capital Allowance - SEAI is a tax incentive encouraging investment in energy saving technology. Companies and sole traders that operate and pay corporation tax in Ireland can avail of the scheme. Technologies and products supported by ACA need to be on the SEAI's Triple E Products Register.

6.3.2.7 Electric Vehicle Grants (SEAI) – co-funding

The Electric Vehicle Grants - SEAI provides grant supports towards the purchase of new electric vehicles for business and public entities. The co-funded vehicles are typically small goods carrying vans with a technically permissible maximum mass not exceeding 3500kg. A maximum grant of €3,800 is available for qualifying EVs.

6.3.2.8 Energy Contracting Support Scheme

The Energy Contracting Support Scheme - SEAI provides financial assistance to implement energy efficiency and decarbonisation projects. The Scheme aims to support the direct external consultancy and/or specialist advisory costs related to project appraisal and procurement of pay-for-performance energy contracts. Find out more about Energy Contracting.

6.3.3 Retrofit Case Study Campaign

The SEC is a highly populated urban area. There are unique synergies available from this concentration of businesses. Energy audit findings and the opportunities for upgrades can be shared between businesses and community organisations. We propose that each of the buildings audited in this EMP to carry out the measures recommended in a staged process. This would provide an opportunity to provide case studies to other businesses and community organisations in the SEC to recruit additional participants in efficiency programmes. Galway City Council, the Galway Chamber of Commerce, could assist the SEC committee in this work.

We suggest that Westside DZ (in particular around the Seamus Quirke Road area) be a focal point for efficiency projects: in particular Community Energy Grant projects. This should be seen as the start of series of energy efficiency retrofit programmes radiating out from the DZ area. This will not be trivial to organise but could gain momentum based on a strong starting point with the participation of as many of the audited premises as possible.

6.3.4 Impacts of Measures

Our survey of premises in the SEC is a detailed examination of a small fraction of businesses and community buildings there in general. We can look to the generality of the SEAI's experience of helping business to reduce energy use. Based on the SEAI's tracking of business owners' experiences, the average SME could reduce its energy bill by as much as 30% by implementing energy efficiency measures. Typically, 10% saving can be achieved with little or no capital cost[41].

[41] https://www.seai.ie/business-and-public-sector/small-and-medium-business/why-invest-in-energy-effi/

Therefore, if qualifying SMEs in the SEC were recruited to participate in the relevant energy reduction program, we can estimate that it would save up to 171,702 MWh energy, saving local businesses in the SEC €537,201 per year and avoiding 53,330 tCO_2 emissions.

6.4 Non-Domestic Transport Opportunities

As we saw in Section 5.2.4 if we divide the transport energy use between buses and other forms of non-domestic transport, the sustainability picture is markedly different.

6.4.1 Public Buses

6.4.1.1 2024 - Hybrids

Many of the buses, (all Bus Éireann buses) in the SEC are hybrid. As such, they are lower emission than diesel. We can estimate the CO_2 avoided by these buses at 333 tCO_2 which is 25% the total of 1,309 tCO_2.

1. Electric buses are the most energy efficient, followed by hybrid and diesel buses – CNG buses are the least efficient.

2. Electric buses emit no tailpipe CO_2 emissions. Of the remaining technologies, diesel hybrid buses emit the lowest quantities of CO_2 per kilometre. Even though the carbon intensity of natural gas is less than that of diesel, the energy efficiency of the CNG buses is such that the CO_2 emitted per kilometre is greater than the diesel bus and the hybrid bus.

3. Based on lifecycle GHG emissions, electric buses perform the best, when compared with diesel hybrid buses and CNG buses run on fossil fuels. If the diesel hybrid and CNG buses were run on 100% biofuel (i.e. biodiesel and biomethane), the hybrid buses would achieve the lowest lifecycle GHG emissions followed by CNG buses and then electric.

4. The performance of CNG buses and diesel buses vary with respect to NOX emissions. In some cases, the data indicate that, relative to diesel buses, NOX emissions can be marginally higher for CNG buses; in other cases, NOX emissions from CNG buses are lower.

5. Particulate emissions for diesel and diesel hybrid buses observed at both locations (excluding cold starts) were significantly below the particulate limit for passenger cars.

Figure 24: Report on Diesel- and Alternative-Fuelled Bus Trials 2019 Summary Findings[42]

The short-term opportunity for emissions reduction is fairly clear: the switching of City Direct to hybrid vehicles. This will have a similar reduction on the emissions as was achieved by Bus Eireann, i.e., 25% of total. Saving approximately 36,325 litres of diesel and 96 tonnes of Carbon Dioxide emissions.

The 2019 Department of Transport, Tourism & Sport study noted that there were further sustainability gains that could be made by running the hybrid buses on biodiesel. We would

[42] Byrne Ó Cléirigh Consulting, 2019, *Report on Diesel- and Alternative-Fuelled Bus Trials 2019 Summary Findings* https://assets.gov.ie/69312/eadd09d7dd5a49f698dbb4a77db4c78c.pdf

instead propose that HVO be used in buses which has lower particulate and CO_2 emissions but **only if it was the case that there was no palm oil content in the HVO**[43].

6.4.1.2 2025-28 Electric or Fuel Cells

There are a number of studies that look at the feasibility and comparative advantages of EVs and Fuel Cell Vehicles (FCVs) for public buses. We propose that these move to real world trial stage during 2024.

We do however note that, on paper, EV buses would be feasible replacements for diesel. Taking the 401-bus route for example, the minimum requirement for diesel buses to service the route is 4 buses each travelling approximately 205 kms per day. This would be well within the range of an EV bus and would permit a one-for-one substitution, given the requisite charging infrastructure was in place.

We have shown elsewhere that FCV buses are more economically and technically viable in the intercity or rural bus environment, but this is outside the transport hinterland of the SEC and thus not examined in this report.

We therefore recognise an opportunity for Bus Éireann buses to migrate to EVs in the SEC area. This would avoid 4,881MWh of fossil fuel use in the form of diesel and would avoid 1,289 tCO_2.

6.4.2 Small PSVs

As discussed above, these represent a small proportion of the non-domestic carbon emissions (2.7% of all non-domestic transport related carbon emissions – 1,104 tCO_2). However, they are very amenable to replacement with existing technologies (EVs). The cost of an EV is higher than that of a diesel hybrid.[44] The pattern of nighttime driving and daytime charging that is typical of taxi use would mean that while the hybrid driver is achieving a €7.68 cost per 100km and the EV driver is achieving €6.03, the difference of €1.65 would not achieve a realistic payback on its own. There is however a grant scheme that assists small PSV drivers to switch from ICE to EV[45]. In essence this can provide €20,000 in grant funding for a new EV taxi (second hand EVs are granted less) for qualifying drivers. Drivers should be existing SPSV licence holders; and owners of an SPSV registered for at least the previous three years, and with older vehicles (within three years of the maximum permissible age as originally) or vehicles with a mileage of 300,000 km or greater.

[43] Palm oil is generally produced from unsustainable sources which require deforestation and critical habitat destruction. HVO can be made from rapeseed oil however which is produced in Ireland. Biofuels do have their critics and widespread use of biofuels where not necessary and where there is a feasible non-ICE alternative should not be considered best practice.
[44] A Toyota Corolla Luna Sport hybrid costs (at time of writing) €36,000 while a Toyota BZ4X costs €50,000. It would not be feasible to make up the difference of €14,000 on fuel cost alone, bearing in mind that an EV taxi would recharge during daytime at peak electricity cost.
[45] Full details https://www.nationaltransport.ie/wp-content/uploads/2023/03/eSPSV23-Grant-Scheme-Information-Guide.pdf

This would mean that, even on peak rate electricity charges, an EV taxi could save its owner an estimated €12,695 over ten years.

Figure 25: Toyota bZ4X

The environmental benefit would be considerable, reducing emissions by 4,491 kg CO_2/yr (44,910 over a 10-year lifespan). The equivalent of the CO_2 uptake of 320 mature trees in a year.

It is important to note that the grant scheme relates to replacement of older and more used vehicles. We can presume that these will be replaced in any event: the contrast is between replacing with ICE or EV.

Over the whole SEC area, the switch amongst PSVs to EVs would save the PSV sector €2,495,716.22 over ten years while saving 883 tCO_2 yearly: the same as offset by 63,071 mature trees per year.

6.4.3 Tractors and machinery

These were seen to contribute 13.1% to the non-domestic transport energy use and emissions. Reduction in these emissions would contribute to sustainability. This is an area where it is almost impossible to achieve significant energy efficiencies. There are also technical barriers to switching from ICE to EV (or FCEV) in the short term – there are few market-ready EV tractor or construction machinery examples. However, it may be possible to realise emission reductions opportunities from the adoption of HVO. The caveats previously made around the true sustainability of the feedstock of HVO remain. However, it should be possible to establish a supply-chain certification system even in the short term where HVO fuels of European origin from ethically and sustainably managed sources can be guaranteed.

Technically a switch from diesel to HVO is achievable today. There is an economic cost in that HVO is more expensive by approximately 10% than diesel, but construction companies may be willing to absorb this in the interests of increased sustainability.

The difference between the costs of the two fuels is more a matter of policy than reality. Diesel as a fossil fuel product is heavily subsidised where it is produced. It is heavily taxed in Ireland where it is distributed. Both subsidy and tax levels are political judgements. It may be that the level of taxation in Ireland for fossil fuels in the future is raised to account for the cost of the established unsustainability of its use.

The transition to HVO should be seen as a stop gap measure however in advance of a move towards electrification: either directly with battery operated vehicles (though these may be ultimately found to be impracticable) or indirectly through fuel cell electric systems (that use hydrogen as their energy storage).

We discuss HVO is greater detail below in Appendix Section 8.6.4.

6.4.4 Smaller Goods Vehicles

These accounted for 76% of all non-domestic road vehicles. 89% of these (3,700 vehicles) were less than 5 tonnes. These contributed 38% of non-domestic transport emissions however, while goods vehicles (GVs) over 12 tonnes contributed 50%. This is because the smaller number of >12t trucks travel longer distances and use more fuel per km than smaller goods vehicles.

GVs less than 5 tonnes are in effect small to medium sized vans. There are numerous EVs on the market that can meet the requirements of this transport segment up to transit type vans. There is a good independent guide to EV vans costs available in Ireland here.

The price per km for an electric van will be better than was stated for an electric PSV in Section 6.4.2 above, as the owner will be more easily able to avail of night rate electrical tariffs. This could provide the electric van owner with a cost of €3.36 per 100km[46]. For comparison, a Ford transit requires 7.2L/100km which would cost €11.38/100km[47].

Transitioning the small goods vehicles fleet to electric vehicles has clear economic as well as sustainability logic and this are a medium-term opportunity that the SEC could disseminate to the local businesses.

6.4.5 Large Goods vehicles

We do not see these as a medium-term opportunity. The power demand of these vehicles, were they to be battery powered, would require a significant reconfiguration of our electrical grid. There is therefore much attention being given in this sector to FCEV for large trucks typically travelling long distances (as there is for trains and inter-city buses). This is an area that is being investigated by two large research projects in Galway City (GH2 and Sh2amrock[48]). We suggest that the SEC follow developments in these projects and inform the local transport companies of all developments and upcoming opportunities.

[46] 16.kWh per 100km @ €0.21/kWh night rate.
[47] Assuming diesel price of €1.58/L
[48] The authors of this EMP are involved as partners in Sh2amrock

6.5 SEC level Opportunities

In this section we discuss the opportunities for carbon emission reduction across the entire SEC in both the domestic and non-domestic sector.

