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Energy Master Plan for the Community of Enniscorthy Co. Wexford

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Sustainable Enniscorthy

Comhairle Contae Loch Garman
Wexford County Council

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Purpose of this document

This document presents the Energy Master Plan for the Sustainable Enniscorthy Sustainable Energy Community.

GDPR

General Data Protection Regulation (GDPR) is an EU data privacy and security law. If you process the personal data of EU citizens or residents, or you offer goods or services to such people, then the GDPR applies to you even if you're not in the EU. KRA Renewables has made sure that the personal data captured during the EMP process meet the requirements of GDPR, particularly for this final EMP report, which will be available to SEAI to be published and shared as required.

Preface

This report serves as the final deliverable for the Energy Master Plan for Enniscorthy, conducted in collaboration with the Sustainable Enniscorthy SEC and Wexford County Council. This project presents the formulation, potential, and barriers responsible in developing a sustainable energy road map for the community of Enniscorthy. The report encapsulates the culmination of extensive work undertaken for this Energy Master Plan.

We extend our heartfelt gratitude to Fiona O'Loughlin and Yvonne Byrne SEC mentors, for their invaluable guidance, unwavering support, and constructive feedback throughout this project. Our sincere thanks also go to Irene Cadogan, Chairperson of SEC Enniscorthy, for sharing her wealth of experience and insights, which proved instrumental in navigating project uncertainties.

We extend our appreciation to Fiona McCoole and Feidhlim O'Shea, fellow SEC members, for their unwavering support and enthusiasm during the project's duration.

The authors of this report wish to express their gratitude to the Retrokit team for their collaboration on the residential sector of the EMP. Their openness to feedback and willingness to adapt ensured that this project bore a distinctive and personal touch.

Together, we have endeavoured to chart a sustainable course for Enniscorthy, and this report encapsulates our collective efforts.

KRA Renewables Team,

Date: 15/01/2024

1. Introduction

1.1. Sustainable Enniscorthy SEC

Sustainable Enniscorthy is a voluntary community group established in 2019 to focus on the incorporation of the UN Sustainable Development Goals and bring about positive change in Enniscorthy. It is led by a committee of local volunteers who work on a range of sustainability focused projects in the area. This area (Enniscorthy Urban and Rural Electoral Division) is shown below in Figure 1. As part of its work Sustainable Enniscorthy have become a Sustainable Energy Community (SEC) through the SEAI programme

The vision of the Sustainable Enniscorthy is that Enniscorthy is a thriving town where the community is working together to make it an even better place to live, work and visit, with a strong focus on sustainability. One of the areas of action for Sustainable Enniscorthy is energy and it became an SEC in order to:

- Work with stakeholders and communities in Enniscorthy to deliver a sustainable roadmap to a more energy efficient town.
- Facilitate, advocate, help make connections, deliver projects, support the work of others, educate, communicate, and raise awareness.
- Be a driver of actions to support increased energy efficiency that will promote increased health outcomes and wellbeing in Enniscorthy.

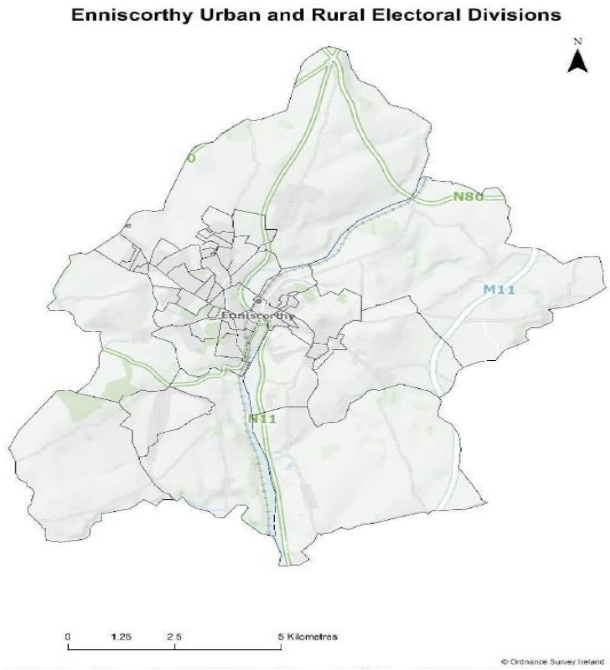

Figure 1:Enniscorthy EMP study area

The SEC is just one of the key projects undertaken by Sustainable Enniscorthy. Sustainable Enniscorthy has two pillars for action, (1) Sustainability and (2) Health and Wellbeing, and under each pillar are three sub-themes. The sub-themes for Sustainability are Energy, Biodiversity and Circular Economy. The sub-themes for Health & Wellbeing are Air Quality, Water Quality and Active Travel. The group have chosen these pillars as priority areas as they feel Sustainable Enniscorthy has the potential to make positive changes in Enniscorthy through various activities. Each of these priorities will be pursued with an emphasis on a Just Transition lens. This Energy Master Plan focuses on the sub-theme of Energy, with acknowledgement of the importance of all other sub-themes.

A key activity for Sustainable Enniscorthy in 2022-2023 is the progression of the SEC Energy Master Plan. With the vision of become an energy efficient community that reduces its carbon footprint and has a positive impact on the local community and businesses in the town. The SEC plans to do this by:

• Supporting the community and stakeholders in reducing energy consumption and costs for homeowners while improving their home comfort levels.

• Improving the energy performance of Enniscorthy's buildings based on the findings of an audit.

• Increasing the renewable energy in the SEC region.

• Reducing energy consumption for the SEC region.

• Creating greater awareness of and promoting better energy choices in the community.

Enniscorthy as a Decarbonisation Zone

Enniscorthy was chosen for decarbonization initiatives by the Wexford County Council (WCC), with the expertise of the 3 Counties Energy Agency (3CEA) being harnessed to conduct a decarbonisation of baseline study. This study delves into the methodologies and outcomes associated with energy utilisation and emissions in residential, commercial and transport sectors within the Enniscorthy region. Its primary objective is to cultivate awareness surrounding climate change and underline the profound impact that distinct sectors within Enniscorthy exert on Ireland's overarching carbon emissions and energy consumption. By equipping WCC and the Sustainable Enniscorthy group with critical insights, this decarbonisation baseline report empowers them to make informed decisions regarding climate action. These decisions are instrumental in reducing carbon emissions within the areas under their purview and solidify the group's pivotal role in facilitating the town's decarbonization efforts.

1.2. SEAI Sustainable Energy Communities

The Sustainable Energy Communities (SEC) Programme is a comprehensive initiative developed by the SEAI that engages and empowers communities in Ireland to work together towards achieving sustainable energy goals. With over 750 communities participating, the program offers numerous benefits and support mechanisms to help communities transition towards a more sustainable energy future.

Program Objective: The SEC Programme aims to promote sustainable energy practices at the community level by encouraging energy citizens to collaborate and adopt energy-efficient and renewable energy solutions.

Benefits for Communities:

Financial and Energy Savings: Communities can achieve cost savings through reduced energy consumption and improved energy efficiency.

Improved Public Wellbeing: Energy-efficient buildings contribute to enhanced public comfort and wellbeing.

Local Knowledge and Skills: The program helps boost local knowledge and skills in sustainable energy practices, potentially leading to employment opportunities.

Capacity Building: Communities build capacity in sustainable energy planning and implementation.

Funding Support: The program provides access to funding opportunities, including grants for developing Energy Master Plans.

Climate Change Contribution: Communities play a role in meeting climate change targets by reducing greenhouse gas emissions.

Equitable Transition: The program supports a fair and equitable transition to a low-carbon society, ensuring that no one is left behind.

Supports for Communities:

Local Mentorship: Communities are assigned a local mentor from the Sustainable Energy Authority of Ireland (SEAI) who provides guidance based on their specific needs and interests.

Financial Support: Communities can access dedicated funding (€10,000-€25,000) to develop Energy Master Plans, enabling them to plan and implement sustainable energy projects.

Information Sharing: Communities are kept informed about network activities, updates, and opportunities through community platforms, e-zines, and network-only groups.

Training and Events: Participants have the chance to attend regional and national training sessions, events, and webinars to enhance their knowledge and skills in sustainable energy practices.

Funding Guidance: Communities receive guidance on additional funding opportunities beyond the SEC Programme.

1.3. KRA Renewables

KRA Renewables is an independent energy and sustainability consultancy, founded in 2018 and operating in Ireland and the U.K. KRA Renewables specialises in Built-Environment Energy, Utility-Scale Renewable Energy Production, ESG and Community Energy. KRA Renewables approach is highly data-driven and leverages a flexible, outside-of-the-box approach to our private sector, public sector and community projects alike, focusing on quality, impact and cost-effectiveness.

KRA's team of Renewable Energy Engineers, Domestic and Non-Domestic BER Assessors, Certified Energy Auditors, Grant Coordinators and experienced Project Managers handle projects at all scales.

2. Energy Master Plan

2.1. Scope of the Energy Master Plan

The energy master plan acts as a key asset for Sustainable Enniscorthy to transition towards a more energy efficient community and a decarbonisation zone that reduces its carbon footprint. As part of the development of the energy master plan the following activities were carried out.

- Defining the boundaries for the study area based on small area division.
- Creation of Baseline Energy Balance for the three major energy consuming sectors
    - Residential- with a focus on permanently occupied dwellings in the study area.
    - Commercial and Industrial - including public buildings and commercial buildings/facilities (including small industry).
    - Transport- including fuel used in the study area, in cars, for freights, public transport.
- On-Site ASHRAE Level 1 Energy Audits for three community buildings.
- Register of Opportunities
    - A roadmap for energy retrofit of residential and non-residential buildings in the study area, with the potential to reduce energy use in buildings by 30% by 2030.
    - Options to reduce transport related emissions such as active travel and demand management measures.
    - Options for reducing solid fuel use through appliance improvements in the shorter term.
    - A high-level analysis of options increasing renewable energy resources within the study area using SEAI's LARES Sieve methodology.
    - Identifying the potential future feasibility studies.
    - Creating greater awareness of and promoting better energy choices.
- Sustainable Energy Roadmap- The 2030 sustainable road map design will help achieve the goal of energy efficient community that constantly reduces its carbon emissions.
- Community Engagement - Engagement in SEC meetings, public forums, and community events and gather community input, share information, raise awareness, and promote active participation. Providing discounts on energy audits to engaged commercial consumers willing to contribute to the creation of the energy baseline. Initiate dialogues with community members through Energy Master Plan presentations post-project completion to inform them about opportunities and sustainable pathways.

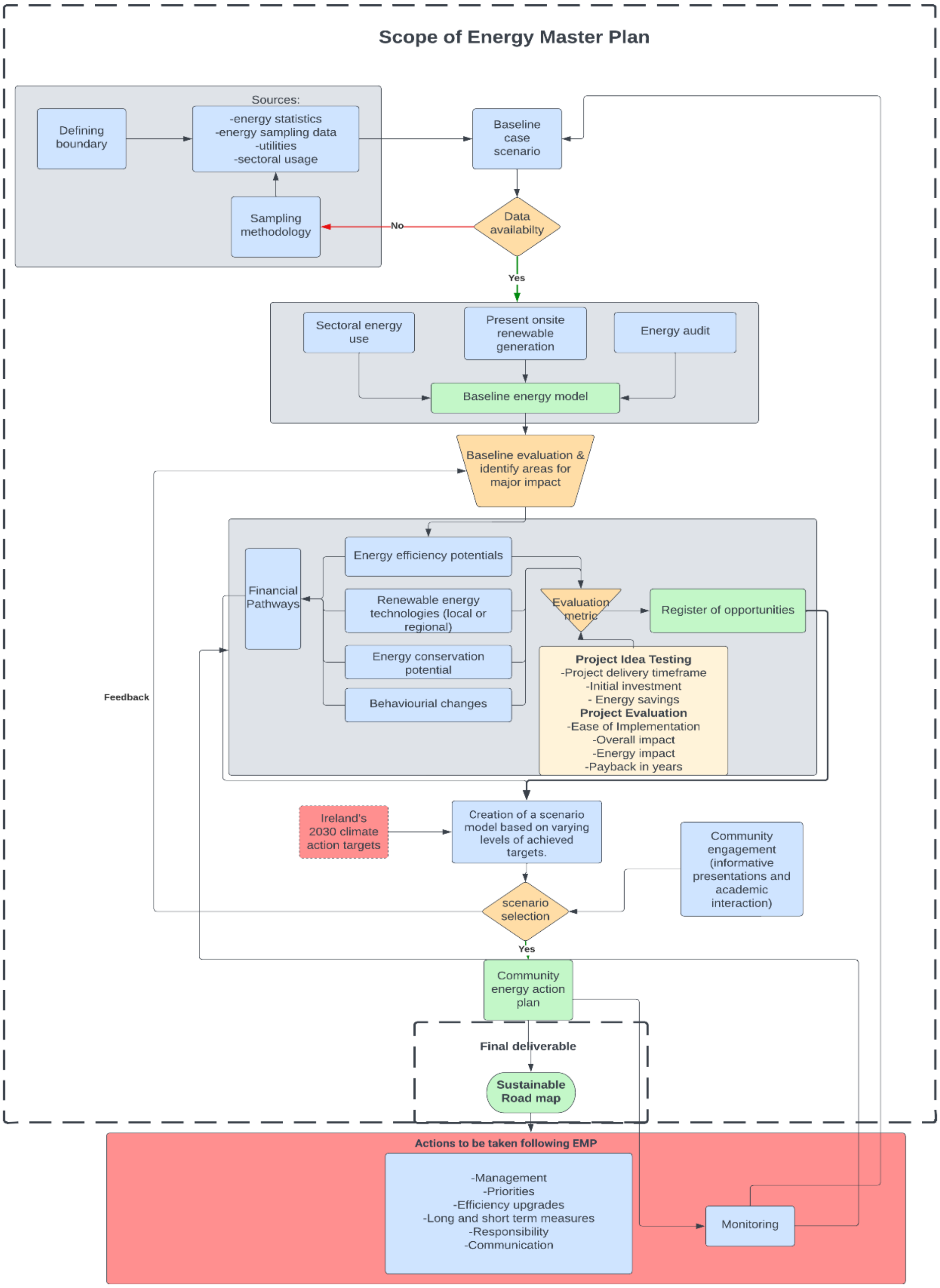

Figure 2:Flow diagram for the Scope of the EMP

2.2. Summary of the EMP outputs

1) Introduction: In alignment with the Sustainable Enniscorthy SEC and Wexford County Council, KRA Renewables have constructed the Energy Master Plan (EMP) for the Enniscorthy community. This plan encompasses a series of crucial outcomes, each geared towards Enniscorthy to transition towards a more energy efficient community and a decarbonisation zone that reduces its carbon footprint.

2) Energy Baseline: The initial milestone involved constructing an energy baseline, offering a comprehensive overview of the community's current energy consumption. This analysis included data from the residential, commercial, industrial, and transportation sectors, dissected by energy type and usage categories. Section 3 of this report provides a detailed breakdown of this energy baseline.

3) ASHRAE Level 1 Energy Audits: As a part of the EMP, ASHRAE Level 1 energy audits were conducted on three key community buildings. The findings and recommendations from these audits were issued separately to the SEC and the building occupants, shedding light on opportunities for energy their optimisation.

4) Backcasting Solution Strategy: The strategic approach revolved around Backcasting, a method where we envisioned a future state and worked backward to the present, devising strategies to achieve this vision. Section 4 elaborates on this approach's implementation within the EMP framework.

5) Proposal Development (Actionable solutions): Post-backcasting, a series of actionable solutions were explored, taking into account their potential impact on social, economic, and environmental aspects. These proposals were crafted through extensive research and dialogue with SEC members. A Balanced Scorecard was employed to evaluate and rate these solutions, complemented by the development of Key Performance Indicators (KPIs) for future measurement.

6) Balanced Scorecard and Register of Opportunity: An essential tool designed explicitly for Enniscorthy the Balanced Scorecard, serves as a living Register of Opportunity. Section 6 delves into the specifics of this invaluable resource, detailing how it aids in tracking progress and seizing opportunities for sustainable growth.