6.5.1 Efficiencies and fossil fuel avoidance

As we have shown there will be considerable savings achievable from domestic retrofits, renewable transport initiatives, active travel, and non-domestic opportunities. These savings will be both financial as well as in CO2 reductions.

6.5.2 Generation

There are relatively few opportunities for large-scale energy generation in the SEC area. This is largely connected to the density of population and thus the unavailability of the kind of space usually required to accommodate large grid-scale energy generation.

The vast majority of the SEC is zoned residential, community, amenity[49]. Areas designated as enterprise or related uses are already densely developed.

6.5.2.1 Wind

In terms of wind generation, we would note that the accepted setback distance for turbines from the nearest residence in the Draft Revised Wind Energy Development Guidelines December 2019 (Department of Housing, Planning and Local Government) [50] is 500m. We do not identify any areas in the SEC that would satisfy this setback requirement.

6.5.2.2 Photovoltaic

Over the past 10 years there has been an increase in the efficiency of new PV panels and a reduction in costs per unit owing to greatly increased volumes of production worldwide resulting in an overall reduction in cost per MWh produced.

In general, 5MW PV sites require approximately 10 hectares of contiguous land in a relatively low-lying flat location (incline <5 degrees) with an unobstructed South facing aspect, sheltered from the prevailing elements and sea with a good solar resource. A proximity of less than 2km to 38kV substation with open capacity is advantageous.

Photovoltaic in the suburban environment does not have the same setback requirement. It must be designed taking into consideration avoidance of glare near to airports and flightpaths, but Galway Airport is to the North East of the SEC and Indreabhán airport to the West. The 110kV substation at Salthill has open capacity for generation.

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[49] See city council development map https://consult.galwaycity.ie/en/system/files/materials/613/MAP%20A%20City%20Land%20Use%20Zoning%20and%20Specific%20Objectives%20Map%20Jan%202022_update.pdf

[50] https://www.gov.ie/pdf/?file=https://assets.gov.ie/46097/6e68ea81b8084ac5b7f9343d04f0b0ef.pdf#page=null p129

Community scale PV would be possible in certain areas of the SEC but would require positive community acceptance and even partnership within the development to overcome planning obstacles and public acceptance issues.

The economics of a community scale PV system in the SEC are good.

Solar resource for the area is moderate. Figure 26 shows modelled output from a 5MW PV installation in the SEC area over 12 months.[51]

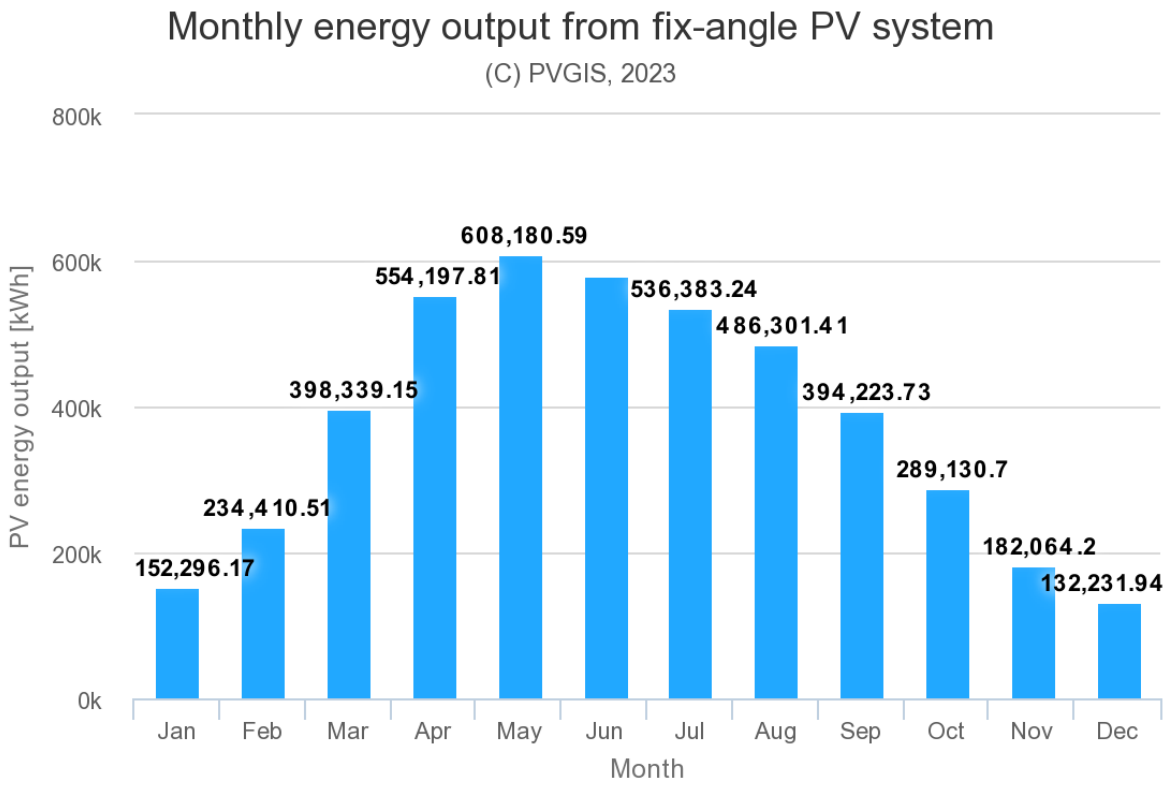

Figure 26: Output from 5MW PV installation in SEC area

The total production would be 4,548 MWh. This would have the effect of removing 1,500 tCO2 from the SEC's energy system.

At a realistic projected capital cost of €8.8m and OPEX of €3m for the 30-year lifespan of the project, the LCOE would be €125MWh making it an economically viable project. If a community initiative, the project is likely to qualify for support from the upcoming Small-Scale Generation Scheme[52] (SSGS).

[51] Using Photovoltaic Geographical Information System: https://re.jrc.ec.europa.eu/pvg_tools/en/tools.html
[52] Department of the Environment, Climate and Communications, 2022, *Consultation on a Small-Scale Generation Support Scheme (SSG) in Ireland* https://www.gov.ie/en/consultation/353f2-consultation-on-a-small-scale-generation-support-scheme-ssg-in-ireland/

The SEAI has produced a very helpful guide explaining how to carry through Community Energy PV projects to fruition which is available at this LINK.

6.5.2.3 Small Scale Hydro

The river Corrib runs into Galway Bay through the SEC. Historically there were a number of mills on the river banks. There is a considerable resource across eight sites on the Corrib in the SEC area. Despite the generally low headraces <5m, the flow-rates are extremely strong. There is a calculated hydro-electric resource of 6,265 MWh across the sites. Fully realised these micro-hydro installations could avoid 2,380 tCO_2 emissions.

Table 19: Hydroelectric potential in the SEC area across 8 sites

Site	1	2	3	4	5	6	7	8	ALL
HEAD	2.5	2.5	3.9	2.7	3	2.6	2.6	5.8	-
POWER kWp	117	100	465	35	31	33	33	330	1144
OUTPUT MWh/yr	643	549	2,554	192	153	181	181	1,812	6,265
tCO2 avoided [1] /yr	217	186	863	65	52	61	61	613	2118

[1] We assume the displacement of grid electricity at 0.330kg CO_2/kWh (2021 value)

Hydroelectricity is a proven resource of renewable energy in Ireland and elsewhere. In Austria it accounts for approximately 60% of all electricity generation[53]. The City Development Plan[54] states:

> Consideration will also be given to the potential for developing hydroelectric energy schemes, potentially located on the Eglinton Canal.

According to the EPA[55], there are over 560 sites capable of operating at scale to export electricity to the National Grid (i.e >10kW power). Of these there are only a small number (less than 60) in operation today. The EPA estimated that these sites could generate a considerable amount of renewable energy which would help avoid over 50,000 tonnes of carbon emissions per annum[56].

Within the SEC there are land ownership and access issues that would need to be fully investigated while any project to harness the hydro-electric resource of the SEC area is fully explored.

There are non-energy related opportunities that may arise from a successful micro-hydro installation in the SEC area, namely that a community-based organisation with skills and

[53] https://www.iea.org/reports/austria-2020
[54] https://consult.galwaycity.ie/en/consultation/draft-galway-city-development-plan-2023-2029/chapter/chapter-9-environment-and-infrastructure
[55] https://seaiopendata.blob.core.windows.net/hydro/DOE_1985_Small%20Scale%20Hydro-Electric%20Potential%20of%20Ireland.pdf
[56] Equivalent to the carbon sequestration of approximately 3.5m mature trees

expertise in micro hydroelectricity projects could have a very strong business model that could be applied to the 560 sites identified by the EPA above. The GEC SEC includes in its membership experts on hydro-electricity – there is therefore a clear opportunity for the SEC to pursue medium scale hydro projects in the Eglinton Canal area.

6.6 Sustainability Effects of Opportunities

The opportunities identified will have considerable benefits to residents and businesses in the SEC area reducing fossil fuel energy consumption and avoiding CO2 emissions. A full implementation of the opportunities discussed above will reduce energy use by 440,106 MWh per year or 34%, and carbon emissions by 126,503 tCO2 per year, or 31%.

Figure 27 clearly shows the areas where the greatest energy savings can be achieved: namely in Domestic and Non-Domestic building retrofits, a switch of 30% of domestic transport to EVs, and the switch of Goods Vehicles to EVs. It is in these areas that the SEC would have the greatest impact. Fortunately, they are also areas well supported by SEAI grants and making use of mature technologies. The economic case for each energy reduction and CO2 avoidance opportunity is thus very clear.

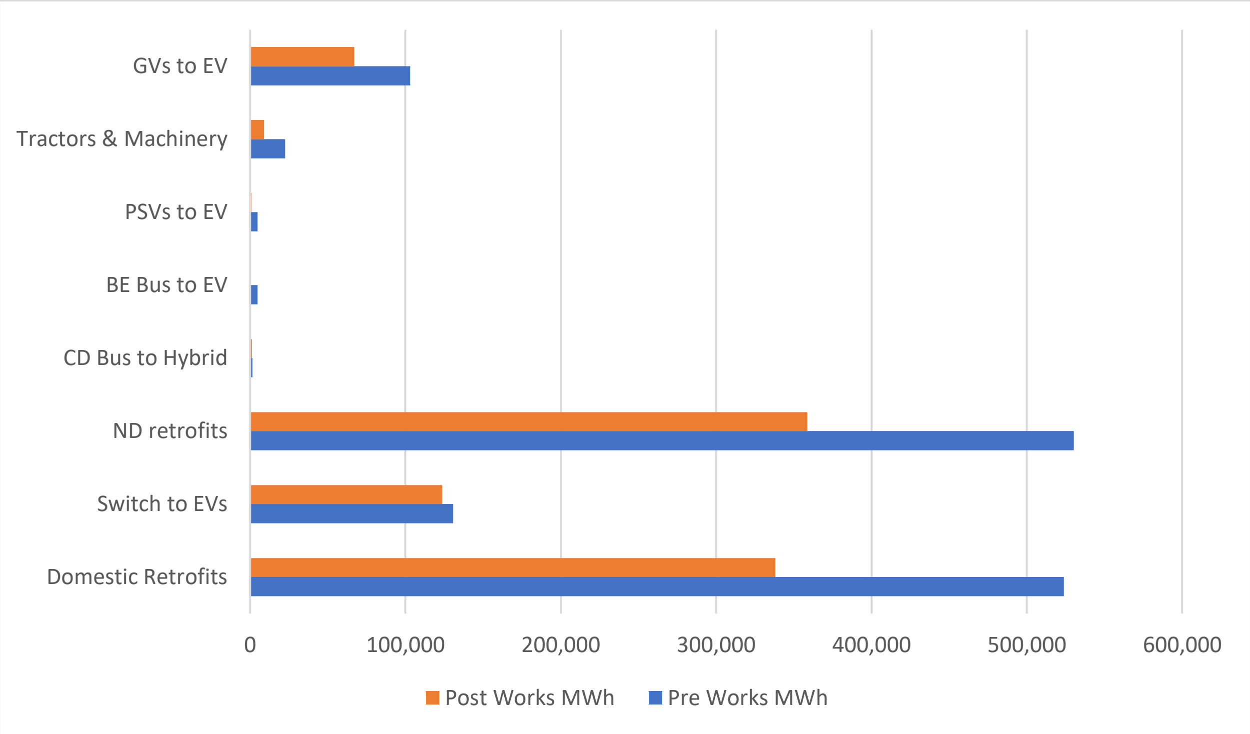

Figure 27: Pre and Post Opportunities Energy Use for the SEC

7 Conclusion: Holistic Effects of Co-ordinated Strategy

In this section we bring together the energy conservation and generation measures to show the potential positive impact of carrying through the Energy Master Plan on a holistic level.

7.1 Strategy Outline

Table 20: RoO Strategy Outline: Priority and Projected Reduction in Co2

		Emissions Reductions Each Year in kg Co2/yr							
Priority [1]	Action	2024	2025	2026	2027	2028	2029	2030	TOTAL/yr
1.1	Retrofit 15% of G-C3 homes each year	15,961	15,961		15,961	15,961	15,961	10,640	90,443
1.2	15% ND Buildings upgraded each year achieving >30% energy reduction overall	8,000	8,000	8,000	8,000	8,000	8,000	5,333	53,330
1.3	Active Travel Campaign to switch 330 commuters in Barna and Knocknacarragh to Cycling per year	67	67	67					202
1.4	Information campaign to encourage GV owners to switch to EV Vans	1,020	2,040	3,060	4,080				10,201
1.5	5% replacement of FF ICE domestic cars with EVs annually	104	104	104	104	104	104	69	694
1.6	Campaign for Tractors & Machinery in SEC to switch to HVO	1,779	1,779						3,557
1.7	500 homes with 2kWp installations with 500 additional homes recruited each year until a target of 3,322	275	275	275	275	275	275	183	1,834
1.8	Encourage 50 PSVs to transfer to EV per year	221	221	221	221				883

Table 20 continued from previous page									
Priority	**Action**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**TOTAL/yr**
2	Community/Council Partnership 5MW PV electricity generation project			1,500	1,500	1,500	1,500	1,500	1,500
3.1	50% Replacement of Diesel Bus by Hybrid Bus on Private Route		48	48					96
3.2	Micro-Hydro Scheme 1		186						186
4.1	25% of Bus Éireann Buses from Hybrid to EV			322	322	322	322		1,289
4.3	Micro-Hydro Schemes 2 per year			282	915	122	612		1,932
	Total Emissions Reduction tCO2	**27,426**	**28,679**	**13,879**	**31,377**	**26,284**	**26,774**	**17,726**	**166,146**

[1] Priority level is based on both achievability, the timescale required and the effect on emissions.

The effect of these measures, taken in consort will achieve the ambitions stated by the SEC in their scoping document for this EMP. Figure 28 shows how the actions would achieve a 96% reduction in on-island energy related emissions with a consequent reduction in energy use.

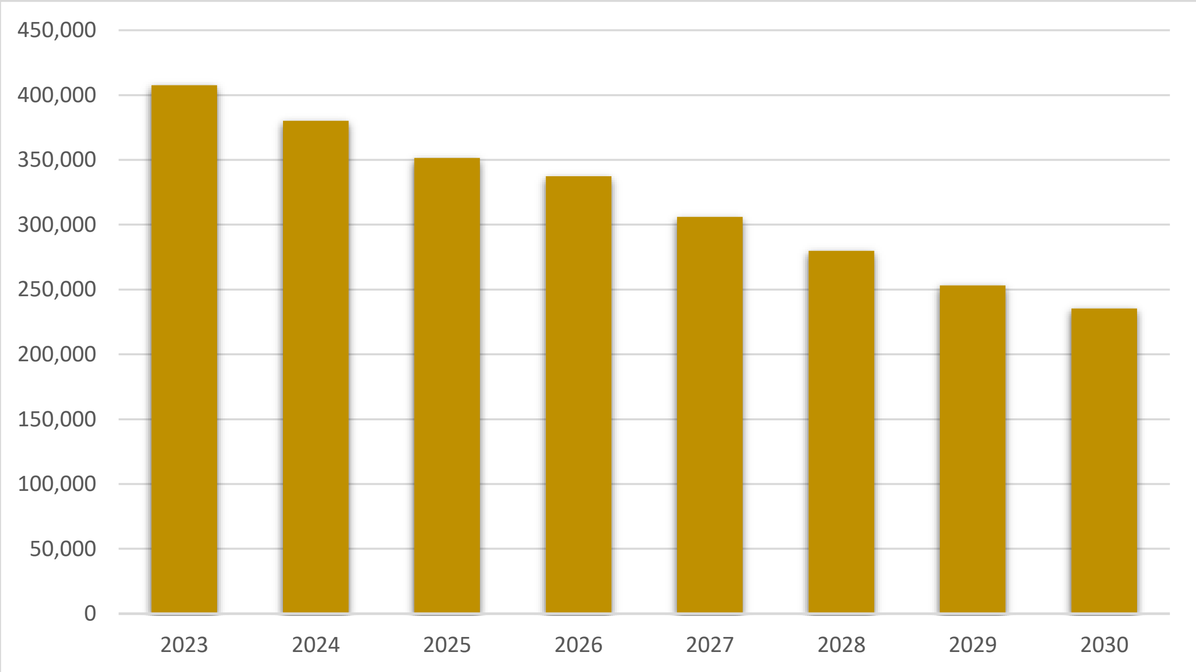

Figure 28: Reductions in Emissions Achieved through EMP Strategy

Financial Savings from Actions are equally significant. Residents and businesses in the SEC will achieve considerable financial benefits to match the sustainability gains that are possible from the actions outlined in this EMP. As we saw in Section 6.1.3 and F rated home could save as much as 80% on its energy bills if upgraded to BER A2.

There should be an initial focus on achieving progress on each of these targets in the WDZ which if co-ordinated and pursued with conviction will act as a beacon for the rest of eth SEC area.

7.2 Capacities

Through its participation in the NWE STEPS EU project, Galway Energy Co-operative SEC has demonstrated the in-house ability to manage complex and demanding projects. It has built up a series of contacts with relevant energy efficiency contractors, council level policy makers, and sustainability experts. Its membership includes staff of the University of Galway. We would be confident that a group Community Energy Grant Scheme is feasible for 2024 to achieve the recommendations outlined in the Strategy, Section 7.1.1.

Building expertise and capacities within the group is critical to achieve the success of the SEC. Already there has been a continuous process of ‘learning, planning and doing’, both through the Community Futures Program and the SEC program. Increasing the membership of the group, delegating responsibilities to achieve different elements of the Master Plan will have the twin benefits of reducing overload on the individuals as well bringing in fresh perspectives.

We recommend a resources analysis exercise which will help build connections with other stakeholders as well as deepening the reservoir of talent and person-power that is available to the SEC to achieve the ambitious program outlined in the EMP.

The presence of a strong Community Service provider in the WDZ in the Westside Resource Centre puts the SEC in a strong position to conduct in depth activation measures with SEC residents and businesses. The successful recruiting of participants in this EMP in both sectors demonstrates this capacity clearly. The GEC has also built-up a strong relationship with the City Council and as this deepens through successfully implementing CEG projects on-the-ground, the progress towards achieving this EMP's opportunities will become more certain.

7.3 Energy Master Plan Dissemination to Community

The dissemination of the Energy Master Plan throughout the community is one of the key actions for the SEC now that the plan has been completed. The Energy Master Plan will provide the community with an understanding of what their current energy profile is and where they as a community should put their efforts in reducing their energy and carbon footprint. We suggest that the SEC host workshop events for each of the community subgroups that are targeted by the sustainability actions outlined in this EMP. These would be:

- Homeowners – in particular the fuel poor in relation to home upgrades
- Community Facilities/School Managers in relation to participation in CEG applications as well as facilitating outreach to residents.
- SMEs in relation to energy efficiency projects
- Local business groups, Chambers of Commerce particularly PSV and GV driver groups
- The City Council
- Landowners and Stakeholders Adjacent to the Eglinton Canal
- Climate Action Regional Office

These workshops will enable the SEC to recruit participants in the EMP actions. It is vital that these workshops are pitched appropriately – the needs of each group are very different, even if there are commonalities between all members of the community.

7.4 Low Lying Fruit First

The SEC is encouraged to develop low-effort, low-cost efficiency projects first to increase their internal capacity and skills. These low-effort, low-cost efficiency measures can be quick wins for the community and encourage the group to tackle more complex, higher effort projects in the future. These projects also provide a focus point for the greater community to prompt discussions and knowledge sharing experiences.

We recommend that the SEC seek to partner with the local authority in a Community Energy Grant project: this will build capacity and demonstrate the value of the collective approach to sustainability. It will also develop the skill sets within the group. There are CEG specialists who have wide experience in managing successful projects. However, the SEC should remain engaged with every step of a CEG to maximize learnings as well as ensuring widest possible community benefit.

7.5 Continue the Journey with the SEAI

The SEC program has resources in addition to the county level SEC mentoring. The engagement of specialist mentors is possible, as is the Community Enabling Framework program (more information available here)

The SEC can also benefit from the SEAI's funding streams for energy efficiency projects within your community. These are constantly evolving, and the SEC should continue to engage with SEAI mentors to learn what funding and supports are available.

8 Appendix

8.1 Individual Level Behaviour Changes for homeowners

These are some quick and easy sustainability 'wins' the homeowner can achieve while they are planning long term solutions to their reliance on imported fossil fuels.

Step 1: Do Your Own Audit:

- Check windows, external doors, vents, interstitial floor spaces, fireplaces, and stoves with a stick of incense: and track down and eliminate draughts.
- Check insulation levels in attic, basement, walls (including the meter box), and interstitial floor spaces.
- Check your boiler and stove; what age are they? When were they last serviced?
- Collect energy bills and scrutinise them over a year or 2.
- To save money in the short term see if you need to change your electricity supplier.

Step 2: Actions to save 36% of your energy costs and fossil fuel use:

- Turn everything off – don't leave things on standby (2%)
- Use a clothes line when possible – tumble dryers are very energy heavy (7%)
- Wash clothes @ 30 degrees (1%)
- Turn off lights when not in a room, replace bulbs with CFLs at least, or with LEDs if possible (2%).
- Use oil to heat water – not the electric immersion or electric power shower (24%)

Step 3: Save energy by thinking about the way you control and use heat

Close the curtains at dusk to keep heat in the room that would otherwise be lost through the cold windows, and you could save up to 10% of your heating costs.

Consider fitting shelves above radiators as they redirect the warm air that rises from them back into the room.

Ventilate your house 3 to 5 minutes, a couple of times a day, instead of opening windows a little bit all day. Shut off your heating, during ventilation. This can reduce heat loss by 16%.