7) Resilience Strategies: Strategies: Enniscorthy's path to sustainability is further solidified by the development of integration strategies. These strategies offer a clear roadmap for effectively combining the various solutions proposed throughout the EMP.

8) Scenarios for Sustainability: Integral to the sustainable roadmap for Enniscorthy, scenarios were constructed based on input from the Register of Opportunities and the Balanced Scorecard. These scenarios categorize technologies and proposals, providing a structured approach to achieving our sustainability goals.

9) Sustainable Roadmap: The 2030 sustainable road map design will help achieve the goal of energy efficient community that constantly reduces its carbon emissions. All the technologies and energy savings are presented.

2.3. Methodology

The Table 1 below highlights the methodology used for the Energy Master Plan project.

Table 1: EMP Methodology

Data and tools used	SEC input	KRA Renewable's input
CSO & BER data	▪ Collation of data from CSO and SEAI sources ▪ Collection of small area data for the SEC region	▪ Data analysis based on CSO and small area division
Data collection – local small business	▪ Collection of the commercial and public sector building data ▪ Collection of the transport data	▪ Data analysis for the commercial and public buildings ▪ Data analysis for the transport ▪ Survey design & setup ▪ Analysis of results and creation of energy baseline
Home energy survey	▪ Outreach to local community for participation ▪ Distribution of survey questionnaire	▪ Survey design & setup ▪ Analysis of results ▪ Cross reference to CSO/BER data
Residential Baseline– (Retrokit)	▪ Collation of data from CSO and SEAI sources	▪ Creation of baseline for residential sector based on CSO data and SEAI BER map ▪ Modelling of 4 energy renovation scenarios ▪ Creation of anonymised home energy upgrade plans ▪ RoO for the residential sector ▪ Roadmap to deliver home energy retrofits
Energy Audits – non-residential	▪ Identification/selection of facilities/buildings for audit ▪ Coordination with owners/managers	▪ Onsite energy audit survey ▪ Energy audit reports with long term and short-term energy efficiency measures
Register of Opportunities	▪ Input on the identification of community energy efficiency and renewable energy projects	▪ Identification of energy efficiency projects in building environment ▪ Identification of behavioural projects in the community ▪ Analysis for Renewable Energy project potential ▪ Creation of live balance scorecard
Register of Opportunities and quantification of proposals	▪ Input on the identified technologies/ proposals ▪ Technology reediness level, for the proposals, in relation to the SEC region ▪ Review of the balance scorecard and structured draft	▪ Creation of economic, environmental and social KPIs ▪ Developing the scoring matrix for the technologies, in the balance score card ▪ Based on literature review quantification of technologies/proposals

		▪ Filter technological immature and infeasible proposals, with regards to SEC
Resilience Strategies (Scenario Planning)	▪ Review of the scenarios and input on the same	▪ Identifying four scenarios based on possible and optimal pathways to achieve the EMP targets ▪ Categorising technologies/ proposals to the suitable scenario based on scores from balance score card
Sustainable Roadmap model	▪ Review of the roadmap and input on the same	▪ Summarising all the deliverables results into a roadmap, using the scenarios.

Energy Audits for Community/Public Buildings

Direct energy audits are a valuable way to engage greater local participation in the EMP. They also provide a quick path to implementing energy upgrade projects. KRA Renewables conducted (ASHRAE level 1) energy systems review on three community/public buildings as part of the Enniscorthy SEC Energy Master Plan. The objective was to identify energy usage, costs, and CO_2 emissions while suggesting energy efficiency measures.

Note: Please refer to the separate energy audit report for each facility for detailed information on the energy audit study. The energy audits reports for each facility is separately delivered to the Enniscorthy SEC.

3. SEC Baseline Analysis

This section provides a sectoral baseline of energy use. The baseline analysis of the residential sector was carried out by Retrokit, a summary of their findings is outlined in section 3.1. Figures are expressed in kWh, CO2 and €.

CO_2 is the most important in terms of Climate objectives and € are the most tangible for the community of Enniscorthy and will give the report a greater impact. The costs have been estimated from the kWh figures using SEAI fuel cost comparison or similar.

Section 3.2 covers the baseline analysis which was carried out by KRA engineers on the baseline energy usage of the commercial sector.

3.1. Analysis of Residential Sector (RetroKit Baseline Analysis)

3.1.1.1. Building Stock for Sample Study Area

Retrokit was utilised for the development of the Residential Energy Baseline for the Enniscorthy community. RetroKit conducted their energy baseline analysis by first identifying 4,772 residential units within the region. The residential units underpinning their analysis were found by studying the SEAI BER research tool for Wexford as well as the SEAI's mapping tool for small area BER data, and the CSO 2016 small area mapping tool.

When analysing this data RetroKit first classifies it by categorising the property into 1 of 240 different archetype properties. The archetypes are classified based on 5 age bands, 4 dwelling types, 4 main space heating fuels and 3 main external wall types. The 240 different archetypes are the 240 different combinations that can be made from the different categories listed. The results of this can be seen in Table 2 below.

Table 2: Summary of Residential Housing Stock for the Enniscorthy SEC (Tabular)

Age band	Age band count	Dwelling type	Dwelling type count	Fuel type	Fuel type count	Wall type	Wall type count
0 - 1970	1,408	Apartment	425	Solid fuel	1,386	Timber frame	146
1971 - 1990	878	Terraced house	1,588	Electricity	571	Cavity	3,796
1991 - 2000	910	SemiD house	1,714	Heating oil	2,773	Solid/hollow	830
2001 - 2010	1,506	Detached	1,045	Gas/LPG	42		
2011 - 2021	70						
Total	4,772					Avg floor area	100m2

The contents of table 2 can also be displayed as percentages as shown below in figure 3. As evident from the data, the predominant archetype in the Enniscorthy housing stock is the semi-detached house. Furthermore, a significant portion of the housing stock was constructed between 2001 and 2010, with the next largest segment dating from 1971 to 1990. The prevailing wall construction type is cavity walls, and the primary heating method for the majority of homes involves the use of heating oil. The six most common archetypes for the Enniscorthy region will be discussed in detail in Section 3.2.2 RetroKit Scenario Analysis for Energy Master Plan.

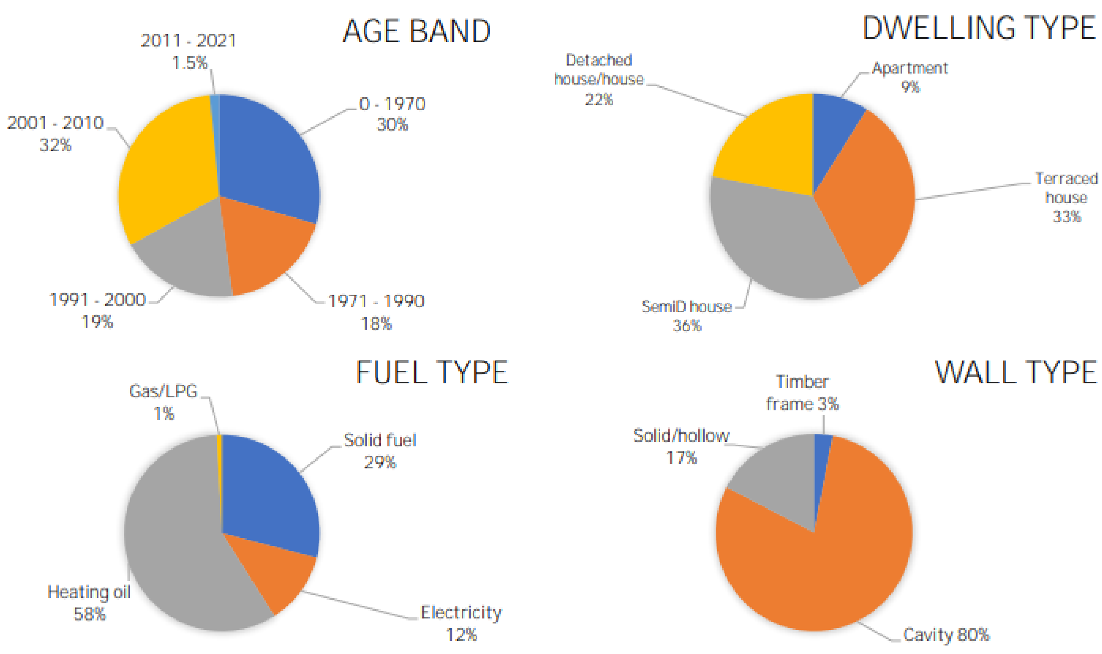

Figure 3: Summary of Residential Housing Stock for the Enniscorthy SEC (Graphical)

3.1.1.2. Energy Usage and Key Performance Indicators for Study Area

Once the dwelling stock has been compiled RetroKit then evaluates the residential energy use, fuel costs and CO_2 emissions for the entire study area. The calculations are based on the same calculations which underpin the BER for Irish homes and gives an estimate of the BER grade.

It should be noted that these calculations utilise standard occupancy levels, heating schedules/temperatures, hot water demand, as well as electricity use for lighting, pumps and fans.

As a result of the aforementioned assumptions as well as the use of typical archetypes means that running costs and energy usage estimated by the RetroKit analysis will differ somewhat from actual fuel bills for specific dwellings.

The results of these calculations are displayed graphically both in terms of Average per Dwelling as well as total across the Housing Stock. The age Band category was selected as the classification medium to display these results through.

<u>Fuel Type</u>

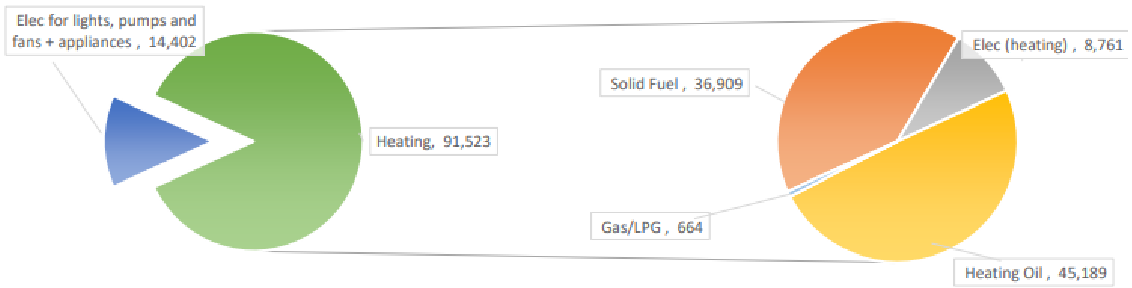

Figure 4: Total Delivered Energy by Fuel Type [MWh/yr]

The above figure displays the breakdown of energy usage in the study region. The pie chart on the left shows the overall breakdown of energy usage in the area, as can be seen 86% of all energy usage is for heating with the remaining 14% for electricity appliance usages (i.e. not including electrical heating). In total electricity consumption accounts for 28% of total energy consumption with the remaining 72% therefore coming from fossil fuels.

The pie chart on the right breaks down the heating energy usage into its constituent parts. As can be seen most all heating in the region is achieved through Solid fuel and Heating Oil, with only a small portion coming from electricity and even less from LPG.

Delivered Energy

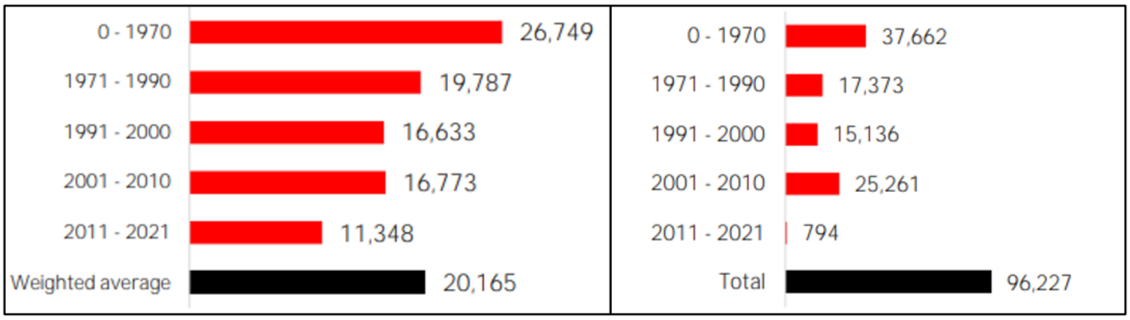

Figure 5: (LEFT) Delivered Energy Average Dwelling [kWh/yr] (RIGHT) Delivered Energy Total Stock [MWh/yr]

The figure above displays the final delivered energy in the region for both the average dwelling (LEFT) and across the entire study area (RIGHT). The graph breaks down the energy use in terms of the dwelling age band.

Also displayed in the "Delivered Energy Average Dwelling" graph is the weighted average, basically, this value is the answer to the question "How much energy does the average dwelling in Enniscorthy consume per year?"

Also displayed in the "Delivered Energy Total Stock" graph is the overall total delivered energy in the study region. Or alternatively, the answer to the question "How much Energy does Enniscorthy's housing stock consume?"

Renewable Energy

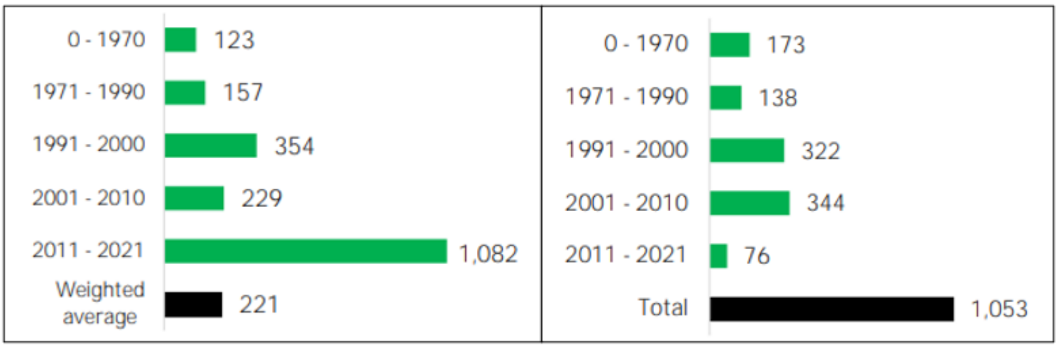

Figure 6: (LEFT) Renewable Energy Average Dwelling [kWh/yr] (RIGHT) Renewable Energy Contribution Total Stock [MWh/yr]

The figures above show the portion of overall energy that was delivered by renewable energy generation and the age band of the dwellings that it supplied. This is displayed in terms of for the average dwelling of each age band (LEFT) and total delivered renewable energy in each building stock age band (RIGHT).

Also displayed in the "Renewable Energy Average Dwelling" graph is the weighted average, basically, this value is the answer to the question "How much renewable energy does the average dwelling in Enniscorthy generate per year?"

Also displayed in the "Renewable Energy Contribution Total Stock" graph is the overall total renewable energy generated by dwellings in the study region.

CO_2 Emissions

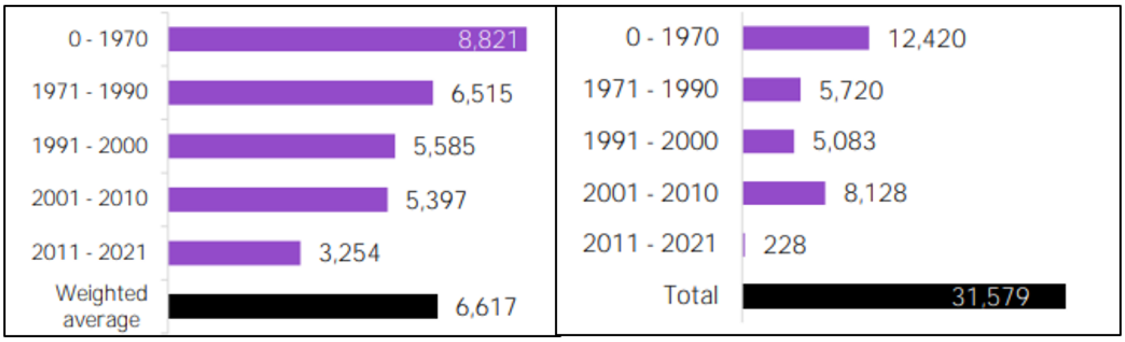

Figure 7: (LEFT) CO_2 Emissions of Average Dwelling [$kgCO_2/yr$] (RIGHT) Total CO_2 Emissions [tCO_2/yr]

The figures above display the CO_2 emissions based on the study areas housing stocks energy usage for both the average dwelling in each age band (LEFT) and the total CO_2 emission across each housing age band in the region (RIGHT).