Maintain room temperature 19^{0}C (this can save up to €350 every year for each degree lower you heat the house)

Bleed your radiators regularly. If there is air in your radiator your boiler burns longer. Always start with the lowest and end with the highest radiator.

8.2 Supports for homeowners.

8.2.1.1 SEAI Supports for Individual Homeowner Applicants

There are three categories of applicants to the SEAI Home Energy Grant Scheme[57] of which this is a brief summary. These are:

Individual Energy Upgrade Grants	One Stop Shop Service	Fully Funded Energy Upgrade
Up to 80% of the cost of the upgrade for a typical family home with SEAI grants	Based on set grants per measure, this can be grant funded by SEAI 45 - 50% of the cost for a typical family home	For qualifying* homeowners in receipt of certain welfare benefits (see below) All home upgrade costs covered by SEAI
Homeowners manage their upgrades including: • contractor selection • grant application • contractor works • pay for full cost of works and claim grants afterwards • follow up BER	*A One Stop Shop contractor manages upgrade including:* • home energy assessment • grant application • project management • upgrade to a minimum B2 BER • contractor works • homeowner pays for the works net of grant • follow up BER	*Service is managed by SEAI and includes:* • home survey • contractor selection • contractor works • follow up BER
For homes built and occupied before: • 2011 for insulation and heating controls • 2021 for heat pumps and renewable system	*For homes built and occupied before:* • 2011 for insulation and heating controls • 2011 for renewable systems	*For homes built and occupied before:* 2006 for insulation and heating systems *Receiving one of the following: • Fuel Allowance • Job Seekers Allowance • Working Family Payment • One-Parent Family Payment • Domiciliary Care Allowance • Carers Allowance • Disability Allowance for over six months with a child under seven

There is a full explanation of the schemes, grants, and levels of funding on the SEAI site here

[57] Available at this link: https://www.seai.ie/grants/home-energy-grants/

Grant name	Grant Value
Heat Pump Systems	€6,500
Central Heating System for Heat Pump	€2,000
Heat Pump Air to Air	€3,500
Heating Controls	€700
Launch bonus for reaching B2 with a Heat Pump	€2,000
Solar Hot Water	€1,200
Attic insulation	€1,500
Rafter insulation	€3,000
Cavity wall insulation	€1,700
Internal Insulation (Dry Lining)	€4,500
External Wall Insulation (The Wrap)	€8,000
Windows (Complete Upgrade)	€4,000
External Doors (max. 2)	€800 per door
Floor Insulation	€3,500
Solar PV	0 to 2 kWp €900/kWp 2 to 4 kWp €300/kWp
Mechanical Ventilation	€1,500
Air Tightness	€1,000
Home Energy Assessment	€350
Project Management	€2,000

8.3 EV Grants

List Price of Approved BEV	Level of Grant
€14,000 to €15,000	€2,000
€15,000 to €16,000	€2,500
€16,000 to €17,000	€3,000
€17,000 to €18,000	€3,500
€18,000 to €19,000	€4,000
€19,000 to €20,000	€4,500
€20,000 to €60,000	€5,000

Grant Eligibility: to qualify for SEAI grant assistance, the purchased vehicle must be new and one of the approved car models. The full list of car models is available at this link.

8.4 SME Supports

8.4.1 SEAI Energy Academy

The SEAI Energy Academy is a free, online, e-learning platform designed to help businesses increase their energy efficiency and reduce their energy related costs.

The SEAI Energy Academy allows anyone to learn with short, interactive, animated modules. It's mobile friendly and offers flexible, self-paced learning with access available 24/7.

Business owners, CEOs, managers, and facilities teams can join the SEAI Energy Academy and start learning. The SEAI Energy Academy courses are also a great way of engaging, up-skilling, and retaining staff. Courses can be implemented into any business's sustainability strategy helping them embed energy efficiency across their organisation.

LINK HERE

8.4.2 Climate Toolkit 4 Business

The Toolkit helps your business get started on your zero-carbon journey. It recommends the most impactful steps to understand and address your environmental impacts.

This Toolkit provides practical and cost-effective actions that every business can take to support this transformation and build resilience.

The Energy bills / usage information calculator asks how much electricity and gas your business uses every year on average.

The Business travel information calculator asks for vehicle fuels (petrol or diesel) volumes or cost as well as flights taken for business purposes in a year.

Waste and Water Usage is also tracked.

LINK HERE

8.4.3 SME Energy Audits

An energy audit is an important step for businesses that want to save money, save energy, and enhance their brand. An energy audit may be carried out on buildings, processes, or systems and it is a three-step process which involves preparation, a site visit and reporting. The audit report that compiles the findings will help you to understand:

- how much energy your business uses.
- the equipment and processes that use the most energy.
- what actions you should take to save energy, and their estimated cost and impact

SEAI's Support Scheme for Energy Audits (SSEA) will offer SMEs a €2,000 voucher towards the cost of a high-quality energy audit. In most cases, this will cover the total cost of the audit. Application to the scheme is easy, with automatic approval for eligible businesses.

Businesses applying to the scheme must be:

- non-obligated entities
- tax compliant
- registered in the Republic of Ireland
- spend at least €10,000 on energy per year at the site being audited.

Non-obligated parties (that is those who are eligible for the scheme) are: small and medium enterprises (SMEs), or public sector bodies with a useful floor area less than 500m2 and spending less than €35,000 per year on energy.

8.4.4 SEAI SME Guide to Energy Efficiency

This document is an excellent short guide for SMEs. This practical guide is based on the real-world experiences of a team of professionals who've been helping companies improve their energy efficiency for decades, so the recommendations are tried and tested.

'Based on experience, the average SME could reduce its energy bill by up to 30% by implementing energy efficiency measures. Typically, 10% saving can be achieved with little or no capital cost. Some investment may be required to get the remaining 20% but the payback is generally around 1.5 years. You won't make a better investment!'

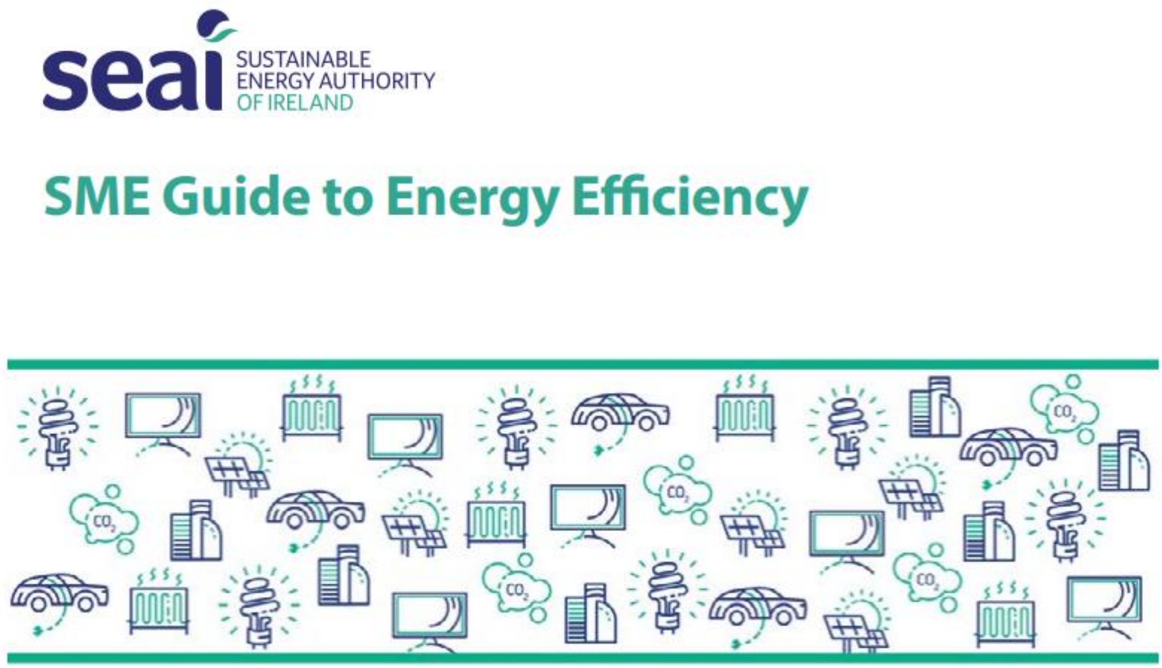

Figure 29: SEAI SME Guide to Energy Efficiency: LINK HERE

8.4.5 PSV: EV Taxi Grants

: https://www.nationaltransport.ie/wp-content/uploads/2023/03/eSPSV23-Grant-Scheme-Information-Guide.pdf

Supported by

8.5 General Resources

8.5.1 Cycling Campaigning

Resource Name/ Description	Link
Carma: Marketing urban cycling Handbook and Case Studies	LINK
Cyclist.ie – The Irish Cycling Advocacy Network	LINK
EMBRACER: integrating public transport (PT) with informal modes (cycling, ride-hailing, car/bike/scooter sharing, on-demand transport, autonomous shuttles)	LINK
Cyclewalk: Best practices and experience on data collecting and processing, to involve users to improve planning of cycling and walking facilities	LINK
Handshake: Sharing Best Practice of Cycling experience from 12 cities (the assessment tool is useful for city planners)	LINK
European Cyclists' Federation: The European umbrella federation of civil society organisations advocating and working for more and better cycling.	LINK

8.6 Technologies Discussed in this report.

8.6.1 Heat Pumps

Air to Water Heat Pumps (AWHPs) are a type of heat pump that use outdoor air as a source of heat to warm up water for heating systems and domestic hot water. Here's how they work:

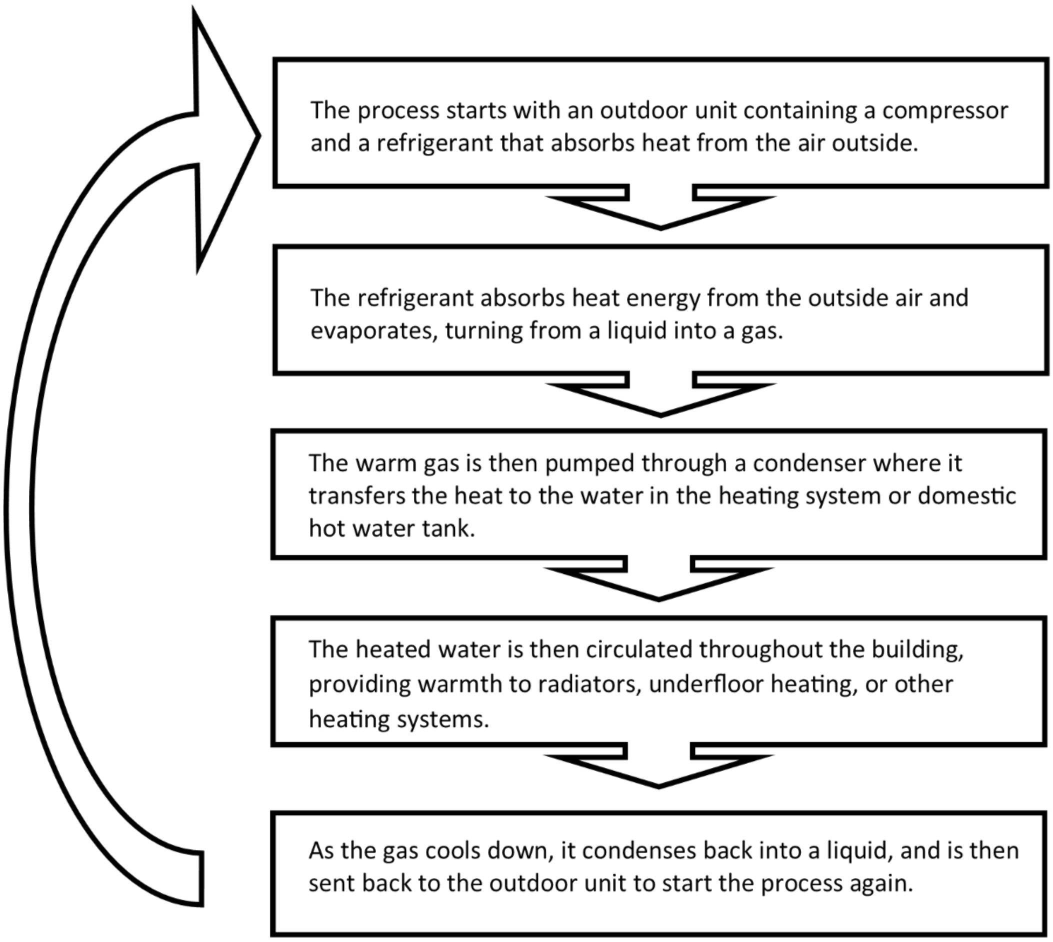

Figure 30: Heat Pump Flow Diagram

AWHPs are highly efficient because they use the freely available heat in the air, and only need a small amount of electricity to operate the compressor and pump. They are also a renewable energy source, as they do not rely on fossil fuels, and can provide significant energy savings compared to traditional heating systems.