Again, also displayed in the "CO_2 Emissions of Average Dwelling" graph is the weighted average, basically, this value is the answer to the question "How much CO_2 emissions does the average dwelling in Enniscorthy cause per year?"

Also displayed in the "CO_2 Emissions Total Stock" graph is the overall total CO_2 emissions caused by dwellings in the study region.

Energy Cost

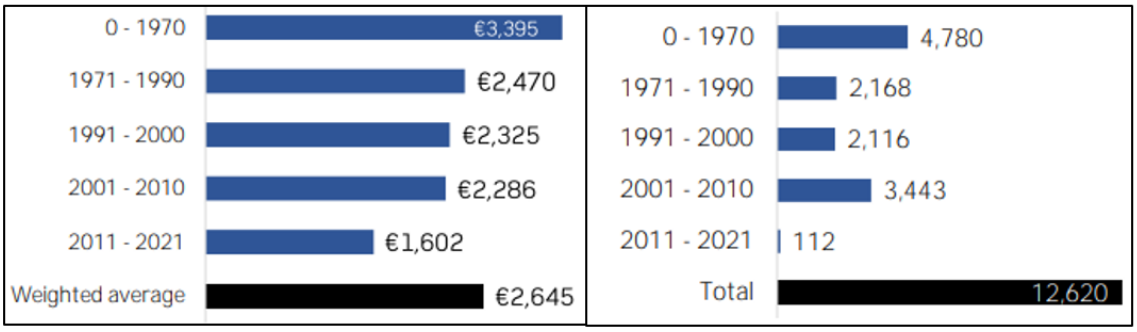

Figure 8: (LEFT) Energy Cost Average Dwelling [€/yr] (RIGHT) Energy Cost Total [k€/yr]

The figures above display the energy related costs broken down in terms of housing age band for both the average dwelling as well as the total energy related costs for each age band.

The weighted average value displayed in the left graph is essentially the answer to the question "What is the average energy related cost for the average home in Enniscorthy per year?"

The graph on the right also displays the total cost of energy across all homes in Enniscorthy in thousands of Euro.

BER

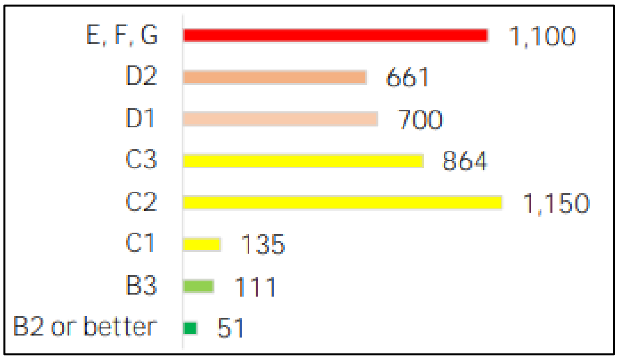

Figure 9: BER Assessment Results of Enniscorthy Housing Stock

The above graph displays the BER grades and the number of properties in Enniscorthy assigned to each grade based on RetroKits analysis. As seen in Figure 9, C2 is the grade the greatest number of dwellings in the region has achieved however, when we account for the primary energy usage across the whole of Enniscorthy's housing stock the weighted average BER grade is found to be a D1. Figure 10 graphically displays the primary energy usage (by age band) for Enniscorthy's housing stock.

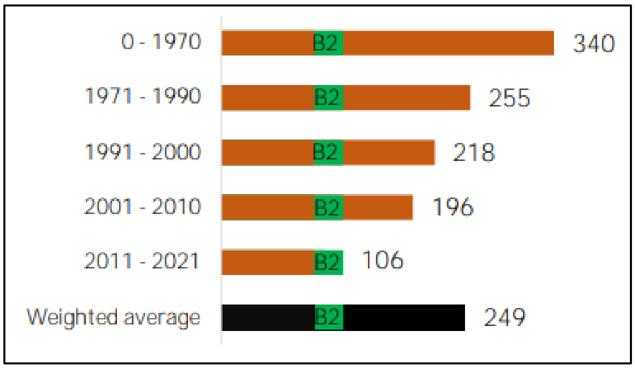

Figure 10: Specific Primary Energy [kWh/m2/yr] & Value Needed to Achieve a B2 Rating

Specific Primary Energy Consumption per square meter per year for housing stock is a metric that quantifies the amount of raw, unconverted energy a building utilises annually, expressed per square meter. This measurement provides valuable insights into the energy efficiency of a building, with lower values signifying more efficient energy utilisation. It serves as a crucial indicator for assessing and comparing the energy performance of different housing structures. The specific primary energy/m2/yr is the determining factor of a BER grade and should be considered for any low energy retrofits.

The National Average for Specific Primary Energy is 277 kWh/m2/yr with an average CO2 emission of 53 kgCO2/m2/yr in comparison to the Enniscorthy housing stock's average of 249 kWh/m2/yr and 66 kgCO2/m2/yr. This explains why, despite the fact C2 is the most common BER grade from the Housing stock, the average BER grade in the region considered is a D1.

Heat Loss Indicator

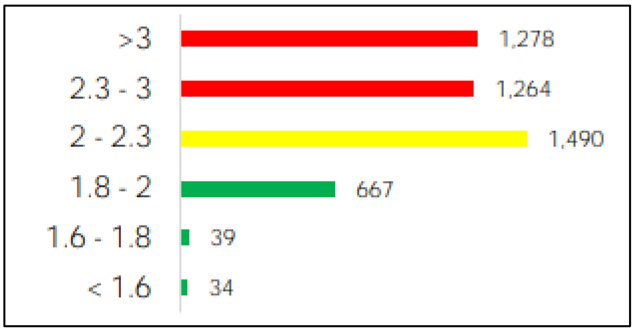

Figure 11: Heat Loss Indicator vs Number of Dwellings

The figure above displays the number of properties as a function of their Heat Loss Indicator ranging from < 1.6 - > 3.0.

The Heat Loss Indicator Value is a value calculated as part of BER assessments and is a measure of fabric heat loss. A heat pump requires lower fabric heat loss to perform efficiently and therefore the above graph is a display of "heat pump readiness" of the Enniscorthy housing stock.

The above table displays the number of dwellings that are "heat pump ready" (green) close to "heat pump ready" (yellow) and not "heat pump ready" (red). 84% of the dwellings in this analysis were deemed to be not heat pump ready or in other words, they have fabric heat loss that is too high for the operation of a heat pump to be considered an efficient measure. This will remain the case unless insulation fabric upgrades have been implemented.

3.1. Analysis of Non-Residential Sector (Commercial & Transport)

Table 3: Usage designation of Property types in the Commercial sector

Usage Designation	Description	Usage Designation	Description
1	Agri/Fish *(Industry)*	20	Health/Fitness *(Community/ Club/ Sporting)*
2	Amusement/Leisure *(Community/ Club/ Sporting)*	21	Manufacturing *(Industry)*
3	Banks/CU/Post *(Office)*	22	Miscellaneous *(Quarry/Sandpits)*
4	Car Park *(Others)*	23	Nursing Home *(Others)*
5	Car Sales *(Retail-National)*	24	Professional *(Office)*
6	Charity/ Voluntary *(Others)*	25	Pubs-Rural (Hospitality)
7	Clubs – Chargeable (Hospitality)	26	Pubs-Urban (Hospitality)
8	Clubs - Non-Chargeable (Hospitality)	27	Restaurant/Coffee shop (Hospitality)
9	Construction *(Industry)*	28	Rural Retail *(Retail-Local)*
10	Convenience/Petrol *(Retail-National or Industry)*	29	Service *(Retail-Local)*
11	Creche *(Others)*	30	Services *(Retail-Local)*
12	DIY/Household Goods *(Retail-Local)*	31	Sports Venues *(Community/ Club/ Sporting)*
13	Engineering *(Industry)*	32	Suburban Retail *(Retail-Local)*
14	Food Processing *(Industry)*	33	Supermarket *(Retail-National)*
15	Garden Centre *(Retail-Local)*	34	Take-away (Hospitality)
16	Global- VO	35	Town Centre Retail *(Retail-Local)*
17	Global- WCC	36	Transport *(Others)*
18	Hair/Beauty *(Retail-Local)*	37	Warehousing *(Industry)*
19	Hardware/DIY/Household *(Retail-Local)*	38	Hotel (Hospitality)

Table 4:Total Baseline Energy consumption for commercial and transport sector

Baseline Energy Type	Baseline Energy (GWh)
Electrical Baseline	36.5
Fossil-Thermal Baseline	39.0
Transport Baseline	100.45
Total Energy Baseline	***175.95***

Table 5: Total Baseline CO2 emissions for commercial and transport sector

Baseline Emission Type	Baseline Emissions (Tonnes)
Electrical Baseline	20,065
Fossil-Thermal Baseline	740,5
Transport Baseline	25,553
Total Emission Baseline	***53,023***

The data required for the baseline was obtained from the Enniscorthy SEC, which involved KRA identifying 629 commercial properties in the region based on the small area division of urban and rural electoral areas. These commercial properties were further categorised based on their usage type or designation, resulting in 38 usage designations, as presented in the table above. A customised benchmark matrix was developed to benchmark the energy usage of each of the 38 different usage designations for commercial properties in the Enniscorthy SEC region. The CIBSE TM46 Energy Benchmarking Document (2008) was used as a reference for creating this benchmark matrix. The matrix was designed to calculate the electrical and fossil fuel baseline for each commercial property in the region, based on their usage designation and total floor area. This benchmark matrix enables accurate determination of the energy usage and carbon emissions of each commercial property, providing essential data for the development of energy baseline for the SEC region.

The CO_2 emissions resulting from electrical and fossil fuel usage were also calculated for each individual property. All baseline data and calculations are compiled into an MS Excel document, which will have been provided to the Enniscorthy SEC members (post final review meeting) by the time the final version of this document has been disseminated.

After streamlining the process of benchmarking the commercial properties, we have further simplified the analysis by categorising the properties in the Enniscorthy SEC region into nine major sectors based on their provided service. Visual representations of the baseline data have been generated in the form of pie charts and tables, showcasing the electrical and fossil fuel baseline, as well as the respective CO_2 emissions for each sector. The following Tables and figures represent the total baseline energy and carbon emission for the commercial and transport sector for the Enniscorthy SEC region. These charts and tables offer a clear overview of the distribution of energy consumption and emissions across different usage designations, highlighting areas where improvements in energy efficiency can be implemented.

3.1.1. Division of Commercial Properties

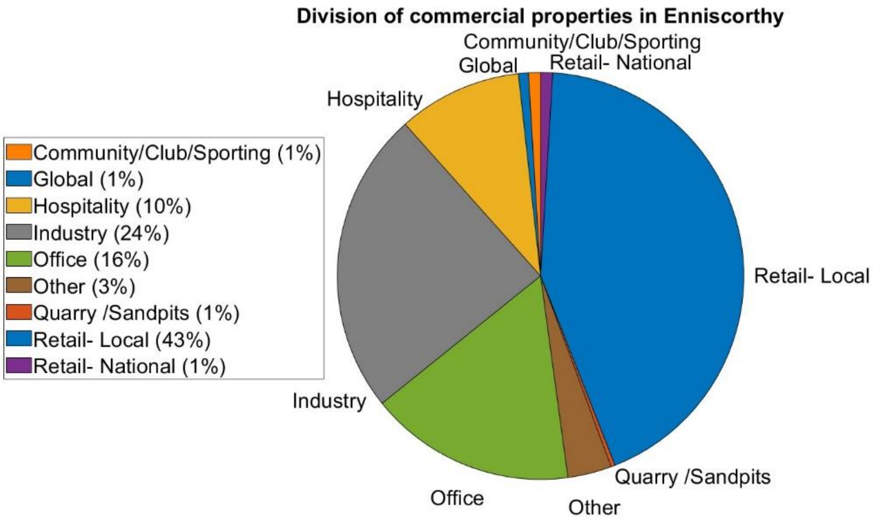

Figure 12: Property Category

Figure 12 displays a pie chart of the percentage of properties in each sector, while the table below shows the numeric value of properties in each sector. This grouping methodology provides a useful way to understand the distribution of properties and their respective energy consumption, and CO_2 emissions.

Table 6: Categorised properties

Property Category	**Number of Properties**
Community/Club/Sporting	6
Global	5
Hospitality	62
Industry	152
Office	103
Quarry /Sandpits	2
Retail- Local	271
Retail- National	6
Other	22
Total	*629*

3.1.2. Electric Baseline

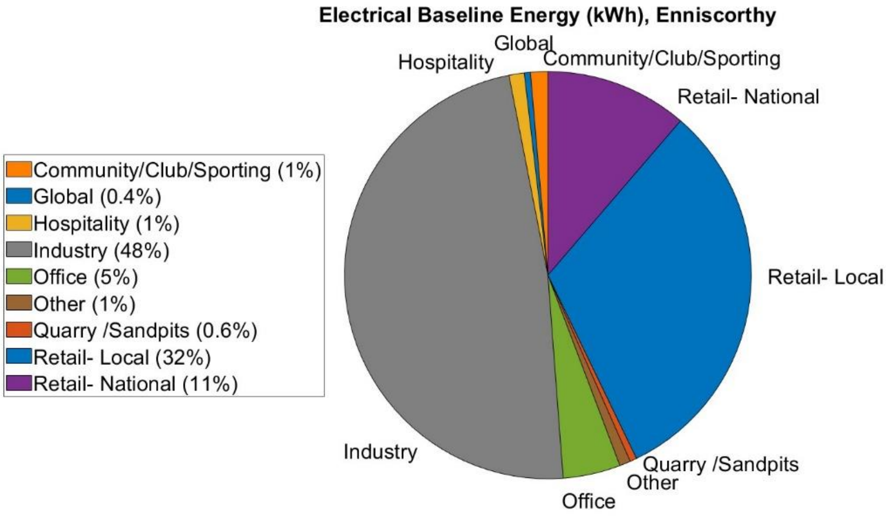

Figure 13: Electricity baseline energy consumption

Figure 13 depicts a pie chart representing the breakdown of electrical energy consumption by each sector, contributing to the overall electrical energy baseline for commercial properties in the Enniscorthy SEC region.

The table below shows the pie chart that provides actual electrical energy consumption in GWh/year for the commercial electrical energy baseline. This information provides a comprehensive understanding of the energy consumption patterns of various sectors and highlight where energy efficiency improvement should be concentrated.

Table 7: Electrical baseline energy

Property Category	**Electrical Baseline Energy (GWh)**
Community/Club/Sporting	0.5
Global	0.2
Hospitality	0.4
Industry	17.5
Office	1.7
Other	0.3
Quarry /Sandpits	0.2
Retail- Local	11.5
Retail- National	4.1
Total	***36.5***

3.1.3. Fossil-Thermal Energy Baseline

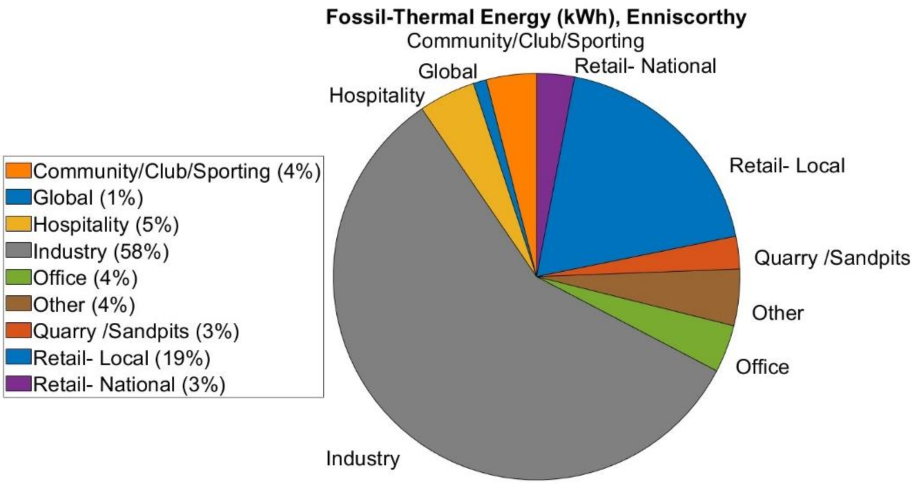

Figure 14: Fossil-Thermal baseline energy consumption

Figure 14 depicts a pie chart that illustrates the contribution of each of the nine sectors to the fossil-thermal baseline, based on their respective energy consumption. Meanwhile, the Table 8 presents the associated numerical values for thermal energy contribution in GWh/year by each sector.