AWHPs can have an efficiency of 3:1 which means that for every kWh of electricity is put in, 3kWh of heat are produced.

For further reading, see this SEAI guide: https://www.seai.ie/publications/Heat-Pump-Technology-Guide.pdf

Figure 31: Small Domestic Heat Pump

8.6.2 PV

PV stands for Photovoltaics, which is a method of generating electricity from sunlight. Photovoltaic systems use solar panels made up of photovoltaic cells to convert the energy from the sun into direct current (DC) electricity. This electricity can be used directly, stored in batteries for later use, or converted into alternating current (AC) electricity for use in homes and businesses. PV technology is considered a renewable energy source because it relies on the sun's energy, which is abundant and free, to generate electricity, and it produces no emissions or pollution during operation. PV systems can be installed on rooftops, in fields, or on other open spaces, and they are commonly used for both residential and commercial applications.

PV electricity can be used in the home as well as exported to the grid. The typical modern panel will last 25 years (although it loses some of its efficiency over time). A 2kW power system will require five 400W panels taking up approximately 2m X 5.5m of south facing roof space.

Figure 32: Micro PV installation

https://www.seai.ie/technologies/solar-energy/electricity-from-solar/

8.6.3 EVs

For a list of BEVs on the Irish market see this list compiled by the Irish Credit Union Association: https://www.creditunion.ie/blog/the-best-value-electric-cars-in-ireland/

For an explanation of SEAI supports for BEVs see here: https://www.seai.ie/technologies/electric-vehicles/

BEVs are Cheaper than Petrol Hybrids

A Nissan Leaf (costing €36k) has a range of 385 km from its 62kWh battery. From a Standard rate of electricity this gives a cost per km of 6.2km per kWh = €0.44 which is €0.071/km.

A Nissan Quashquai will cost €35,400 and achieve 5.22 L/100km or 19.16km/l which at a price of 1.60/l petrol is €0.083/km **14% more expensive than the BEV**, excluding tax, VRT, and lower service costs.

8.6.4 Biofuel

We focus on Hydrotreated Vegetable Oil (HVO) here as it is seen as a like-for-like replacement on diesel in most applications, including tractors and construction machinery.

Hydrotreated Vegetable Oil (HVO) is a type of renewable diesel fuel that is produced by hydrotreating vegetable oil. It is a high-quality, low-emission fuel that can be used as a direct replacement for fossil diesel in diesel engines.

The hydrotreating process involves heating the vegetable oil to high temperatures and pressure in the presence of hydrogen gas and a catalyst. This process removes impurities such as sulphur and nitrogen, reducing the carbon chain length of the fatty acids in the feedstock. The end result is a clear, colourless liquid that has excellent cold flow properties and a high cetane number, which is a measure of its combustion quality.

HVO is considered a transitional sustainable fuel option as it is made from renewable feedstocks and produces lower emissions compared to fossil diesel. It has also been found to be compatible with existing diesel engines and infrastructure, making it a viable alternative to fossil diesel for transportation and industrial applications in the short and medium terms.

HVO Fuel Suppliers Online

lassoil.ie/

inverenergy.ie/

Certaireland.ie

Eurooil.ie

This is a summary guide to biofuels in general. HVO is discussed p12-15

8.6.5 Hydroelectric Power

Small scale hydroelectric power refers to the generation of electricity from water flow using small turbines.

Ireland is well-suited for small hydroelectric power due to its abundant water resources, including rivers, streams, and waterways. These water bodies provide a consistent flow of water that can be harnessed to generate electricity. Small-scale hydropower systems are typically installed in rivers and streams where the natural flow of water can be utilized to turn turbines and produce clean energy.

The primary components of a small hydroelectric power system include a water source, a dam or weir to regulate water flow, a turbine to convert the flow of water into mechanical energy, and a generator to transform this mechanical energy into electricity. In small-scale installations, the capacity of hydroelectric power plants generally ranges from a few kWp up to 100kWp.

The sustainability advantage of small hydroelectric power is as a renewable energy source that utilizes the natural flow of water, which is continuously replenished through abundant rainfall. This reduces the reliance on fossil fuels and contributes to the country's goals of achieving a sustainable energy mix.

Hydroelectric power installations have a long lifespan typically greater than 50 years and can usually provide electricity consistently throughout the year. Galway’s rivers and streams maintain a relatively stable flow, ensuring a relatively reliable source of power generation in comparison to other renewable energy sources, such as wind or solar, which can be very intermittent.

The construction of small-scale hydroelectric projects can contribute to the conservation and restoration of local ecosystems, they usually involve the creation of fish passages and follow recommendations from Inland Fisheries Ireland.

Small hydro can be supported through the Community Export Premium, in which case it is required that a proportion (20%) of the energy generated is also consume onsite.

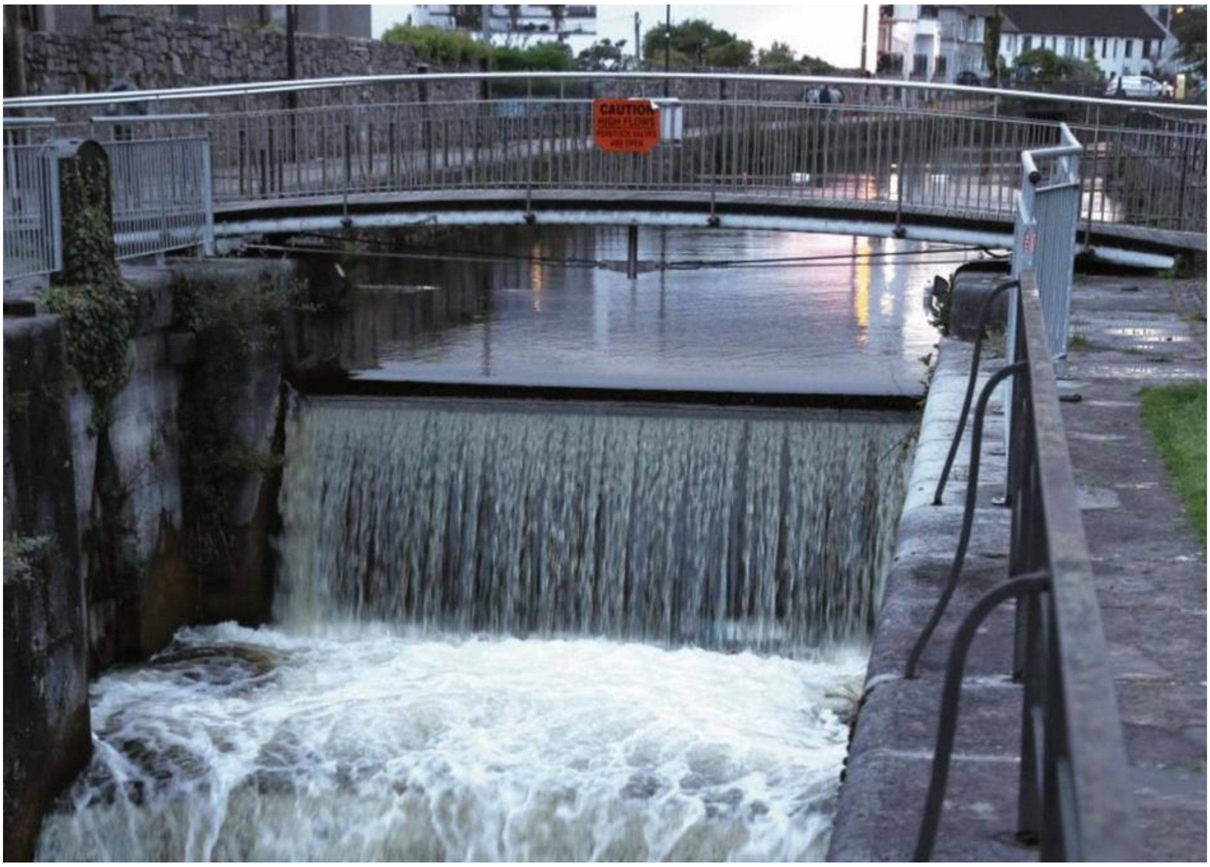

Figure 33: Location is Galway City technically suited to installation of small hydro

8.7 Methodologies

In this section we outline the methods we used to arrive at our measures of energy use based on the available data.

8.7.1 Domestic Energy Use

In the home, we look at energy used in heating, in appliance use, and in transport. We do this using a variety of methodologies.

Firstly, we process the national data on Building Energy Rating Certificates (BERs) as published by the CSO: these are provided on a national and a county basis here[58]. We then compare these to the SEAIs average breakdown BERs for each CSO Electoral Division which are published by the SEAI. This presents us with a picture of the state of the energy efficiency of the housing stock in the SEC.

The BERs for each ED are classified according to energy use per square meter for space heating (SH), for Water heating (WH), and for lighting and pumps and fans (L). Appliance use is not included in the BER but we do account for it through *estimated* values (see below SEAI and DECC estimates). For SH and WH, we determine fuel consumed (oil, natural gas, electricity, etc). For Lighting and Pumps, we assume electricity as the energy source.

Energy use of the home is measured as kWh per square meter per year (kWh/m2/yr). A low kWh/m2/yr is considered more efficient than a high kWh/m2/yr. The level of consumption for homes from most efficient A1 to least efficient G under the BER system is rated as shown in Figure 34.