Table 8: Fossil energy by property category

Property Category	**Fossil-Thermal Energy (GWh)**
Community/Club/Sporting	1.6
Global	0.4
Hospitality	1.8
Industry	22.5
Office	1.5
Other	1.8
Quarry /Sandpits	1.0
Retail- Local	7.3
Retail- National	1.2
Total	**39.0**

3.1.4. Emissions by Electricity

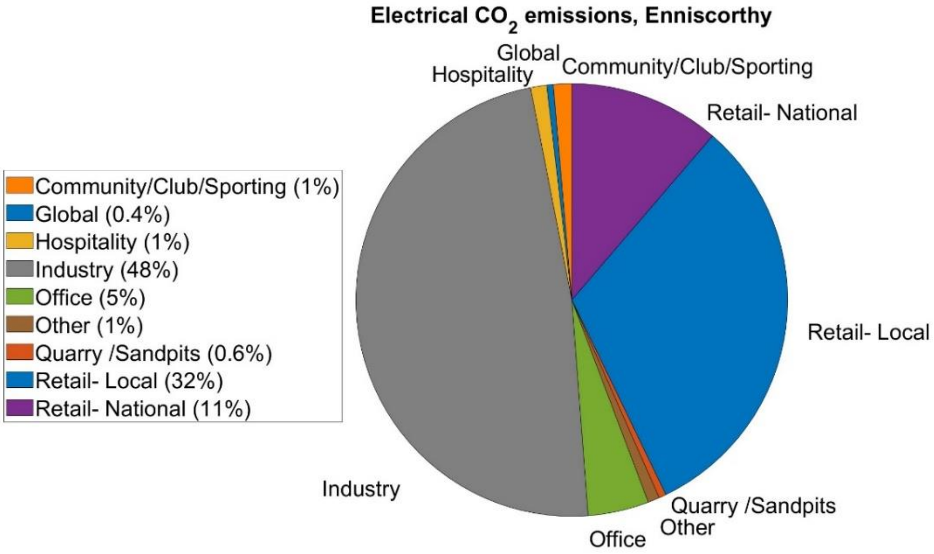

Figure 15: Electrical baseline emissions

Figure 15 depicts the percentage contribution of electrical CO_2 emissions from commercial properties. Additionally, the Table 9 provides the numerical quantities of CO_2 emissions in tonnes/year. The presented data correlates with that previously provided for electrical energy consumption, and as such highlights where carbon reductions can be achieved through implementation of electrical energy efficiency measures in these sectors.

Table 9: Electrical emissions by property category

Property Category	Electrical CO2 Emissions (tonnes)
Community/Club/Sporting	275
Global	97
Hospitality	243
Industry	9,659
Office	916
Other	175
Quarry /Sandpits	108
Retail- Local	6,325
Retail- National	2,267
Total	**20,065**

3.1.5. Emissions by Fossil-Thermal

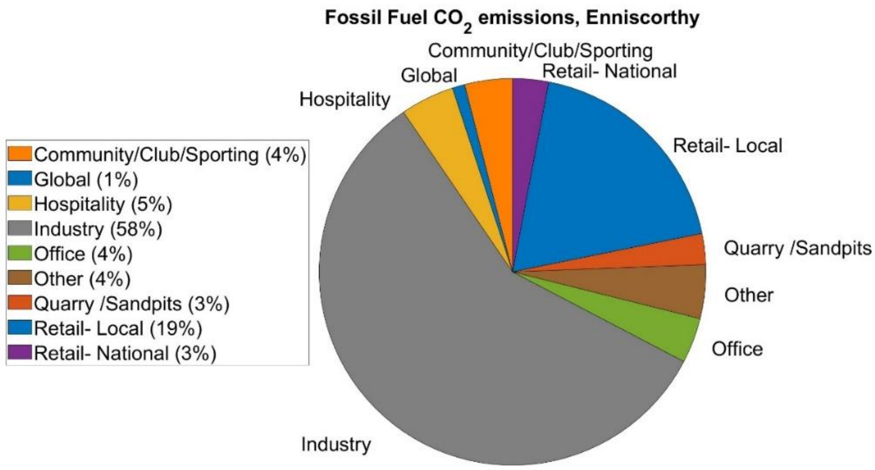

Figure 16: Fossil fuel baseline emissions

Figure 16 illustrates the total CO_2 emissions contributed by fossil fuels used by commercial properties for heating purposes. The pie chart represents the percentage of CO_2 emissions contributed by each sector, while the Table 10 displays the numerical quantities of CO_2 emissions in tonnes/year.

Table 10: Fossil emissions by property category

Property Category	**Fossil Fuel CO2 emissions (tonnes)**
Community/Club/Sporting	295
Global	77
Hospitality	334
Industry	4,279
Office	280
Other	333
Quarry /Sandpits	192
Retail- Local	1,393
Retail- National	222
Total	***7,405***

3.1.6. Transport Sector

The baseline for the transport sector in the Enniscorthy SEC is based on the data acquired from the Central Statistics Office (CSO) and annual transport energy consumption records. The data was collected through the assistance of Enniscorthy SEC members for both urban and rural electoral districts, with each small area being recorded for the years 2016, 2017, 2018, and 2019. The most recent data, which is for the year 2019, was used to create a pie chart that represents the total baseline energy consumption for the transport sector, further divided into different modes of transportation. The analysis reveals that private cars are the primary mode of transport in the Enniscorthy SEC, accounting for 71.9% of the total energy expenditure, followed by Road Freight transport, which includes heavy trucks and large transport vehicles, accounting for 26% of energy consumption. The public transport sector contributes the least amount of transport energy, at only 2.1%, suggesting a lack of public transport connectivity and fewer public vehicles in the region. Additionally, a table was created to represent the total amount of energy, in GWh, contributed by each mode to the total transport energy baseline. The table provides a more detailed insight into the energy consumption patterns of different transport modes in the Enniscorthy SEC.

Moreover, the analysis of emissions from the transport sector in the SEC area was carried out by making certain assumptions about the fuel type used by each transport mode. Private cars were assumed to operate on petrol, while public transport and road freight were assumed to operate on diesel. Corresponding carbon emission factors were used to calculate the CO2 emissions produced by each mode of transport. It is important to note that there is a minor segment of transport vehicles functioning in electric and hybrid modes, and this factor has not been factored into the analysis, contributing to the lower granularity of localised data The resulting pie chart shows that private cars are the primary CO2 contributor, accounting for 71% of the total CO2 emissions. Road freight transport follows as the second-highest contributor, accounting for 26.9% of CO2 emissions, while public transport contributes only 2.2% of CO2 emissions.

Based on the analysis, it is clear that private cars are the primary mode of transport in the Enniscorthy SEC, leading to substantial energy consumption and carbon emissions. To reduce their environmental impact, **it is essential to promote alternative modes of transport such as electric vehicles and public transport or cycling/walking**. The suggested low contribution of public transport also indicates a need to improve the public transport system in the region. This could be achieved by introducing more eco-friendly vehicles, enhancing the transport network and connectivity, and promoting the use of public transport among residents.

To achieve a sustainable and low-carbon future for the Enniscorthy SEC, the register of opportunities and the road map based on the baseline analysis will focus on reducing carbon emissions from the transport sector. The plan will prioritise promoting alternative modes of transport and improving the public transport system, contributing towards achieving sustainable development goals for the SEC area. However, it is important to note here that the modal shift and demand management of transport within the community is not solely within the remit of community groups such as the SEC and, as such, many of the recommendations will also require local government to take an active role in their implementation with community groups taking a more supportive, faciliatory and disseminative role in recommendations implementation.

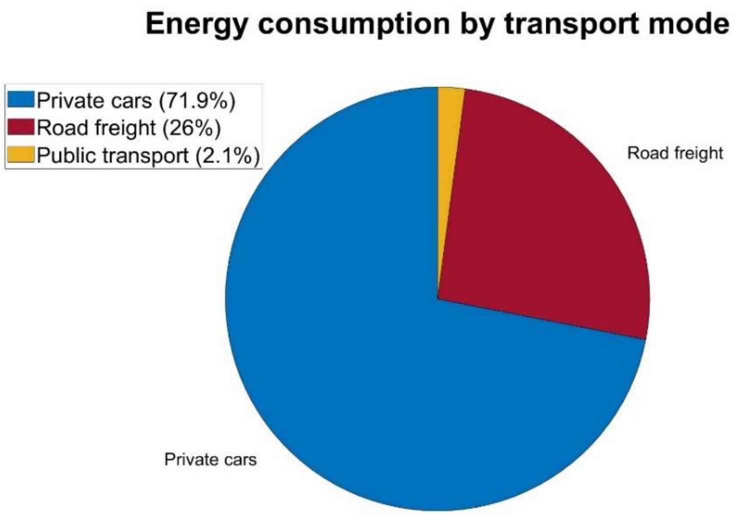

Figure 17: Energy consumption by transport

Table 11: Energy expenditure by transport mode

Transport mode	Energy Expenditure (GWh)
Private Cars	72.25
Road Freight	2.09
Public Transport	26.11
Total energy consumption	***100.45***

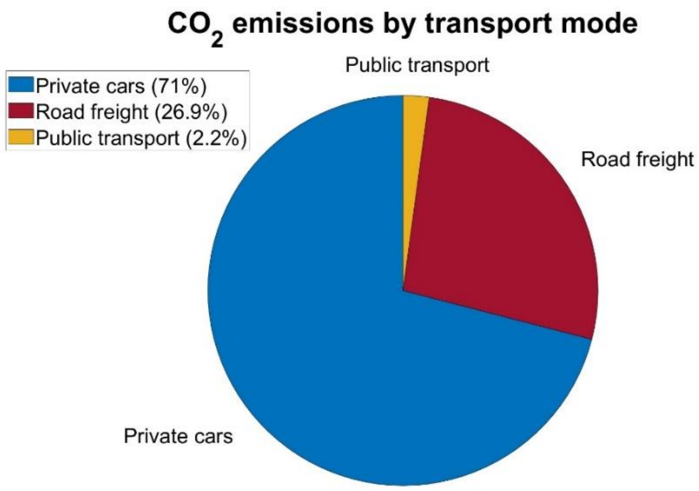

Figure 18:Emission by transport

Table 12: Emissions by transport mode

Transport mode	**Carbon Emissions (Tonnes CO_2/year)**
Private Cars	18,135
Road Freight	6,867
Public Transport	550.2
Total	**25,553**

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3.2. Energy Baseline

Table 13: SEC Primary Energy Baseline (GWh)

Sector	Electricity	Fossil Fuel	Renewable	Total
Residential (2022) *	23.16	82.76	1.05*	105.92
Non-residential (2022)	36.5	39	-	75.5
Transport (2019)	-	100.45	-	100.45
Other (Municipal) (2016)	1.2			1.2
Total Energy	60.86	222.21	1.05*	283.07

*Note: The quantified renewable energy mentioned above cannot be further broken down into its specific usage designation, such as electrical or thermal generation.

The Table 13, above shows the overall baseline energy consumption in the Enniscorthy community. According to the table, the residential sector emerges as the primary energy consumer, accounting for a total energy expenditure of 105.92 GW. Notably, fossil fuels contribute to almost 78% of energy consumption within the residential sector. Following closely is the transport sector, contributing 100.45 GW. In contrast, municipal buildings and other categories exhibit the least energy consumption, with non-residential energy use being lower compared to the baseline figures for residential and transport sectors.

4. Solution Strategies (Backcasting)

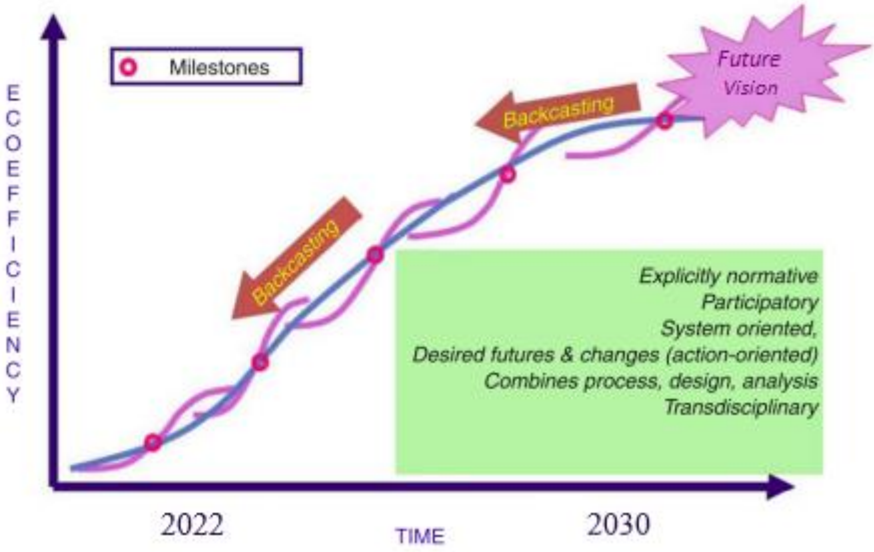


Figure 19: Idea of Back casting

Constructing the baseline for all three sectors provided an overall view of the major areas of improvement in the community toward sustainability and achieve the EMP goals, but to proceed with a plan to tackle the areas of major impact the EMP faces major constraints that can be summarised in twofold; mainly (1) Lack of Data Granularity, Quality and Availability and (2) The large size of the SEC area, (problems encountered in the EMP for data and etc, and this led to follow a solution development strategy).

A) Lack of Data Granularity, Quality, and Availability: Due to poor visibility regarding accurate energy consumption and distribution by all the three sectors (residential, commercial and transport) (both technical and behavioural),
B) The Large Size of the SEC Area: The large geographical expanse of the SEC region complicates efforts to pinpoint specific solutions or technologies that could be replicated throughout the EMP area.

Given these two constraints, it is challenging to determine a single, focused area for impact. Therefore, any potential solution strategy needs to start from the idea of a sustainable community, to address and overcome the existing limitations in identifying and implementing practical solutions. To accommodate these constraints, we have considered the following solution development strategy: **Back-casting:** Choosing a future vision and working backwards from the future to the present in order to strategies and plan how it can be achieved.

The chosen solution development strategy must align with the desired deliverable output. In this context, the strategy must provide both short-term and long-term solutions while reinforcing the idea of our community transitioning towards enhanced energy efficiency and becoming a decarbonisation zone that actively reduces its carbon footprint.

Here are the reasons why Back-casting was selected as the optimal strategy:

- Development of a Sustainability Roadmap: Back-casting empowers the Sustainable Enniscorthy SEC to construct a comprehensive sustainability roadmap that integrates and prioritises sustainability initiatives.
- Actionable Solutions: It offers practical, actionable solutions that can be implemented in the short-term while also considering potential long-term solutions. These align with sustainability goals and the Community Charter.

5. Register of Opportunities

The Register of Opportunities will provide the foundation block to establish the SEC's 10-year sustainable energy roadmap. It is to inform future applications to the Community Energy Grant programme from SEAI (or other suitable funding streams) for priority energy efficiency, renewable energy projects and areas for behavioural change interventions for the SEC.