[58] https://www.cso.ie/en/statistics/climateandenergy/domesticbuildingenergyratings/ accessed 02/02/2022

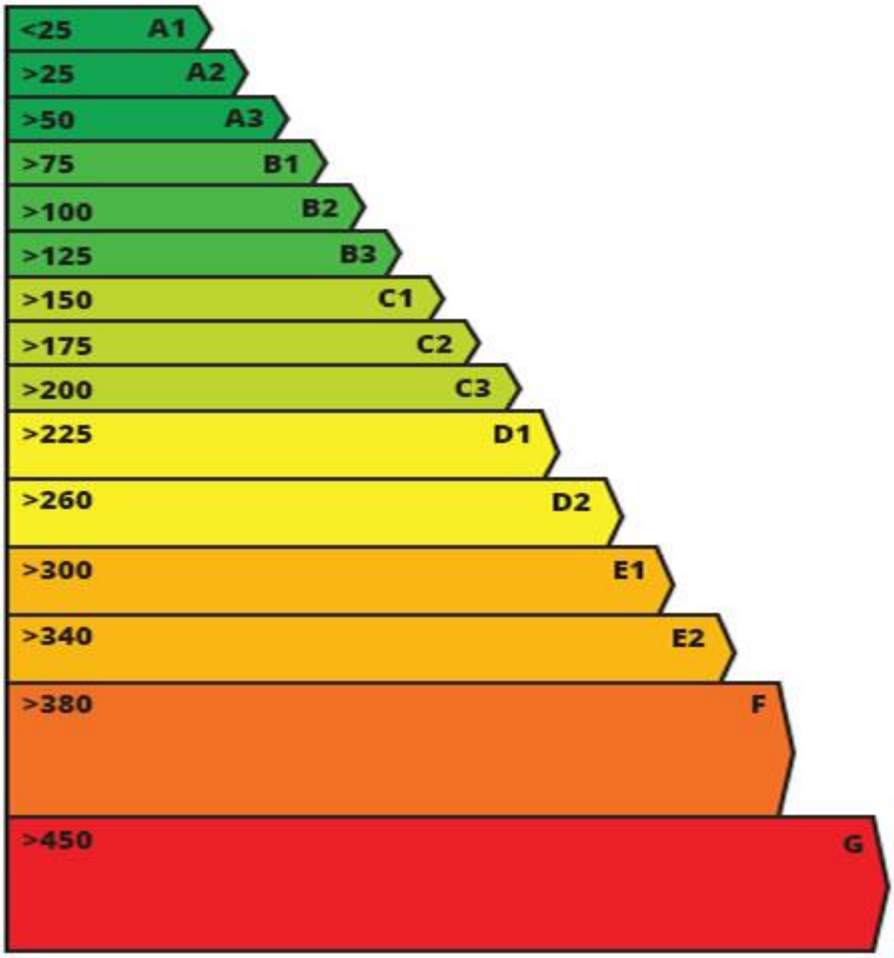

Figure 34: Energy Rating Scale in kWh/m2/yr A1-G

With our method, we calculated the percentage of homes with a BER for each rating A1-G in each ED. We found the results shown in Table 21.

Table 21: Percentage of BER Classes for Each Electoral Division (%)

	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	E1	E2	F	G
Barna	0.3	3.6	4.3	0.9	2.2	6.4	11.7	17.1	23.5	17.9	7.7	2.3	1.1	0.6%	0.3%
Claddagh	0.4	0.9	3.1	0.9	1.9	4.0	5.9	8.1	13.0	14.9	17.0	8.1	7.2	6.4%	8.0%
Eyre Square	0.0	0.3	1.4	0.2	0.6	3.2	6.7	10.1	14.8	17.0	15.4	10.7	9.9	6.3%	3.4%
Eyre Square	0.0	0.1	0.3	0.3	0.3	1.9	5.3	9.2	14.7	18.9	18.7	10.5	7.4	6.4%	6.0%
Knocknacarragh	0.6	1.7	1.7	2.5	3.6	11.3	12.9	17.6	14.9	12.7	11.3	2.2	4.4	1.7%	1.1%
Menlough	0.2	0.7	0.7	0.3	0.7	3.4	8.3	9.2	19.1	22.5	19.2	7.8	3.4	4.0%	0.5%
Newcastle	0.0	1.0	1.2	0.7	0.5	1.4	4.0	8.1	15.4	22.3	14.7	9.7	10.0	5.9%	5.0%
Nun's Island	0.0	0.3	0.8	0.8	1.8	2.1	5.5	4.2	6.8	12.9	14.4	8.7	10.8	8.9%	22.0%
Rahoon	0.4	9.7	3.3	2.5	4.2	8.2	11.3	13.3	13.0	10.4	8.3	3.6	6.4	4.5%	0.9%
Rockbarton	0.6	4.7	2.2	3.7	5.0	6.5	8.7	11.8	10.0	14.6	12.8	4.7	5.3	3.7%	5.6%
Salthill	0.4	1.3	2.1	0.8	3.4	6.3	9.0	12.1	15.0	14.6	14.3	6.2	5.4	4.3%	4.8%
Shantalla	0.0	0.3	2.5	1.3	1.6	1.6	4.4	6.9	10.4	13.2	15.5	7.9	8.2	13.2%	12.9%
St Nicolas	0.0%	0.0	0.4	0.4	0.8	2.6	3.9	8.7	9.3	14.2	15.3	13.4	9.2	8.5%	13.4%
Taylors Hill	0.6%	0.6	0.2	0.3	2.4	5.1	7.2	9.2	12.5	17.0	13.7	9.8	9.9	7.8%	3.9%
SEC AREA	0.3%	2.2	2.3	0.9	1.9	4.9	8.6	12.1	16.7	16.8	12.9	6.5	5.4	4.4%	4.1%

The next step was to find an average energy use for each BER class in each ED. This was achieved by finding the average SH and WH for each class A1-G for both primary and secondary heating in kWh/yr. We did the same for Lighting and Pumps electricity use. This gave an average energy use value for each BER class. This is an important step in our methodology as we found that although the energy consumed per m2 in some homes is low, the total energy consumed by the home is relatively high: i.e., the home is energy efficient, but it is larger than average. Thus, the total energy consumption and emissions for the home are larger than others in the BER class.

We then estimated the appliance and cooking energy use for each home. This was not assumed to be a simple percentage of the overall energy use added. Appliance use does not relate directly to energy efficiency of the building. An A1 passive house using an electric fridge and kettle will use the more or less the same electricity as a C1 house also using an electric fridge and kettle. We arrive instead at an estimated energy use for appliances based on the findings from the SEAI that appliances use on average 10% of the homes energy and cooking 2%. We aggregated the energy use for all homes in the SEC area arriving at an estimate of 2,303 kWh/yr for appliances and 444 kWh/yr for cooking. This is closely related to a figure of 2368 kWh/yr for appliances and 448 kWh/yr for cooking from a 2014 DECC Survey of 250 UK homes[59].

When we added appliance and cooking energy (which here we assume as electrical energy), we arrive at the overall average energy use per BER Class for each ED (Table 22).

[59] Jason Palmer, Nicola Terry, 2014, Powering the Nation 2: Electricity use in homes, and how to reduce it, DECC, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/325741/Powering_the_Nation_2_260614.pdf

Table 22: AVERAGE TOTAL kwh/yr BER by ED

	Barna	Claddagh	Dangan	Eyre Square	Knock-nacarragh	Menlough	Newcastle	Nun's Island	Rahoon	Rockbarton	Salthill	Shantalla	St Nicolas	Taylors Hill
A1	10,337	11,064	2,747	444	11,650	12,617	2,747	2,747	16,340	10,375	12,528	2,747	2,747	14,340
A2	9,729	10,008	9,618	10,552	14,233	11,214	8,238	14,442	9,590	10,030	7,720	7,339	2,747	15,551
A3	10,879	11,404	10,222	12,719	18,749	12,162	16,666	10,778	12,356	13,890	12,214	10,234	8,846	8,208
B1	20,775	17,163	22,663	11,217	30,203	22,727	21,910	15,638	12,125	19,006	21,006	15,383	11,068	14,987
B2	21,642	21,861	17,777	25,905	35,784	24,443	11,767	17,298	16,931	28,406	19,508	16,422	13,554	26,520
B3	23,934	23,648	22,703	23,458	19,905	18,924	18,303	18,207	19,697	30,645	20,949	21,068	15,292	30,760
C1	24,414	21,058	22,174	22,750	27,568	19,108	20,408	22,276	20,368	27,388	22,468	20,661	14,848	29,312
C2	25,675	21,893	21,300	23,946	25,650	20,226	19,913	20,290	22,097	29,732	23,360	22,214	17,579	28,429
C3	26,580	23,566	21,901	25,972	31,604	21,829	21,555	21,111	24,391	30,622	24,533	22,163	19,421	29,044
D1	27,005	22,043	24,370	27,467	28,825	23,670	23,059	21,079	21,136	33,845	23,835	23,723	20,859	28,607
D2	28,649	22,779	26,584	28,696	28,740	25,302	23,893	24,798	24,281	36,855	26,536	27,440	22,216	30,122
E1	28,960	25,969	27,956	29,192	24,807	28,961	24,726	25,793	28,700	37,108	28,219	34,529	24,652	30,413
E2	28,853	26,533	29,332	30,368	37,301	29,537	25,444	23,823	31,075	44,163	38,223	30,014	25,979	33,431
F	31,068	33,376	34,578	38,695	28,981	32,075	32,304	31,730	37,232	50,943	41,711	37,488	29,323	35,378
G	69,759	40,597	38,949	46,176	71,982	51,263	45,093	42,188	48,945	59,348	59,877	49,489	42,314	60,593

Table 23: Assumed BERs for all homes by ED and SEC area

	Barna	Claddagh	Dangan	Eyre Square	Knock-nacarragh	Menlough	Newcastle	Nun's Island	Rahoon	Rockbarton	Salthill	Shantalla	St Nicolas	Taylors Hill	SEC AREA
CSO [1]	5,702	1,213	1,624	1,410	655	2,022	771	724	1,149	606	1,595	609	1,104	1,104	20,288
A1[2]	20	5	0	0	4	4	0	0	5	4	7	0	0	7	54
A2	208	11	5	1	11	14	7	2	112	28	21	2	0	7	430
A3	247	38	22	4	11	14	9	6	38	13	33	15	4	2	456
B1	50	11	4	4	16	5	5	6	29	23	12	8	4	3	180
B2	125	23	9	4	23	14	4	13	48	30	54	10	9	27	394
B3	368	48	51	27	74	68	11	15	94	40	101	10	29	56	992
C1	667	72	108	75	85	169	31	40	130	53	143	27	43	80	1,722
C2	976	99	165	130	115	186	62	30	153	72	193	42	95	101	2,421
C3	1,338	158	240	207	97	385	119	49	150	60	239	63	103	138	3,346
D1	1,020	181	276	267	83	455	172	93	119	89	234	81	156	187	3,414
D2	440	206	251	264	74	389	114	105	95	77	228	94	169	151	2,658
E1	130	99	174	148	14	158	75	63	41	28	99	48	148	108	1,332
E2	65	88	161	105	29	68	77	78	74	32	85	50	101	109	1,123
F	32	77	103	90	11	81	46	65	51	23	68	81	94	86	906
G	18	97	55	85	7	11	38	160	11	34	77	79	148	43	861

[1] Number of occupied or temporarily unoccupied in 2016 census

[2] Assumed number of houses for each BER Class based on % of homes in that ED with BER of that class.

Table 24: ESTIMATED Total Energy Use by BER and ED in kWh/yr

	Barna	Claddagh	Dangan	Eyre Square	Knock-nacarragh	Menlough	Newcastle
A1	202,438	59,559	0	0	42,042	45,233	0
A2	2,022,690	107,746	52,828	14,157	154,092	160,811	60,344
A3	2,687,683	429,738	224,594	51,189	202,989	174,411	152,606
B1	1,032,811	184,780	82,988	45,145	490,479	122,217	120,373
B2	2,706,054	509,957	162,736	104,260	839,388	350,519	43,098
B3	8,797,640	1,145,701	1,163,859	629,426	1,472,616	1,289,023	201,118
C1	16,292,948	1,511,477	2,395,273	1,709,137	2,337,982	3,219,707	635,370
C2	25,063,629	2,160,612	3,509,815	3,116,234	2,962,070	3,770,630	1,239,926
C3	35,557,511	3,721,175	5,252,789	5,365,885	3,079,402	8,412,897	2,565,903
D1	27,541,971	3,994,970	6,737,447	7,333,036	2,392,564	10,776,989	3,969,498
D2	12,602,443	4,700,512	6,668,100	7,584,091	2,126,187	9,842,165	2,712,930
E1	3,752,002	2,562,928	4,862,577	4,308,005	358,102	4,568,412	1,856,572
E2	1,869,080	2,332,894	4,725,846	3,177,833	1,076,887	2,011,977	1,957,097
F	982,866	2,575,216	3,545,321	3,478,170	313,762	2,587,324	1,478,980
G	1,261,089	3,933,714	2,139,360	3,902,812	519,541	551,354	1,734,189
TOTAL	142,372,855	29,930,978	41,523,534	40,819,380	18,368,103	47,883,671	18,728,003

	Nun's Island	Rahoon	Rockbarton	Salthill	Shantalla	St Nicolas	Taylors Hill	SEC AREA
A1	0	74,112	39,173	87,354	0	0	95,080	**438,123**
A2	27,443	1,072,891	284,032	161,492	14,098	0	103,112	**4,326,494**
A3	61,443	467,004	183,552	404,526	157,283	38,397	13,607	**5,518,388**
B1	89,146	348,280	430,575	256,319	118,210	48,043	49,685	**3,287,927**
B2	230,094	819,107	858,014	1,054,173	157,748	117,667	703,385	**8,375,848**
B3	276,784	1,846,311	1,214,936	2,118,044	202,377	442,540	1,733,653	**21,783,849**
C1	888,942	2,648,268	1,447,729	3,211,642	555,698	644,518	2,332,283	**38,728,077**
C2	616,894	3,374,049	2,132,914	4,519,984	938,873	1,678,698	2,874,630	**55,739,479**
C3	1,043,009	3,650,671	1,849,904	5,858,743	1,405,085	1,995,127	3,996,049	**82,285,446**
D1	1,962,743	2,524,356	3,003,065	5,567,396	1,914,175	3,259,528	5,358,560	**85,237,303**
D2	2,591,760	2,312,700	2,852,654	6,059,651	2,583,045	3,760,938	4,543,849	**71,546,542**
E1	1,617,448	1,171,518	1,050,806	2,803,842	1,658,358	3,638,316	3,276,916	**38,044,063**
E2	1,856,095	2,302,052	1,417,339	3,264,836	1,499,176	2,631,269	3,657,535	**34,803,873**
F	2,050,021	1,913,797	1,154,083	2,835,673	3,024,834	2,757,846	3,049,552	**32,028,461**
G	6,734,124	517,977	2,016,720	4,592,540	3,898,053	6,244,953	2,611,491	**44,694,087**
TOTAL	20,045,944	25,043,094	19,935,497	42,796,215	18,127,015	27,257,842	34,399,387	**526,837,961**

8.7.2 Levelized cost of electricity

$$\text{LCOE} = \frac{\text{Sum of Costs over Lifetime}}{\text{Sum of Electrical Energy Over Lifetime}} = LCOE = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

I_t = Investment expenditures in year t (including financing)
M_t = Operations and maintenance expenditures in year t
F_t = Fuel expenditures in year t
E_t = Electricity generation in year t
r = Discount rate
n = Life of the system

8.8 Data Tables Used

Table 25: Persons per home by ED

ED	Occupied Homes	Population	Persons Per Home	As % of mean
Barna	5,702	15,185	2.7	103.8%
Claddagh	1,213	2,593	2.1	83.3%
Dangan	1,624	4,132	2.5	99.1%
Eyre Square	1,410	4,108	2.9	113.5%
Knocknacarra	655	1,490	2.3	88.6%
Menlough	2,022	5,118	2.5	98.6%
Newcastle	771	1,895	2.5	95.8%
Nun's Island	724	1,474	2.0	79.3%
Rahoon	1,149	3,076	2.7	104.3%
Rockbarton	606	2,097	3.5	134.8%
Salthill	1,595	3,633	2.3	88.7%
Shantalla	609	1,912	3.1	122.3%
St Nicolas	1,104	2,394	2.2	84.5%
Taylors Hill	1,104	2,966	2.7	104.7%
SEC	**20,288**	**52,073**	**2.6**	**100.0%**

Table 26: tCO2 per Sq km and Variation above mean.

Electoral Division	tCO2 per Sq km	Variation above mean
Barna	6,139.3	119%
Claddagh	11,771.0	228%
Dangan	7,843.2	152%
Eyre Square	12,311.1	238%
Knocknacarragh	2,591.3	50%
Menlough	1,766.1	34%
Newcastle (WDZ)	7,678.7	148%
Nun's Island	9,119.5	176%
Rahoon	1,561.7	30%
Rockbarton	8,088.9	156%
Salthill	16,564.1	320%
Shantalla (WDZ)	9,872.9	191%
St Nicolas	9,401.0	182%
Taylors Hill	13,441.1	260%
SEC	5,173.1	**100%**

Table 27: Spend on Energy per ED in Euro per year

	OIL	GAS	ELECTRICITY	OTHER	TOTAL
Price per kWh[60]	**€0.1116**	**€0.1544**	**€0.29.5 [1]**	**€0.1195**	
ED	€/yr	€/yr	€/yr	€/yr	
Barna	€9,031,563	€1,495,352	€13,112,689	€873,564	€24,513,168
Claddagh	€1,542,225	€79,153	€3,720,649	€356,915	€5,698,943
Dangan	€2,581,463	€159,867	€3,404,551	€694,999	€6,840,879
Eyre Square	€803,031	€119,036	€7,533,615	€316,312	€8,771,994
Knocknacarragh	€996,874	€276,595	€1,907,530	€140,761	€3,321,761
Menlough	€2,699,575	€36,487	€5,519,419	€567,353	€8,822,833
Newcastle (WDZ)	€1,055,562	€32,309	€1,586,325	€440,110	€3,114,306
Nun's Island	€684,681	€227,973	€2,781,961	€358,969	€4,053,584
Rahoon	€1,077,472	€727,826	€2,412,454	€448,562	€4,666,314
Rockbarton	€1,375,818	€141,793	€1,488,907	€196,206	€3,202,723
Salthill	€1,750,540	€219,433	€6,895,076	€276,766	€9,141,815
Shantalla (WDZ)	€1,043,512	€46,846	€1,669,620	€336,203	€3,096,181
St Nicolas	€550,584	€49,762	€5,371,619	€453,279	€6,425,243
Taylors Hill	€2,024,540	€224,927	€3,336,683	€417,148	€6,003,298
SEC AREA	**€27,217,439**	**€3,837,359**	**€60,741,097**	**€5,877,147**	**€97,673,042**

[1] Electricity cost is taken as the mid-point between night rate and standard rate as not all homes use night rate. This may, however, be an overestimation.

[60] https://www.seai.ie/publications/Domestic-Fuel-Cost-Comparison.pdf Electricity is band DC, Other is mean of coal and peat, Gas is band D2

Table 28: Car Fuel Assumptions

	km/yr	€/L	g CO2/L	L/100km	kWh/L	Efficiency
Diesel	19,681	€1.53	2640	4.81	10.00	30%
Petrol	12,113	€1.62	2310	5.52	8.60	25%

Table 29: Petrol and Diesel Calculations for ED and SEC

Cars	Total Vehicles	Diesel	Petrol	Diesel Kms	Petrol Kms	Cost Diesel €	Cost Petrol €	Emissions Diesel tCO2	Emissions Petrol tCO2	Total Emissions tCO2
Barna	5,516	2,391	2,641	47,063,314	31,989,783	€3,463,967	€2,862,629	5,977	6,005	11,982
Claddagh	1134	492	543	9,675,453	6,576,580	€712,135	€588,510	1,229	1,235	2,463
Dangan	1512	655	724	12,900,604	8,768,773	€949,514	€784,680	1,638	1,646	3,284
Eyre Square	1269	550	608	10,827,292	7,359,506	€796,913	€658,571	1,375	1,382	2,757
Knocknacarragh	617	267	295	5,264,334	3,578,263	€387,467	€320,203	669	672	1,340
Menlough	1823	790	873	15,554,101	10,572,403	€1,144,817	€946,079	1,975	1,985	3,960
Newcastle	713	309	341	6,083,420	4,135,010	€447,754	€370,024	773	776	1,549
Nun's Island	659	286	316	5,622,684	3,821,840	€413,842	€342,000	714	717	1,432
Rahoon	1110	481	531	9,470,681	6,437,393	€697,064	€576,055	1,203	1,208	2,411
Rockbarton	592	257	283	5,051,030	3,433,276	€371,767	€307,229	641	645	1,286
Salthill	1450	629	694	12,371,611	8,409,207	€910,579	€752,504	1,571	1,579	3,150
Shantalla	563	244	270	4,803,598	3,265,092	€353,556	€292,179	610	613	1,223
St Nicolas	962	417	461	8,207,924	5,579,074	€604,122	€499,247	1,042	1,047	2,090
Taylors Hill	1046	453	501	8,924,624	6,066,228	€656,873	€542,841	1,133	1,139	2,272
SEC AREA	18,966	8,222	7,005	161,820,669	84,848,582	€11,910,369	€7,592,736	20,551	20,648	41,200

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Table 30: Private Car Vehicle Energy Use in kWh/yr

Cars	Diesel Energy kWh	Petrol Energy kWh	Car Energy kWh
Barna	22,640,306	15,389,024	38,029,331
Claddagh	4,654,479	3,163,733	7,818,213
Dangan	6,205,972	4,218,311	10,424,284
Eyre Square	5,208,584	3,540,368	8,748,952
Knocknacarragh	2,532,464	1,721,361	4,253,825
Menlough	7,482,465	5,085,967	12,568,432
Newcastle	2,926,494	1,989,190	4,915,684
Nun's Island	2,704,852	1,838,536	4,543,388
Rahoon	4,555,972	3,096,776	7,652,748
Rockbarton	2,429,852	1,651,614	4,081,466
Salthill	5,951,495	4,045,338	9,996,833
Shantalla	2,310,822	1,570,707	3,881,529
St Nicolas	3,948,509	2,683,873	6,632,381
Taylors Hill	4,293,285	2,918,223	7,211,508
SEC AREA	77,845,549	52,913,023	130,758,572

Note KWh in fossil fuels do not relate directly to kms travelled per kWh in EVs as they have different efficiencies. See Table 28

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Table 31: Domestic Energy Use per ED: Energy, Emissions and Cost