The Register of Opportunities developed provides a quantity score on projects that have the greatest potential on the residential, non-residential and transport sector that were assessed on a community scale as part of the EMP process. The results and the methodology adopted for the development of the RoO is presented below:

- Balance scorecard
- Grading aspects and their key performance indicators
- Actionable solutions
- Short- and long-term proposals
- Retrokit scenario analysis
- Key performance indicators for the residential sector
- RetroKit Scenario Analysis - Archetype Case Studies

5.1. Balance Score Card

The balance scorecard is an integral part of the register of opportunities, it is a live scoring matrix for each of the technology assessed for the EMP project. The grading of all proposals is explained in the section below. To grade technologies, each technology/proposal is assessed against a set of four broader KPIs. The four broader KPIs are as follows: General, Environmental, Social and Economical, which are further sub classified into 23 different small KPIs (Key performance indicators). Each broader KPI has been assigned a weighted value, implying that all of them do not share the same level of importance. Aspects that are not applicable to a proposal are ignored in the calculation.

The next section explains about each major aspect and the KPIs corresponding to them in detail.

5.1.1. Key Performance Indicators

A major contributor for a community to become sustainable is first to understand what it means to be(come) sustainable, followed by a shift in attitude toward sustainability practices. There are two ways in which sustainability awareness can originate, namely (1) bottom up, a push towards sustainability comes from the population, and (2) top down, a push towards sustainability comes from the national/ government plans.

However, this 'push towards sustainability' is not a destination, but an iterative process. A tool to monitor these patterns within the community is through a set of Key Performance Indicators (KPIs). The KPIs developed for the community of Enniscorthy are found in the table below (The tables in this section below will explain all the KPIs chosen as a part of the Excel model (ROO)).

These KPIs are indicative, high-level performance indicators (given the scope of the research) and are modified to suit the community of Enniscorthy. Besides, these KPIs also include monitoring both short- and long-term proposals explained in the next subsections.

The main objective of the KPIs is aligned with the scope of the EMP to or Sustainable Enniscorthy to transition towards a more energy efficient community and a decarbonisation zone that reduces its carbon footprint. Each Key Performance Indicator (KPI) within the assessment framework is assigned a score ranging from 1 to 5, with 1 representing the lowest score and 5 representing the highest score. To illustrate the scoring methodology, consider the following example:

Example KPI: Effective reduction of COx emissions associated with fossil fuels.

Proposals that achieve only marginal reductions in COx emissions receive a score of 3. Proposals that demonstrate significant reductions in COx emissions are awarded a score of 4. Proposals that directly generate fossil-free energy or entirely eliminate the need for fossil fuels earn the highest score of 5.

The complete scorecard, including detailed explanations for each KPI, is provided in **APPENDIX A.**

General KPIs

General question to answer for the RoO technologies to check their feasibility.

- Do we know the delivery timeframe for the proposed project in detail?
- Do we know the full cost of the work? Including VAT, labour, etc.
- Do we know the calculated energy savings?
- Economic Feasibility of the technology/ proposal.
- Impact on the other proposals/technologies.

Environmental KPIs

The KPIs that monitor the environmental aspect of sustainability are divided over the objectives:

- To reduce natural resources consumption.
- To improve the use of renewable sources.
- To reduce waste and pollution.

The following is the list of the environmental KPIs used for the environmental assessments for this EMP project.

Table 14: List of Economic Key Performance Indicators

Environmental KPIs
Decrease in emissions of Carbon oxides (COx)
Decrease in fossil fuel consumption
Decrease in electricity consumption
Share of recyclable waste produced
Share of recycled input materials
Decrease in water consumption Increase in water reuse
Absence of noise pollution
Increase in Renewable Energy Utilisation
% of local suppliers contributing to the project

These objectives and the corresponding KPIs are self-explanatory. Some of these are already being monitored for the community of Enniscorthy.

Social KPIs

The social aspects concern the impact on the community and on all stakeholders, such as the Community Residents, local businesses, and transportation authorities, etc. Social objectives to be monitored are:

- To increase the community's awareness on sustainability.
- To increase the local supplier's (local business and manufacturer's) engagement on sustainability and contribution to the RoO technologies.

First, indicative KPIs are provided to increase sustainability awareness by for example, workshops or providing community wide carpooling scheme, etc. With further analysis into behavioural processes of community, more detailed KPIs are developed to address this aspect. A prominent one is indirectly through the local suppliers they support. Community-level decisions, informed by education and information regarding sustainable products, as well as a preference for certified and local sustainable suppliers, serve as catalysts for an internal, community-wide commitment to the sustainability cause. Some of these crucial KPIs are highlighted in the table below.

Table 15: List of Social Key Performance Indicators

Social KPIs
Increase environmental/sustainability awareness in the community
Increase of behavioural changes in the community
Green certification for buildings (LEED, BREEAM, etc.)

Economic KPIs

The economic aspects of sustainability are divided over:

- Increasing return on investments
- Increasing the revenues associated to sustainability dimensions.
- To guarantee the quality of the processes

While transitioning to a sustainable community, it is important to assess the extent of investments made, their efficacy and their impact to the return on investment. "Return on Investment," and it is a measure used to evaluate the profitability or efficiency of an investment by comparing the gain or benefit to the initial cost or expenditure. KPIs suggested in the below table reflect these parameters. However, there exists a crucial factor that significantly influences project success- the degree of community ownership intertwined with sustainability costs and profits. When community members directly benefit from the outcomes of community-wide projects and improvements in energy efficiency, as well as the expansion of renewable energy capacity within the community's housing stocks, they tend to be more motivated and committed to achieving sustainability targets. It is also economically important to ensure monitoring long-term performance of the technology on site. It is vital to have continuous, accurate data from all processes available to all community members in order to further this goal. Accurate data is the foundation of lasting, iterative process-related changes to sustainability. Further, this reinforces the attitude of sustainable thinking amongst the community.

Table 16: List of Economic Key Performance Indicators

Economic KPIs
Overall cost of the solution- economic feasibility
Overall energy impact of the solution
Payback years (score level 1-5)
Directly sustainable revenue created?
Environmental information availability rate
Facilitates Smart Control Technologies?

6. Actionable solutions

After selecting the back-casting process as a strategy for resolving the problem, solutions were explored that could contribute to the goal while impacting the social, economic and environmental aspects for the problem. Proposals were drafted based on extensive literature study, as well as discussions with the SEC members.

Due to the quality of data available, educated assumptions were made based on literature and advice from key figures from the site. After developing the proposals, they were critically assessed to determine their impact on the community as a whole processes/ technology, as well as scored based on parameters that would help determine their overall effect as a proposal. After scoring these proposals, their impact on social, economic and environmental objectives was determined. The tables outlining the scores each of these measures received are displayed in each proposal section.

It is to be noted that a few ideas did not qualify as proposals due to their infeasibility to the SEC region or due to technological immaturity level and the scope of the project (seen **APPENDIX A** for the infeasible technologies). The remaining proposals were classified as either short-term or long-term proposals and scored based on the parameters mentioned before.

6.1.1. Short Term Proposals

6.1.1.1. Smart Meters

Implementing smart meters in both public/commercial properties and industries can bring about significant advancements in energy management, efficiency, and sustainability. Smart meters are digital devices that provide real-time data on electricity consumption, allowing for better control over energy usage and paving the way for a more intelligent and responsive energy system.

The implementation of smart metres could have a substantial positive impact on the environment in the context of small and medium-sized firms (SMEs), which typically have an annual electricity consumption range between 15,000 kWh and 25,000 kWh. After the installation of the smart meter technology, the power usage can be reduced to 14,625 kWh to 24,375 kWh, assuming a 2.5% reduction (based on the trials conducted by CER in 2011) in consumption. This reflects to the carbon emissions reduction of 124 $kgCO_2$ to 206 $kgCO_2$ depending on the consumption of energy. These numbers highlight the potential of smart metres to help SMEs save money and improve their energy efficiency while also reducing carbon emissions, in line with more general sustainability objectives and environmental aims.

There can be a lot of direct and indirect benefits of using smart meters which include but not limited to

- **Environmental Impact:**
  - **Energy Efficiency:** Armed with detailed consumption data, building managers and industrial operators can pinpoint inefficiencies and take targeted actions to optimise energy usage. This can lead to reduced energy waste and lower operational costs.
  - **Demand Response and Load Management:** Smart meters enable demand response programs, where energy consumption can be adjusted in response to peak demand periods. This not only helps prevent grid overloads but also provides potential financial incentives for participating businesses.

- Renewable Energy Integration: As more businesses and industries adopt renewable energy sources, smart meters can assist in monitoring the generation, consumption, and surplus of energy. This aids in maximising the benefits of on-site renewable installations.
- **Carbon Footprint Reduction:** By gaining insights into energy usage patterns, organisations can identify opportunities to reduce their carbon footprint by optimising energy-intensive processes and promoting sustainable practices.

- **Economic Impact:**
  - **Cost Savings:** Businesses and individuals can find opportunities to increase efficiency by carefully analysing energy use patterns. Over time, this equates to lower energy bills, which saves consumers money.
  - **Job Creation:** The deployment, maintenance, and management of smart meters create employment opportunities in various fields, such as technology, data analysis, and customer support.
  - **Grid Management Efficiency:** Smart meters provide utilities with real-time data on energy demand and distribution. This information helps utilities optimize grid management, reduce operational costs, and avoid unnecessary infrastructure upgrades.
  - **Remote Monitoring and Control:** Smart meters can be accessed remotely, allowing for real-time monitoring and control of energy consumption. This is especially useful for large industrial facilities and businesses with multiple locations, as it facilitates centralized management.
- **Social Impact:**
  - **Accurate and Real-Time Data:** Smart meters provide accurate and real-time information about energy consumption. This data granularity enables businesses, public entities, and industries to identify patterns, peak usage times, and areas of energy wastage, leading to more informed decision-making.
  - **Billing Accuracy:** Traditional meter readings can be prone to errors and estimations, leading to inaccurate billing. Smart meters ensure precise billing based on actual consumption, reducing disputes, and providing transparency.

Table 17: EMP Score Card Analysis for Smart Meters

General Aspects - Weighted with 1.10	5.0
Environmental Aspects - Weighted with 1.05	3.7
Social Aspects - Weighted with 0.85	4.3
Economic Aspects - Weighted with 1.00	5.0
Priority	4.5

6.1.1.2. LED lighting and efficient lighting controls

Implementing LED lights and efficient lighting controls in public, commercial properties, and industries offers a significant boost in energy efficiency and environmental impact. With a lifespan of 50,000 to 100,000 hours, LEDs outlast incandescent by a large margin. For SMEs or public/commercial properties, replacing traditional fluorescent bulbs with LEDs yields substantial energy savings and reduced CO2 emissions. LEDs reduce CO2 emissions by 1031 kgCO2 when replacing fluorescent bulbs in a hypothetical SME with 50 bulbs operating for 8 hours, 5 days per week. Utilising occupancy sensors and intelligent dimming systems, efficient lighting controls can further reduce energy use and emissions. For instance, CO_2 emissions can be decreased by 144.7 $kgCO_2$ annually in a single office area by installing occupancy sensors that limit lighting use during times of inactivity.

A SME utilising 40W, 50 fluorescent lights for 8 hours, 5 days a week might potentially reduce power use by 17.5% and subsequently lessen CO_2 emissions by integrating smart lighting with LED technology. This holistic approach to energy-efficient lighting, incorporating both LED technology and intelligent lighting controls, not only leads to substantial cost savings but also contributes to environmental sustainability by reducing energy consumption and CO_2 emissions across various scales of implementation.

- **Environmental Impact:**
  - **Energy Efficiency:** LED lighting is significantly more energy-efficient than traditional incandescent or fluorescent lighting. LEDs convert a higher percentage of electrical energy into visible light, resulting in reduced electricity consumption and lower carbon emissions.
  - **Reduced Light Pollution:** LEDs can be directed more precisely, minimizing light spill, and reducing light pollution. This helps preserve natural nightscapes and supports wildlife by reducing disruption to nocturnal behaviours.
  - **Longevity:** LED bulbs have longer lifespans compared to traditional lighting technologies. This results in fewer replacements and less waste, contributing to resource conservation.
- **Economic Impact:**
  - **Cost Savings:** The energy efficiency of LED lighting translates directly into reduced electricity bills for both commercial establishments and individuals. This provides immediate and long-term financial savings.
  - **Maintenance Reduction:** LED bulbs have longer lifespans, leading to fewer replacements. This lowers maintenance costs and the associated labour and downtime expenses.
  - **Productivity Gains:** In commercial settings, well-designed LED lighting can improve employee productivity due to enhanced visual comfort and reduced glare.
  - **Market Value:** Buildings equipped with energy-efficient lighting systems and controls may have higher market values due to their reduced operational costs and sustainability features.
- **Social Impact:**
  - **Safety and Security:** Efficient lighting controls, such as motion sensors and dimming systems, improve safety by ensuring well-lit areas when needed. This is particularly important in public spaces and commercial environments.
  - **Enhanced Comfort:** LED lighting can be tuned to various colour temperatures, mimicking natural daylight. This contributes to better visual comfort, mood enhancement, and productivity in indoor spaces.

Table 18: EMP Score Card Analysis for LED lighting

General Aspects - Weighted with 1.10	5.5
Environmental Aspects - Weighted with 1.05	3.4
Social Aspects - Weighted with 0.85	4.0
Economic Aspects - Weighted with 1.00	3.3
Priority	4.1

6.1.1.3. Transport: Increase public transportation use

Enhancing the utilisation of Enniscorthy's public transportation system is a crucial step towards achieving carbon reduction goals. Public transportation not only reduces individual carbon footprints but also fosters community cohesion, accessibility, and economic sustainability. Increased reliance on public transportation offers numerous advantages, including:

- **Emission Reduction:** Public transportation is inherently more environmentally friendly than individual car use. By choosing buses, trams, and other forms of public transit, we can significantly decrease the overall carbon emissions associated with transportation.
- **Reduced Traffic Congestion:** A well-utilised public transportation system can alleviate traffic congestion, making our streets safer and more efficient for all road users.
- **Economic Savings:** Using public transportation can lead to substantial savings for residents who no longer need to maintain, fuel, and insure personal vehicles. This can have a positive impact on household budgets.
- **Reduced Parking Demand:** Greater use of public transit reduces the demand for parking spaces, freeing up valuable land for other community uses or green spaces.

To encourage greater use of our public transportation system, we recommend the following initiatives:

- **Improved Infrastructure:** Invest in the expansion and improvement of Enniscorthy's public transportation infrastructure. This includes expanding routes, enhancing the frequency of services, and upgrading the quality of vehicles including the roll or of EV busses.
- **Affordable Fares:** Consider reducing public transportation fares or offering discounts to specific demographics such as students, seniors, or low-income individuals to make it a more attractive option.
- **Transit-Oriented Development:** Encourage development around public transportation hubs, creating walkable neighbourhoods that reduce the need for car travel.
- **Carpooling and Ride-Sharing Integration:** Integrate public transportation with carpooling and ride-sharing services, allowing commuters to combine modes for a more flexible and convenient travel experience.

By implementing these strategies and fostering a culture of public transportation usage, transportation-related emissions can be significantly reduced and create a more sustainable and connected community.

To quantify the effects of an increase in public transport use we can consider the baseline transport related emissions.

Table 19: EMP Score Card Analysis for Increase public transportation use

General Aspects - Weighted with 1.10	2.6
Environmental Aspects - Weighted with 1.05	3.9
Social Aspects - Weighted with 0.85	4.3
Economic Aspects - Weighted with 1.00	2.3
Priority	3.3

6.1.1.4. Implementing congestion pricing and parking policies to reduce car usage.

The adoption of congestion pricing and parking policies carries significant environmental benefits, including:

- **Emission Reduction:** Congestion pricing discourages unnecessary car trips and encourages the use of public transportation, leading to lower emissions of greenhouse gases and air pollutants.
- **Improved Air Quality:** Reduced traffic congestion results in improved air quality, benefiting the health and well-being of Enniscorthy residents.

Social Impact

The promotion of congestion pricing and parking policies has positive social implications, such as:

- **Reduced Stress:** Congestion pricing reduces traffic congestion, making commuting less stressful for residents and improving overall quality of life.
- **Safer Streets:** Reduced car usage and congestion lead to safer streets for pedestrians and cyclists.