	Home Energy Total MWh	Home Energy Emissions Total tCO2	Home Energy Cost €	Private Car Energy MWh	Private Car Emissions tCO2	Private Car Cost €	Domestic Sector Energy MWh	Domestic Sector Emissions tCO2	Domestic Sector Costs €
Barna	142,373	41,380	€24,513,168	38,029,331	11,982	€6,326,595	180,402	53,363	€30,839,763
Claddagh	29,931	9,109	€5,698,943	7,818,213	2,463	€1,300,645	37,749	11,572	€6,999,588
Dangan	41,524	12,410	€6,840,879	10,424,284	3,284	€1,734,194	51,948	15,695	€8,575,073
Eyre Square	36,151	11,500	€8,771,994	8,748,952	2,757	€1,455,484	44,900	14,256	€10,227,478
Knock-nacarragh	18,368	5,361	€3,321,761	4,253,825	1,340	€707,670	22,622	6,701	€4,029,431
Menlough	47,884	14,528	€8,822,833	12,568,432	3,960	€2,090,896	60,452	18,488	€10,913,730
Newcastle	18,728	5,710	€3,114,306	4,915,684	1,549	€817,778	23,644	7,259	€3,932,084
Nun's Island	20,046	6,157	€4,053,584	4,543,388	1,432	€755,842	24,589	7,589	€4,809,426
Rahoon	26,300	7,628	€4,666,314	7,652,748	2,411	€1,273,118	33,953	10,040	€5,939,432
Rockbarton	19,936	5,808	€3,202,723	4,081,466	1,286	€678,996	24,017	7,094	€3,881,720
Salthill	42,796	13,122	€9,141,815	9,996,833	3,150	€1,663,083	52,793	16,272	€10,804,898
Shantalla	18,127	5,485	€3,096,181	3,881,529	1,223	€645,735	22,009	6,708	€3,741,916
St Nicolas	27,258	8,774	€6,425,243	6,632,381	2,090	€1,103,369	33,890	10,864	€7,528,612
Taylors Hill	34,399	10,231	€6,003,298	7,211,508	2,272	€1,199,713	41,611	12,504	€7,203,011
SEC AREA	523,821	157,203	€97,673,042	130,758,574	41,199	€21,753,118	654,579	198,405	€119,426,162

ED	Home Energy Total kWh/yr	Home Energy Emissions Total tCO2/yr	Home Energy Cost €/yr	Private Car Energy kWh/yr	Private Car Emissions tCO2/yr	Private Car Cost €/yr	Domestic Sector Energy kWH/yr	Domestic Sector Emissions tCO2/yr	Domestic Sector Costs €/yr
Barna	142,372,855	41,380	€24,513,168	38,029,331	11,982	€6,326,595	180,402,186	53,363	€30,839,763
Claddagh	29,930,978	9,109	€5,698,943	7,818,213	2,463	€1,300,645	37,749,191	11,572	€6,999,588
Dangan	41,523,534	12,410	€6,840,879	10,424,284	3,284	€1,734,194	51,947,818	15,695	€8,575,073
Eyre Square	36,151,218	9,456	€6,946,947	8,748,952	2,757	€1,455,484	44,900,171	12,212	€8,402,431
Knocknacarragh	18,368,103	5,361	€3,321,761	4,253,825	1,340	€707,670	22,621,927	6,701	€4,029,431
Menlough	47,883,671	14,528	€8,822,833	12,568,432	3,960	€2,090,896	60,452,103	18,488	€10,913,730
Newcastle	18,728,003	5,710	€3,114,306	4,915,684	1,549	€817,778	23,643,687	7,259	€3,932,084
Nun's Island	20,045,944	5,114	€3,122,367	4,543,388	1,432	€755,842	24,589,333	6,546	€3,878,209
Rahoon	25,043,094	5,342	€2,624,687	7,652,748	2,411	€1,273,118	32,695,841	7,753	€3,897,805
Rockbarton	19,935,497	5,808	€3,202,723	4,081,466	1,286	€678,996	24,016,962	7,094	€3,881,720
Salthill	42,796,215	13,122	€9,141,815	9,996,833	3,150	€1,663,083	52,793,047	16,272	€10,804,898
Shantalla	18,127,015	5,485	€3,096,181	3,881,529	1,223	€645,735	22,008,544	6,708	€3,741,916
St Nicolas	27,257,842	16,244	€13,095,197	6,632,381	2,090	€1,103,369	33,890,223	18,334	€14,198,567
Taylors Hill	34,399,387	10,231	€6,003,298	7,211,508	2,272	€1,199,713	41,610,896	12,504	€7,203,011
SEC AREA	**522,293,683**	**159,301**	**€99,545,106**	**118,662,859**	**41,200**	**€19,503,105**	**640,956,542**	**200,501**	**€119,048,211**

Table 32: Energy Use by Non-Domestic Sector

	Retail	Office	Restaurant/ public house	Hotel	Warehouses	Workshops/ maintenance depot	Industrial process building	Community/ day centre	Nursing residential homes	Schools and colleges	Sports facilities	Total MWh/yr
Building type area m2	279	394	207	4,050	578	298	3,139	587	1,490	2,434	447	
Number	536	465	313	29	4	7	27	19	0	36	43	
Total m2	149544	183210	64791	117450	2312	2086	84753	11153	0	87624	19221	
kWh/m2	1,085	550	1,184	485	754	739	876	323	268	137	1,074	
Total MWh/yr	162,255	100,766	76,713	56,963	1,743	1,542	74,244	3,602	0	12,004	20,643	510,475

Table 33: Fuel type usage by sector[61]

	Electricity	Gas	Renewables	Heating Oil
Industry	27.50%	61.00%	2%	9.20%
Accommodation and Food: Restaurant/ public house and Hotel	62%	20%	0.60%	17%
Workshops/ maintenance depot	73.6%	16.4%	1.75%	8.3%
Warehouse	71.70%	18.30%	0.29%	9.70%
Offices	73%	16.40%	1.75%	8.30%
Retail	71.70%	18.30%	0.29%	9.70%
Health, Community/Daycare Centre	32.50%	40%	1.38%	26.20%
Education	35.40%	20%	7%	37.50%
Sports and Recreation	25%	20%	1.50%	53.50%

Table 34: Public Buses in SEC

Route	One-Way Route Distance km	Number Journeys per Week	Total Km/wk	km/yr	Liters Diesel[62]	tCO2
401 Salthill	7.591	686	5,207	270,786	124,562	329
402 Seacrest	9.175	420	3,854	200,382	92,176	243
404 Newcastle Westside	7.957	448	3,565	185,366	85,268	225
405 Rahoon Knocknacarra	4.14	490	2,029	105,487	48,524	128
410 - Salthill Knocknacarra	9.7	140	1,358	70,616	32,483	86
411 Knocnakarra to Eyre Square	11.83	370	4,377	227,609	104,700	276
414 Barna	9.88	5	49	2,569	1,182	3
412 KnaC express	7.25	40	290	15,080	6,937	18

[61] https://www.seai.ie/data-and-insights/seai-statistics/energy-data/
[62] Taken as 46L/100km https://assets.gov.ie/69312/eadd09d7dd5a49f698dbb4a77db4c78c.pdf

Table 35: Goods Vehicles Calculations

GVs by Weight t	L/100km	% of Goods Vehicles (GV) Ireland[63]	Est Number of GV in SEC[64]	Average kms by type	Total kms	Total L diesel	Total Energy MWh
0 to 2	12.8	62.87%	2,597	18,584	48,256,550	6,176,838	61,768
2 to 5	16	27.75%	1,146	22517	25,805,638	4,128,902	41,289
5 to 7.5	18	1.25%	52	24,482	1,267,275	228,110	2,281
7.5 to 10	20	1.84%	76	33,338	2,528,562	505,712	5,057
10 to 12.5	25	2.32%	96	42,233	4,051,025	1,012,756	10,128
Over 12.5	25	3.96%	164	57,721	9,446,608	2,361,652	23,617
ALL GVs	**-**	**100.00%**	**4,130**	**-**	**91,355,658**	**14,413,971**	**144,140**

Table 36: All non-domestic transport SEC area: Diesel, Energy and CO2 emissions per yr

	Goods vehicles	Tractors and machinery	Small PSVs[65]	All Transport
SEC	4,130	1,097	197	5,423
Average km	-	17,066	40,504	-
Total km	91,355,658	18,713,901	7,962,506	118,032,066
L/100km	-	12	6	-
Total Liters	14,413,971	2,245,668	477,750	17,137,389
Total MWh	144,140	22,457	4,778	171,374
Total CO2	**33,296**	**5,187**	**1,104**	**39,587**

[63] https://www.cso.ie/en/releasesandpublications/ep/p-tranom/transportomnibus2019/roadtrafficvolumes/
Table 5.8
[64] Ibid Table 5.4a with Galway data based on SEC population 20.2% of county.
[65] Taxis and minibuses

Table 37: MWh per person per year 2019 County, National and SEC area[66]

County	MWh	Persons	MWh/person
Carlow	395,420	56,875	6.95
Cavan	2,267,850	76,092	29.80
Clare	697,800	118,627	5.88
Cork	5,628,920	542,196	10.38
Donegal	848,990	158,755	5.35
Dublin	111,333,990	1,345,402	82.75
Galway	**1,779,390**	**258,552**	**6.88**
Kerry	1,535,160	147,554	10.40
Kildare	4,686,890	222,130	21.10
Kilkenny	1,686,350	99,118	17.01
Laois	302,380	84,732	3.57
Leitrim	186,080	31,972	5.82
Limerick	9,059,770	195,175	46.42
Longford	441,940	40,810	10.83
Louth	3,349,440	128,375	26.09
Mayo	1,093,220	130,425	8.38
Meath	1,500,270	194,942	7.70
Monaghan	360,530	61,273	5.88
Offaly	2,523,710	78,003	32.35
Roscommon	220,970	64,436	3.43
Sligo	872,250	65,357	13.35
Tipperary	1,837,540	160,441	11.45
Waterford	1,360,710	116,401	11.69
Westmeath	976,920	88,396	11.05
Wexford	1,035,070	149,605	6.92
Wicklow	581,500	142,332	4.09
Average			15.60
SEC	**686,807**	**52,073**	**13.19**

There is a wide variation between MWh per person across counties. Some counties have intensive industry (Dublin) and Cavan has a lot of intensive energy agriculture (pigs and poultry). Galway County's below average MWh/pp may be as a result of large parts of the county being rural with non-intensive agriculture. As we can see, the SEC's urban setting makes it on average a higher energy using community than the surrounding county.

[66] https://www.cso.ie/en/releasesandpublications/ep/p-beu/businessenergyuse2019/ From Table 7a with CSO 2016 population data.

Table 38: Energy and CO2 based on retrofit programme in SEC

	Per Home kWh/y	% of SEC Average	Reduction kWh/y	Total kWh/yr	Total tCO2 reduction
Barna	17,488	104.9%	7,481	42,653,895	11,670
Claddagh	16,436	98.6%	8,239	9,994,448	2,734
Dangan	15,581	93.5%	9,987	16,219,183	4,438
Eyre Square	13,902	83.4%	11,737	16,549,022	4,528
Knocknacarragh	26,957	161.7%	1,086	711,112	195
Menlough	18,048	108.3%	5,633	11,390,848	3,117
Newcastle	15,187	91.1%	9,104	7,019,182	1,920
Nun's Island	15,209	91.3%	12,479	9,034,667	2,472
Rahoon	16,150	96.9%	6,740	7,743,840	2,119
Rockbarton	21,643	129.9%	11,254	6,819,852	1,866
Salthill	16,684	100.1%	10,147	16,185,070	4,428
Shantalla	13,250	79.5%	16,515	10,057,685	2,752
St Nicolas	9,444	56.7%	15,246	16,831,143	4,605
Taylors Hill	18,054	108.3%	13,105	14,467,514	3,958
SEC AREA	16,667	100.0%	9,152	185,677,461	50,801

Assumed that C1-G homes will be retrofitted to a minimum of B2. With 25% to each BER rating B2-A2. Existing homes from B3 to A1 are not retrofitted.

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