Economic Impact

Encouraging the use of congestion pricing and implementing effective parking policies also has economic advantages, including:

- **Improved Traffic Flow:** Reduced congestion enhances the efficiency of the transportation network, benefiting businesses and commerce in Enniscorthy.
- **Revenue Generation:** Congestion pricing generates revenue that can be reinvested in transportation infrastructure, such as public transit and pedestrian pathways.
- **Reduced Infrastructure Costs:** A decrease in car usage can reduce the need for costly road expansion and maintenance.

How to Implement Congestion Pricing and Parking Policies

- **Congestion Pricing:** Introduce congestion pricing in designated areas during peak hours to encourage residents to use public transportation or carpool.
- **Parking Policies:** Implement parking policies, such as increased parking fees in congested areas and the introduction of parking permits, to discourage car usage.

- **Public Awareness:** Launch public awareness campaigns to inform residents about congestion pricing and parking policies, emphasizing their benefits for the community.
- **Investment in Public Transit:** Invest in the improvement and expansion of public transit services to provide convenient and accessible alternatives to driving.
- **Sustainable Mobility Options:** Promote sustainable mobility options, such as cycling and walking, by enhancing pedestrian pathways and bike lanes.
- **Equity Considerations:** Ensure that congestion pricing and parking policies consider the needs and circumstances of low-income residents and provide equitable solutions.

The implementation of congestion pricing and parking policies in Enniscorthy reflects our commitment to reducing car usage, enhancing environmental sustainability, and creating a more liveable and economically vibrant town. These measures contribute to a healthier, more prosperous future for Enniscorthy and its residents.

Table 20: EMP Score Card Analysis for Implementing congestion pricing

General Aspects - Weighted with 1.10	3.6
Environmental Aspects - Weighted with 1.05	4.6
Social Aspects - Weighted with 0.85	4.3

Economic Aspects - Weighted with 1.00	2.3
Priority	3.7

6.1.1.5. Promoting a Community Wide Carpooling and Ridesharing Scheme

Transportation is a significant contributor to carbon emissions, and addressing this issue is vital for Enniscorthy's commitment to reducing its carbon footprint. One effective strategy is to encourage carpooling and ridesharing within the community. Carpooling and ridesharing not only reduces the number of vehicles on the road but also fosters a sense of community spirit and shared responsibility to the community and environment. There is a common misconception that "hitchhiking" is illegal in Ireland however, hitchhiking in Ireland is legal so long as it does not take place on motorways.

Benefits of Carpooling and Ridesharing are many. Carpooling and ridesharing offer multiple advantages, including:

- **Emission Reduction:** By sharing rides, you can significantly reduce the number of vehicles on the roads, resulting in lower carbon emissions. This directly contributes to Enniscorthy's goal of mitigating climate change and improving air quality in the town and region.
- **Cost Savings:** Sharing transportation costs, such as fuel and maintenance, can ease the financial burden on individuals and families. This can make it an appealing option for community members.
- **Strengthening the Community**: Carpooling and ridesharing create opportunities for people to connect and build stronger community relationships.
- **Reduced Traffic Congestion:** Fewer single-occupancy vehicles on the road can alleviate traffic congestion and could assist in making Enniscorthy's transportation system more efficient and effective for everyone.
- **Accessible Transportation for All:** Carpooling and ridesharing can enhance accessibility for those who don't own a vehicle, or for those who find it difficult to conduct the busy school runs, this would provide more inclusive transportation options.

To encourage and promote a shift towards carpooling and ridesharing in the Enniscorthy community, we propose the following initiatives:

- **Designated Ride-Sharing Stops:** Consider establishing designated ridesharing stops at key community intersections, such as entrances to busy housing estates, schools, shopping centres, town centre as well as other high-traffic areas. These stops could function similarly to bus stops, making it convenient for commuters to find rideshare partners.
- **Public Awareness Campaigns:** Launch a public awareness campaigns highlighting the environmental and economic benefits of carpooling and ridesharing. Use various communication channels, including social media, local newspapers, and community events as well as approaching schools within the community and seeking their assistance in facilitating this service. Or Organise community events focused on carpooling and ridesharing to encourage participation and provide opportunities for people to meet potential ride-sharing partners.
- **Incentives:** Explore the possibility of offering incentives for carpooling and ridesharing, such as preferential parking spots for carpoolers or reduced parking fees for shared vehicles.
- **Ride-Share Matching Platforms:** Facilitate the creation of ride-sharing networks or platforms where community members can easily find potential carpool partners based on their routes and schedules such as through community WhatsApp or Facebook groups.

By implementing these strategies and promoting a culture of shared transportation, transport-related emissions could be significantly reduced while building a stronger sense of community in Enniscorthy. Carpooling and ridesharing represent sustainable solution that align with Enniscorthy's goals of reducing transport related emissions and a commitment to a greener, more connected future.

Table 21: EMP Score Card Analysis for a Community Wide Carpooling and Ridesharing Scheme

General Aspects - Weighted with 1.10	4.2
Environmental Aspects - Weighted with 1.05	4.2
Social Aspects - Weighted with 0.85	4.3
Economic Aspects - Weighted with 1.00	4.3
Priority	4.2

6.1.1.6. Evaluation of the Effectiveness of Pedestrian and Cycling Pathways in Enniscorthy

Assessing the impact of pedestrian and cycling pathways in Enniscorthy is crucial to understanding their effectiveness in reducing carbon emissions, promoting community well-being, and contributing to the economic vitality of our town.

- **Environmental Impact**

The presence of pedestrian and cycling pathways has notable environmental benefits for Enniscorthy, including:

- **Reduced Carbon Emissions:** Enniscorthy's pedestrian and cycling pathways encourage active transportation methods, reducing the reliance on carbon-emitting vehicles and lowering overall carbon emissions.
- **Improved Air Quality:** By promoting non-motorised modes of transport, these pathways help mitigate air pollution, leading to better air quality and the reduction of harmful pollutants.

- **Social Impact**

Pedestrian and cycling pathways in Enniscorthy have positive social implications, including:

- **Enhanced Community Well-being:** Accessible and safe pathways promote physical activity, leading to improved public health, reduced stress, and enhanced quality of life among residents.
- **Inclusivity and Accessibility:** These pathways make it easier for people of all ages and abilities to move around the town, fostering inclusivity and improving access to services and amenities.

- **Economic Impact**

The presence of pedestrian and cycling pathways contributes to the economic vitality of Enniscorthy in various ways, such as:

- **Increased Tourism:** Well-designed pathways attract tourists interested in exploring Enniscorthy on foot or by bicycle, boosting local businesses, hospitality, and the tourism sector.
- **Property Value:** Homes located near pedestrian and cycling pathways tend to have increased property values, benefiting homeowners and the local real estate market.

- **Reduced Infrastructure Costs:** Promoting non-motorised transportation can reduce the need for expensive road and parking infrastructure, leading to potential cost savings for the town.

Evaluating the impact of pedestrian and cycling pathways in Enniscorthy would demonstrate your effectiveness in reducing carbon emissions, promoting community well-being, and contributing to the economic growth of the town. This assessment would support Enniscorthy's commitment to a greener, healthier, and more prosperous future for Enniscorthy and its residents.

Table 22: EMP Score Card Analysis for Effectiveness of Pedestrian and Cycling Pathways in Enniscorthy

General Aspects - Weighted with 1.10	3.6
Environmental Aspects - Weighted with 1.05	4.6
Social Aspects - Weighted with 0.85	4.3
Economic Aspects - Weighted with 1.00	2.3
Priority	3.7

6.1.2. Medium Term Proposals

6.1.2.1. Rooftop Solar Installations for Public/Commercial Properties

The adoption of rooftop solar photovoltaic (PV) systems by commercial properties in Enniscorthy is a crucial step towards achieving carbon reduction objectives. By embracing clean, renewable energy sources, Enniscorthy's commercial sector can reduce its environmental footprint, decrease energy costs, and contribute to the overall sustainability of the community.

The integration of rooftop solar PV systems for commercial properties offers numerous advantages, including:

- **Clean Energy Generation:** Rooftop solar PV systems convert sunlight into electricity, providing a renewable and emissions-free energy source. This reduces our town's dependence on fossil fuels and lowers greenhouse gas emissions. Generation at the point of consumption also reduces losses, as well as grid congestion.
- **Cost Savings:** Commercial properties can significantly reduce their energy bills by generating their own electricity. Over time, solar PV installations can lead to substantial savings on operational expenses.
- **Enhanced Property Value:** Rooftop solar PV systems increase the value of commercial properties, making them more attractive to investors and tenants who prioritize sustainability.
- **Energy Independence:** Commercial properties with solar PV installations gain a degree of energy independence, reducing vulnerability to energy price fluctuations.
- **Public Image and Sustainability:** Embracing solar energy demonstrates a commitment to environmental stewardship, enhancing the public image of commercial properties and attracting environmentally conscious customers.

In order quantify the effects the rollout of commercial rooftop solar would have on the emissions of the Enniscorthy region, KRA have used roof top area values for the commercial sector, provided to use by the Enniscorthy SEC, to calculate the total potential energy generation, and thus, total potential offset CO_2 emissions.
First, we calculated the total area of the 608 commercial units, as per the data set provided to KRA by the Enniscorthy SEC. This was found to be roughly 319,200m^2 meaning that there is an average floor area 525m^2 across the 608 units. However, the data set provided does not include information such as area of roof space taken by plant equipment, the orientation of the roof space, shading, feasibility of current electrical infrastructure, etc., KRA have assumed that 40% of the available roof space will not be suitable for a PV system. Therefore, this left us with an estimated 315m^2 per building suitable for PV generation.
Based of this estimated area, we designed an east-west orientated PV system utilising our inhouse design software. This design resulted in a 34kWp with a yield of 800kWh/kWp (yield based off design software and PVGIS data for solar irradiation for Enniscorthy region). Therefore if we assume that the average system size across the 608 properties is 34kWp it would result in result in approximately 16.5 GWh of energy produced in the first year of operation. However, this generation value does not account for the self-consumption rates of the PV system. Is we assume an average self-consumption rate of 80%, this would in mean an **annual generation of 13.2GWh** which in turn would result in an **offset of ~4,370 tonnes of CO_2** in the first year of operation.

We usually discuss the cost of roof top solar systems in terms of cost per kWp. These changes depending on the size of the system due to economies of scale but is roughly €1,500-€2,500 per kWp for small scale systems or domestic properties up to roughly 50kWp. Larger scale systems, depending on size, would be roughly €900 - €1,000 per kWp. The €/kWp encompasses the cost of everything related to the install so it also varies depending on the complexity of a specific project. For example if a crane or scaffolding would be needed to install it would increase the cost /kWp as would project location, i.e., transport of components and labour long distances. However the main driver of cost within the €/kWp would be components and labour. In order to get a rough estimate of the installation costs of the aforementioned solar systems, if we consider the average system size of 34kWp with an individual contractor would have an estimated cost of €1,500/kWp (€51,000). However it should be noted that if on contractor was instructed on many of the commercial properties within the community at once it would significantly reduce the cost per kWp.

Table 23: EMP Score Card Analysis for Rooftop Solar Installations for Public/Commercial Properties

General Aspects - Weighted with 1.10	4.8
Environmental Aspects - Weighted with 1.05	3.8
Social Aspects - Weighted with 0.85	4.0
Economic Aspects - Weighted with 1.00	4.7
Priority	4.3

6.1.2.2. Community Owned Solar Photovoltaic (PV) System

A Community-owned solar project represents a transformative step towards achieving The SEC EMP goals. A 1 MW (megawatt) solar project, collectively owned by the community, would not only generates clean energy but also foster local involvement, reduced energy costs, and create a resilient and sustainable future for Enniscorthy.

The establishment of a community-owned 1 MW solar project brings forth a host of advantages, including:

- **Clean Energy Generation:** The solar project harnesses the power of the sun to produce clean and renewable energy, significantly reducing our town's carbon footprint and reliance on fossil fuels.
- **Local Ownership and Control:** This initiative allows our community to have a direct stake in the project, fostering a sense of ownership and control over our energy future.
- **Energy Cost Savings:** Community members who participate in the project can benefit from reduced energy costs over the long term, as solar energy is a cost-effective source of electricity.
- **Economic Development:** The project can create jobs during installation and maintenance, stimulating economic development within our community.
- **Education and Awareness:** A community-owned solar project provides an opportunity for educational initiatives and public engagement, raising awareness about renewable energy and sustainability.

To successfully plan and implement a community-owned 1 MW solar project, Enniscorthy would need to consider the following steps:

- **Feasibility Study:** Conduct a comprehensive feasibility study to assess the suitability of potential project sites, estimated costs, and energy production forecasts.
- **Financing and Funding:** Determine the financial structure of the project, including sources of funding such as grants, community investments, and partnerships with local organisations or government agencies.
- **Site Selection:** Identify suitable sites for the solar installation, considering factors such as solar exposure, land availability, and proximity to the community.
- **Community Engagement:** Involve community members in the planning and decision-making process. Gather input, address concerns, and garner support for the project through public meetings and outreach.
- **Installation:** Select a reputable solar contractor to design, install, and maintain the system. Ensure that the project adheres to safety and environmental regulations. Consider putting the project out to tender.
- **Ownership Structure:** Establish a legal and organisational structure for community ownership, which may involve forming a cooperative, nonprofit, or other entity. Energy cooperatives are the most impactful way of implementing community renewable energy projects.
- **Education and Outreach:** Launch educational campaigns to inform community members about the benefits of the project, how to participate, and the potential returns on investment. Implement a system for monitoring the project's performance and sharing updates with the community.

A community-owned 1 MW solar project embodies a commitment to sustainability, self-reliance, and local empowerment. Through collective efforts and investment, Enniscorthy could generate clean energy, reduce emissions, and build a more resilient and prosperous community for generations to come.

The amount of land required for a 1 MW solar farm can vary significantly depending on several factors, including the type of solar panels used, their efficiency, and the local climate conditions. On average, a rough estimate is that you would need approximately 3-5 acres of land for a 1 MW solar farm using standard solar panels. Before proceeding with a solar farm project, it's crucial to conduct a detailed feasibility study and site assessment to determine the specific land requirements based on your chosen solar panel technology, local solar irradiance (sunlight availability), and other site-specific factors. This study would provide a more accurate estimate of land needs for your solar project.

That being said, a brief desktop study has found that a 1MW solar project located within 5km of Enniscorthy would have the ability to generate roughly 1GWh of green electricity meaning an offset just under 300 tonnes of CO_2 in the first year of operation.

The cost of developing a solar farm in Ireland ranges from €362,500 to €453,000 per acre, barring maintenance costs. The maintenance costs range from €13.5 to €22.6 per kWh. If we put it at an average of €18 per kWh, the cost of maintaining a 1MW solar farm will be roughly €18,000. The grid connection could be anything from €300,000 up to €1m and above. Another point to note is that the distance to the nearest grid substation determines a substantial part of the cost. Depending on the distance from the grid connection point, the power transmission cables are effectively scaled. The location of the selected site southeast is advantageous in terms of transmission use with it being relatively close to the electrical grid Utilising the ESB heatmap, several substations were identified in the community as possible connection points.

Table 24: EMP Score Card Analysis for Community Owned Solar Photovoltaic

General Aspects - Weighted with 1.10	4.6
Environmental Aspects - Weighted with 1.05	3.4
Social Aspects - Weighted with 0.85	3.4
Economic Aspects - Weighted with 1.00	4.5
Priority	4.0

6.1.2.3. Building fabric improvement (eg. Roof insulation, energy efficiency glazing)

The "fabric first" approach is consistently recommended due to its inherent capacity to reduce energy consumption, constituting an energy-saving measure in itself. This approach centres on optimising the building's fabric elements to enhance energy efficiency and overall comfort. Key strategies encompassed within the fabric-first approach include: Enhanced Insulation: Implementing measures such as wall and roof insulation serves to minimise heat transfer. This, in turn, significantly reduces the demands for heating and cooling within the structure. Energy-Efficient Glazing: The incorporation of energy-efficient glazing, featuring improved solar control properties, effectively mitigates heat gain and loss while optimising the utilisation of natural light. This not only ensures a cozy interior temperature, particularly crucial during the cold Irish winters but also yields substantial energy savings and lower utility expenditures.

According to publications by the SEAI (cite), the adoption of appropriate insulation for roofs and walls can yield potential energy savings of up to 30%. Furthermore, by effectively insulating windows and doors, an additional 10% in energy savings can be realised. The detailed calculation and assumptions underpinning this actionable solution are comprehensively outlined in Appendix A.

- **Environmental Impact:**
  - **Energy Conservation:** Proper insulation reduces heat transfer through walls, roofs, and floors, leading to lower energy consumption for heating and cooling. This directly results in reduced greenhouse gas emissions and a smaller carbon footprint.

- **Resource Efficiency:** Insulation helps maintain stable indoor temperatures, reducing the need for continuous heating or cooling. This reduces overall energy demand and lessens the strain on energy resources.
- **Reduced Demand for Fossil Fuels:** By decreasing the need for heating and cooling, effective insulation helps lower the demand for fossil fuels, promoting a transition to cleaner energy sources.

- **Economic Impact:**
  - **Energy Cost Savings:** Insulated buildings require less energy for heating and cooling, leading to significant cost savings on energy bills for both commercial establishments and individuals.
  - **Long-Term Savings:** Although the initial investment in insulation might be higher, the long-term savings on energy bills and maintenance costs outweigh the initial expenses.
  - **Increased Property Value:** Buildings with energy-efficient features like insulation tend to have higher resale values due to reduced operating costs and improved comfort.
  - **Job Creation:** The installation of insulation materials and retrofitting existing buildings creates employment opportunities in construction and related industries.

- **Social Impact:**
  - **Improved Comfort:** Insulated buildings provide consistent indoor temperatures, enhancing occupant comfort and well-being. This is particularly crucial in public spaces, where visitors' comfort is a priority.
  - **Health Benefits:** Proper insulation reduces the risk of moisture-related issues such as Mold growth, which can have negative health impacts on occupants.
  - **Noise Reduction:** Insulation can serve as a sound barrier, reducing external noise pollution and creating quieter and more peaceful indoor environments.

Table 25: EMP Score Card Analysis for Building fabric improvements

General Aspects - Weighted with 1.10	2.4
Environmental Aspects - Weighted with 1.05	3.8
Social Aspects - Weighted with 0.85	3.6
Economic Aspects - Weighted with 1.00	2.8
Priority	3.2

6.1.2.4. Transport: Increasing Electric Vehicles (EVs) & EV Charging Stations in Enniscorthy

Promoting the adoption of electric vehicles (EVs) and expanding the availability of EV charging stations in Enniscorthy is a key strategy to reduce carbon emissions, enhance air quality, and advance the town's commitment to sustainable transportation.

- **Environmental Impact**

The transition to electric vehicles and the expansion of charging infrastructure have substantial environmental benefits, including:

  - **Carbon Emission Reduction:** EVs produce zero exhaust emissions, significantly reducing the town's contribution to greenhouse gases and air pollution.
  - **Improved Air Quality:** The adoption of EVs leads to cleaner air, benefiting the health and well-being of Enniscorthy residents.

- **Social Impact**

The promotion of EVs and EV charging stations has positive social implications, such as:

  - **Public Health Benefits:** Reduced emissions from EVs result in improved air quality, leading to fewer respiratory illnesses and enhanced overall public health.
  - **Accessibility:** Charging stations increase accessibility to EVs for all residents, regardless of whether they have private parking or access to home charging.

- **Economic Impact**

Encouraging the use of electric vehicles and expanding the charging infrastructure also has economic advantages, including:

  - **Reduced Fuel Costs:** EV owners benefit from lower operating costs due to cheaper electricity compared to petrol or diesel.
  - **Local Jobs:** The installation and maintenance of EV charging stations can create local job opportunities.
  - **Tourism Promotion:** Enniscorthy can attract eco-conscious tourists by offering EV charging facilities, benefiting local businesses and tourism.

Increasing the adoption of electric vehicles and expanding EV charging infrastructure in Enniscorthy aligns with our commitment to a cleaner, healthier, and economically vibrant community. This initiative contributes to a more sustainable and prosperous future for the town and its residents.

Table 26: EMP Score Card Analysis for Increasing Electric Vehicles (EVs) & EV Charging Stations in Enniscorthy

General Aspects - Weighted with 1.10	4.6
Environmental Aspects - Weighted with 1.05	3.2
Social Aspects - Weighted with 0.85	3.1
Economic Aspects - Weighted with 1.00	4.3
Priority	3.8

6.1.2.5. Heat pumps for commercial and public buildings

The installation of heat pump systems in Enniscorthy's commercial and public structures offers a revolutionary chance to boost energy efficiency, lower carbon emissions, and promote environmentally friendly heating and cooling options. By adopting heat pump technology, the community can transition away from conventional fossil fuel-based heating systems, contributing significantly to its environmental and economic goals.

Key advantages of integrating heat pump systems in commercial and public buildings include:

- **Environmental Impact:**
    - **Carbon Reduction and Energy Efficiency:** Instead of producing heat through combustion, heat pumps work by moving heat from a lower-temperature source to a higher-temperature area. Compared to conventional heating methods, this procedure uses less energy and produces much less carbon emissions. Heat pumps, when appropriate, are the most impactful technologies for reducing heating emissions.
    - **Renewable Heating and Cooling:** Heat pumps can provide both heating and cooling, offering a versatile solution that can adapt to the diverse climate needs of commercial and public buildings. This dual functionality enhances comfort while also contributing to reducing energy consumption.
- **Economic Impact:**
    - **Cost Savings:** While initial installation costs of heat pump systems can vary, the long-term operational savings can be substantial. Heat pumps consume less electricity than fossil fuel-based systems, leading to reduced energy bills for building owners and tenants (thought this depends on the relative costs of electricity and fossil fuels). Additionally, as renewable energy sources continue to grow, the cost of electricity for heat pump operation can become even more competitive.
    - **Technological Innovation:** Advances in heat pump technology continue to improve efficiency, performance, and integration with renewable energy sources. By investing in these innovations, Enniscorthy can stay at the forefront of sustainable building practices.

- **Social Impact:**
    - **Improved Air Quality:** Unlike combustion-based heating systems, heat pumps do not produce direct emissions, improving indoor air quality within buildings. This benefit is especially crucial for public spaces where air quality affects the health and well-being of occupants.
    - **Enhanced Resilience:** Heat pumps are not reliant on fuel deliveries, making them more resilient to supply chain disruptions or price fluctuations in the fossil fuel market. This stability ensures consistent heating and cooling for businesses and public facilities.

Table 27: EMP Score Card Analysis for Heat pumps for commercial and public buildings

General Aspects - Weighted with 1.10	2.2
Environmental Aspects - Weighted with 1.05	3.5
Social Aspects - Weighted with 0.85	3.6
Economic Aspects - Weighted with 1.00	2.8
Priority	3.0

6.1.3. Long Term Proposals

6.1.3.1. Community-scale wind project

The site selected for the community-scale wind turbines for the Enniscorthy SEC area is proposed in the South of the SEC region (in close proximity to the Enniscorthy wastewater treatment plant and Lucas Park). This location was selected based on five key parameters: 1) Geological mapping for rocks and sub-soils, 2) Distance to the nearest grid/ load-out facility, 3) Wind regime, 4) Environmental conditions, and 5) Social influence. There are also other possible potential sites considered in this study, though they are ruled out due to their unsuitability to the key parameters. The other considered sites are the southwest direction to the SEC area of the community.

Geological mapping for rocks and sub-soils

The geological mapping for the proposed location was found using the databases at Dcern-maps and Teagasc-soils and, by examining the rock and subsoil conditions, a preliminary estimation of the suitability of the site could be made (Geological Survey Ireland Spatial Resources, 2022), (LandIS, n.d.). The most favourable soil profiles are rock-anchored foundations or sandy soil profiles without peat (TNO Geological Survey, 2022). The least favourable soil profile consists mainly of large clay/ peat layers covered by thin sand layers.

Desktop assessment using data from the Dcern and Teagasc sites shows chosen site consists of Dolomitised dark-grey muddy sandstone. These conditions are sub-optimal for large-scale multi-megawatt turbines but are capable of withstanding foundational load-bearing capacity for small/medium scale wind turbines. Further analysis is advised to determine the penetration depth of the foundation, in combination with soil sampling to greater depths, to identify all the constituent horizons in the soil profile.

Distance to the nearest grid/ load-out facility

Distance to the nearest grid substation determines a substantial part of the cost. Depending on the distance from the grid connection point, the power transmission cables are effectively scaled. The location of the selected site south to the SEC region, is advantageous in terms of transmission use with it being relatively close to the electrical grid but not so close that there is a risk of catastrophic failure occurring. Utilising the ESB heatmap, several substations were identified in the community. The closest substation to the selected site is Monfin 38 kV substation with demand capacity available (3.2MVA), which would accommodate a community scale wind project, based on the available demand capacity.

Figure 20: Masked area for a potential community scale wind park

Wind regime

height above ground	wind speed
150 m	10.07 m/s
140 m	9.95 m/s
130 m	9.83 m/s
120 m	9.69 m/s
110 m	9.54 m/s
100 m	9.38 m/s
90 m	9.20 m/s
80 m	9.00 m/s
70 m	8.78 m/s
60 m	8.51 m/s
50 m	8.21 m/s
40 m	7.83 m/s
30 m	7.34 m/s
20 m	6.65 m/s
10 m	5.47 m/s

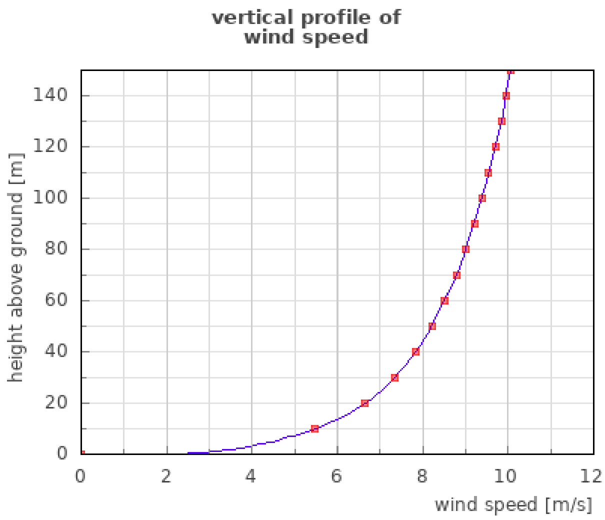


Figure 21: Wind velocity scaled to a height of 150m using the logarithmic scaling law

The wind resource is one of the most important factors in the selection of a wind farm location. Studying the wind resource data using the wind atlas model, for most of the year, the wind mainly prevails from the south and south-west side of the SEC region. The average mean wind speed for the community is 5.47 m/S at a 10 meters (m) height above ground level (wind atlas model). Applying the wind logarithmic scaling law, the wind profile, and wind shear calculations can be determined. Considering the selected site away from the tall building of the SEC region, Towns, villages, agricultural land with many or high hedges or 8 m high trees. A roughness class of 3, roughness length of 0.4m, and energy index of 52% are assumed for the log-scaling of the wind to 100 meters. As shown in figure 3, the results of the graph show

Environmental assessment for small-scale wind park

The major environmental concerns related to wind farm developments are a disturbance in natural habitat, noise level, risk of bird collisions, and alterations to the migratory patterns of birds. Studying the migratory patterns of these birds, major migratory routes are towards the southwest and the spring migration to the east towards Europe, Asia, and Africa (Shupeng and van Genderen, 2008). The selected site in the south of the community is located away from the migratory patterns and offers the least possible hindrance to the natural habitat and vegetation.

Other recommended solutions for the small-scale wind farms can be painting a single-blade black, thereby reducing the potential rate of bird collisions by up to 70%. This step makes blades more visible to the birds as they spin, even when they have reached maximum rotational velocity. A study on this solution was performed as part of the R&D project “Innovative Mitigation Tools for Avian Conflicts with Wind Turbines” (INTACT) funded by the Research Council of Norway (May et al., 2020). It is further recommended to undertake a comprehensive study on the natural habitat and local vegetation and bird migratory patterns in the local area. In addition an environmental impact assessment study for the local area will also be beneficial for the community scale wind farm.

Social influence

The social influence of wind farms on the residents of an area can be majorly related to noise pollution, shadow flicker, wind turbine hazards, and transmission hazards. To counter these potential aspects, the selected site has been considered following the environmental regulations for social welfare and domestic settings which require a distance of at least four times the tip height of the turbine between a wind turbine or wind farm and the nearest dwelling or residential area (Loughil, 2019). Further discussions would be required to engage the necessary consultants with the local communities during the early stage of the development process.

Sizing of wind turbines (economic impact)

The sizing of the wind turbine is correlated to various factors, ranging from the environmental condition to the turbulence intensity of the location. For the case of Enniscorthy community, the three major constraints to consider are the average wind speed, extreme 50 -years gust, and the turbulence intensity.

Average wind speed and rated power for the turbine: The power in the wind is proportional to the cubic square of the velocity, relating to the logarithmic scaling of the wind profile figure above, it can be concluded that with increasing height above ground level, the average wind speed increases and hence the power. Looking at the same graph the wind speed is almost constant at 6.7 and 7.5 ms-1 between 20-30 m. Also considering the geological mapping for rocks and sub-soils, it can be asserted that the site is better for small to medium tower heights and not for multimegawatt scales. To increase the power output further an additional increment in the height by 10 m should be observed as stated by the logarithmic scale law and this is not viable looking at the geological and financial values of the project. Considering all these factors, a height of 20-30m is optimum for the wind turbine at this site. A wind turbine with a rated power of 25kW would match these specifications. Extreme gust 50 years, turbulence intensity: Considering the location of Enniscorthy, the site experiences a medium turbulence wind speed over the year and the extreme wind gust does not surpasses 35 knots (18 ms-1). Considering these weather factors, a conclusion can be made that a wind class/turbulence of IIIa, with an annual average wind speed of 6.5 to 7.5 m/s at a hub height of 25 m, with an extreme 50-year gust to be 52.5 ms-1, rated power of 25kW can be optimally obtained at this specification (First, 2015). The following will be an effective class for the following site. There are many wind turbine models in the market to choose from, however, a recommendation would be the Solid-Wind-Power-25kW wind turbine produced in Denmark (Solid Wind Power, n.d.). The rotor meets the optimal specifications needed for the location, as seen in the table below.

Table 28:Wind turbine specifications for Solid-Wind-Power-25kW

Parameters	Value and Unit
Rated Power	25kW
Cut-in-wind speed	3.0 ms-1
Rated wind speed	8.5-9.5 ms-1
Cut-out wind speed	25 ms-1
Survival wind speed	52.5 ms-1
Wind class	IIIa- low wind speed, high turbulence

Considering the above turbine specifications, wind regimen, a community scale wind farm consisting of 5 wind turbines specified above would generate approximately around 536250 kWh per year, assuming the operational hours for the wind park are 8,250h and the capacity factor for the area is 0.52 (based on the wind atlas model scaled values from 100m to 10m). The calculated cost for the wind turbines is estimated in the range of €330,000 to €350,000, excluding the installation and wind energy assessment studies.

Table 29: EMP Score Card Analysis for Community-scale wind project

General Aspects - Weighted with 1.10	4.6
Environmental Aspects - Weighted with 1.05	2.9
Social Aspects - Weighted with 0.85	3.4
Economic Aspects - Weighted with 1.00	4.2
Priority	3.8

6.1.3.2. Car Microgrid

A car micro grid developed Enniscorthy town based on the parking area in Abbey Square shopping centre carpark. It would integrate PV panels, energy storage and charging stations. This enables EV charging and establishes a bi-directional flow of electricity between the stations and the rest of the grid, enabling to use or sell electricity elsewhere when no charging is needed.

The proposal for a car microgrid has been scored as shown in the table below.

- **Environmental aspects:** It would increase the share of renewable generation on-site, providing a fossil-free energy solution for transportation and decrease electricity consumption.
- **Social aspects:** Any solution that addresses transportation can be expected to imply significant increases in sustainability awareness.
- **Economical aspects:** PV technology is the cheapest among RES in terms of installation costs and ease of implementation. However, the chargers, batteries and complexity increase the cost in comparison to a regular PV installation. An evaluation of a similar system done by Siemens concluded that such a system would be expensive even if it generates revenue with the unused energy.

Table 30: EMP Score Card Analysis for Car Microgrid

General Aspects - Weighted with 1.10	4.8
Environmental Aspects - Weighted with 1.05	3.0
Social Aspects - Weighted with 0.85	3.8
Economic Aspects - Weighted with 1.00	4.5
Priority	4.0

6.1.3.3. Process integration and heat recovery for low temperature processes

Process integration and heat recovery involve the systematic design and optimisation of industrial processes to minimise energy consumption and reduce waste heat. This approach is particularly valuable for low-temperature processes, where energy efficiency improvements can lead to significant energy savings and environmental benefits.

- **Environmental Impact**

The adoption of process integration and heat recovery for low-temperature processes yields significant environmental benefits, including:

  - **Energy Efficiency:** Optimising processes reduces the overall energy consumption, lowering carbon emissions and minimising the environmental footprint of industrial and agri activities.
  - **Resource Conservation:** By recovering and reusing waste heat, less energy is required from non-renewable sources, helping conserve valuable natural resources.
  -
  - **Economic Impact**

Encouraging the use of process integration and heat recovery also has economic advantages, including:

  - **Reduced Operating Costs:** Energy efficiency improvements translate into lower operating costs, benefiting industrial businesses and consumers alike.
  - **Increased Productivity:** Optimised processes often result in increased productivity and product quality, contributing to economic growth.
  - **Regulatory Compliance:** Meeting or exceeding energy efficiency standards ensures regulatory compliance and minimises the risk of penalties.

This process is usually associated with the industrial sector however it is useful in the agricultural sector for instance:

- **Greenhouses:** Heat recovery and process integration can be valuable in greenhouse operations, especially in colder climates. Capturing waste heat from various processes can help maintain a stable and optimal growing environment while reducing heating costs.
- **Livestock Farming:** In livestock farming, heat recovery systems can be used to capture and reuse heat from manure management processes, such as anaerobic digestion. This not only reduces energy costs but also helps manage waste more sustainably.

- **Drying and Processing:** Agricultural operations involved in drying and processing crops can benefit from heat recovery systems that capture and reuse heat generated during these processes.
- **Renewable Energy:** Farms that produce biogas or operate biomass heating systems can incorporate heat recovery to enhance overall system efficiency and reduce energy expenses.

Table 31: EMP Score Card Analysis for Process integration and heat recovery for low temperature processes

General Aspects - Weighted with 1.10	2.2
Environmental Aspects - Weighted with 1.05	3.5
Social Aspects - Weighted with 0.85	3.6
Economic Aspects - Weighted with 1.00	3.0
Priority	3.1

7. Resilience Strategies (Scenario planning)

Strategic decisions at the community level, aimed at achieving sustainability, do not happen in isolation. To align with Ireland's Climate Action plan, the community of Enniscorthy must consider the broader national context., which includes regulatory, competitive, political, economic, social and technological driving forces that impact the community (Camilleri, cite).

Firstly, scenario planning is crucial. This involves creating multiple scenarios to anticipate various possible futures. It helps the community prepare for different challenges and opportunities.

Secondly, Enniscorthy needs to develop strategies that integrate actionable solutions from previous chapters. These strategies demonstrate how to effectively combine these solutions, providing a clear roadmap for sustainability.

In the realm of policymaking and an energy master plan for the community, it's essential to consider these factors. Sustainability efforts should align with the ever-changing regulatory, competitive, political, economic, social, and technological landscape.

Scenario planning is a tool that communities can use for strategic decision making when facing complex uncertain futures (Gausemeier.,cite). This technique is especially useful while considering futuristic planning for a community such as Enniscorthy.

7.1.1. Sustainability and National & European targets

Enniscorthy, as a community in Wexford and a growing Irish town, finds itself inextricably linked to both national and international climate objectives. The town's current position aligns closely with Ireland's commitments under the Paris Agreement and the European Union's ambitious target of reducing greenhouse gas (GHG) emissions by a minimum of 55% by 2030 (compared to 1990 levels), with the ultimate goal of achieving climate neutrality in the EU by 2050.

Across Ireland and Europe, there is a resounding call for sustainable practices, with cities and towns taking up the mantle of responsibility. Notable examples such as Belfast's "A Net-Zero Carbon Roadmap For Belfast" (2020) and the "Dublin Region Energy Masterplan" (2021) underscore the growing trend of fostering sustainability within communities. This momentum serves as a direct catalyst for other towns and cities throughout Ireland, driving them toward the shared objective of meeting the national climate targets by 2030. (cite)

By becoming a more sustainable community, Enniscorthy has a unique opportunity to distinguish itself as a conscientious and forward-thinking locale. It can set an inspiring example for nearby areas and cities, inspiring them to embark on their own journeys towards net-zero carbon goals. Furthermore, Enniscorthy can leverage this position to foster sustainable practices among its major energy consumers and within the spectrum of products imported into the town.

As a sustainable community, Enniscorthy can actively promote environmentally responsible business practices, simultaneously catalysing the creation of job opportunities related to decarbonisation initiatives. In essence, it has the potential to evolve into a decarbonisation zone, progressively moving toward the ultimate goal of becoming a zero-carbon community.

The driving force behind this transformation is rooted in community-driven sustainability initiatives. This qualitative feature, though not directly factored into the development of scenarios in our assessment.

7.1.2. Scenarios

Scenario planning can be done with different objectives, namely possible futures, probable futures, and preferable futures (Gelatt, cite). We chose the first path of identifying possible futures. According to Porter (cite), a scenario is “an internally consistent view of what the future might turn out to be”. The place-based climate action network has developed a net zero roadmap for cities like Belfast and Edinburg were used as a reference and a context for scenario development for a community/ town city. The scenarios are possible paths for a community to reach a common future of transition towards a more energy efficient community and a decarbonisation zone that reduces its carbon footprint in line with the national targets. The four paths differ in the way the technologies are employed to achieve this common goal. The scenarios have divergent characteristics to clearly differentiate between the possible levels of energy savings and/or carbon reduction / offset in working towards achieving the EMP targets.

Business as usual

Under the BaU scenario, the community continues to function as it is now, with no efficiency or sustainability improvements. This is the Status Quo - or the benchmark against which all other scenario’s will be measured.

Easy to Implement

This scenario includes solutions that require minimal effort to implement. This scenario focuses on efficiency improvements in the community and implies that a change of behaviour towards investments or social patterns does not occur.

Medium effort

This scenario includes solutions that focus on the improvement for medium effort scale. It includes both short- and long-term solutions.

EMP target

This scenario includes both short- and long-term solutions. These would typically be deployed with a long-term sustainability vision to achieve set EMP targets.

Scenarios are constructed based on the Register of Opportunities and the Balanced Scorecard. Proposals gathered from the balance scorecard are organized into scenarios, with categorisation guided by each technology's priority score. The matrix provided below serves as the foundation for classifying technologies within each scenario. This systematic approach ensures a structured and data-driven methodology for scenario development, facilitating the strategic planning process for the Energy Master Plan.

Table 32: Scenario scoring matrix

Scenario Type	***Score Division***
Business as usual	**0**
Easy to Implement	**≥4.0**
Medium effort	**3.0>5.0**
EMP target	**1.0>5.0**

Table 33: Scenario selection

Scenarios	Business as usual	Easy to Implement	Medium effort	EMP target
Technologies				
Community Owned Solar Photovoltaic (PV) System	No	No	yes	yes
Rooftop solar installations for public/commercial properties	No	No	yes	yes
Community scale wind project	No	No	No	yes
Small-scale wind turbines (behind the meter)	No	No	No	yes
Implementing microgrids for localised renewable energy distribution	No	No	No	yes
Switch to Biogas / Greengas	No	No	No	yes
Transport: Increase Evs & Ev charging stations	No	No	No	yes
Car Microgrid	No	No	yes	yes
Smart Meters	No	yes	yes	yes
Scenarios	**Business as usual**	**Easy to Implement**	**Medium effort**	**EMP target**
Technologies				
LED lighting and efficient lighting controls	No	yes	yes	yes
Building fabric improvement (eg. Roof insulation, energy efficiency glazing)	No	No	No	yes
Heat pumps for commercial and public buildings	No	No	yes	yes

Process integration and heat recovery for low temperature processes	No	No	No	yes
Transport: Increase public transportation use	No	No	yes	yes
Evaluation of the effectiveness of pedestrian and cycling pathways	No	yes	yes	yes
Implementing congestion pricing and parking policies to reduce car usage	No	yes	yes	yes
Conduct workshops and training programs to educate locals and businesses on sustainable energy practices and their implementation	No	yes	yes	yes
Community-wide ridesharing/ Carpooling Scheme	No	yes	yes	yes

7.1.3. RetroKit Scenario Analysis

Once the baseline analysis was completed in order to determine the energy usage by the stock as it currently stands, RetroKit then ran a number of customised scenarios based on shallow, medium (Boiler & Heat Pump) and deep fabric upgrades with associated upgrades to heating systems and renewable energy. RetroKit evaluated the residential energy use, fuel costs and carbon dioxide emissions for the full study area for each of the aforementioned scenarios as well as conducting a more detailed analysis for the 6 of the most common archetypes.

The scenario overview is detailed in the table below.

Table 34: Measures Considered in Each of the Upgrade Scenarios

Measure description	Shallow	Medium boiler	Medium HP	Deep+
Cavity wall insulation	✓			
Attic insulation	✓	✓	✓	✓
Insulate hot water cylinder and pipework	✓			
Draught proofing - windows, doors and attic hatch	✓	✓	✓	
Fit chimney draught excluder	✓	✓	✓	✓
Fit Digital heating Controls	✓			
Change open fire for high efficiency wood stove	✓	✓	✓	✓
Fit low energy lighting throughout property	✓	✓	✓	✓
Cavity and 80mm external wall insulation		✓	✓	
100mm External insulation to solid wall		✓	✓	
50mm Internal insulation to uninsulated sloping ceiling		✓	✓	
Fit extract fans and passive vents		✓	✓	
New Radiators and Central Heating Pump		✓		
Fit Pipework, Pumps and Valves for Central Heating		✓	✓	✓
New condensing oil boiler including controls		✓		
Replace door with highly insulated door		✓	✓	✓
Replace windows with double glazed windows		✓	✓	
Air to water heat pump, new cylinder and controls			✓	✓
Change existing rads to low temperature radiators			✓	✓
100mm Internal insulation to uninsulated sloping ceiling				✓
Install 2kWp solar electric panels				✓
Fit mechanical 'demand control' ventilation				✓
Draught proofing - full fabric sealing				✓
Replace windows with triple glazed windows				✓
Ground floor insulation				✓
Cavity and 150mm external wall insulation				✓
180mm External insulation to solid wall				✓

7.1.3.1. Key Performance Indicators (per Dwelling)

The following Graphs compare the four scenarios to the baseline (current scenario) on a per dwelling basis including:

- Energy use for fuel and electricity delivered to each house for space and water heating, lighting, pumps, fans.
- Primary Energy per m2 floor area based on the energy usage "at source" associated with the energy usage and is an indication of the average BER grade after the scenarios are implemented.
- Extent to which the energy usage is "renewable" such as wood, solar energy, heat pumps.
- Fuel costs arising from the energy usage.

- CO2 emissions arising from the energy usage.
- Expected CAPEX per dwelling to implement each scenario (does not account for grants).

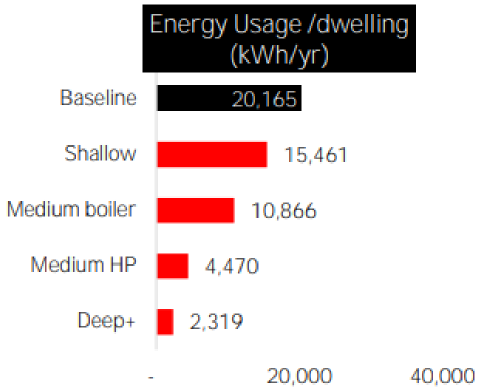


Figure 22: Energy Usage per average dwelling per yr for all Scenarios [kWh/yr]

As can be seen by the above figure, all of the proposed RetroKit scenarios result in a decrease in final energy when compared to the baseline (current) usage discussed in the previous section. These values displayed in terms of percent decrease from the current baseline usage are as follows:

- Shallow ~23% decrease in energy use
- Medium Boiler: ~46% decrease in energy use
- Medium Heat Pump: ~78% decrease in energy use
- Deep+: ~89% decrease in energy use

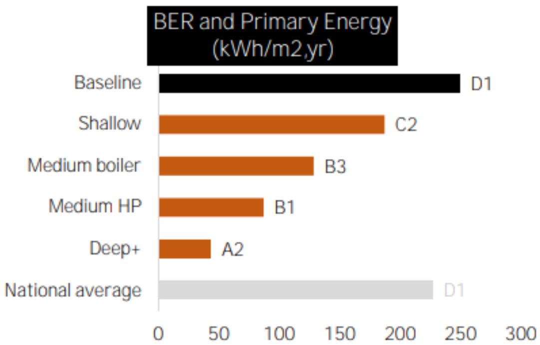


Figure 23: Projected Increase in BER Grade for the Average Dwelling

As can be observed, currently the average domestic BER grade of the housing stock in Enniscorthy is a D1 which is equal to the current national average grade. Thes grades Improve with each subsequent upgrade scenario with only the "Medium Heat Pump" and "Deep+" resulting in an average BER grade of a B2 or higher.

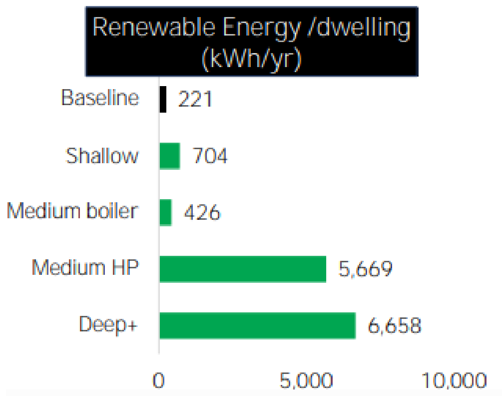


Figure 24: Renewable Energy Contribution of the Average Dwelling

The current renewable energy contribution to the final energy usage of the average household is only 221kWh/yr. Interestingly the "Shallow" upgrade scenario actually results in a higher uplift in renewable energy contribution when compared to the "Medium Boiler" upgrade scenario.

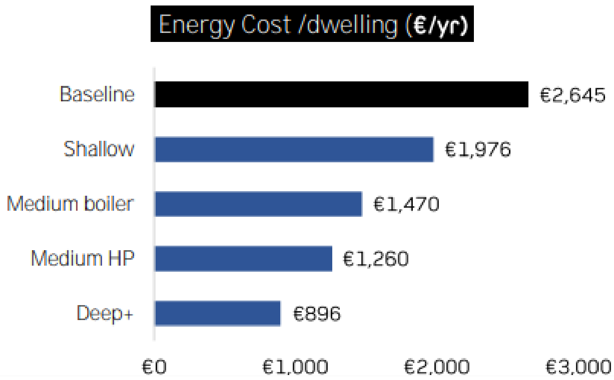


Figure 25: Final Average Annual Energy Cost per Scenario

All proposed energy scenarios see a decrease in the cost of energy to the average dwelling in Enniscorthy.

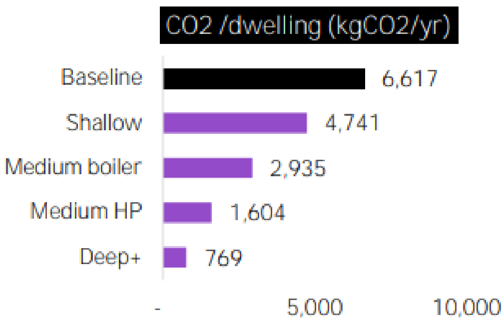


Figure 26: Average Dwellings CO_2 Emissions for Each Energy Upgrade Scenario

Each energy upgrade scenario comes with a decrease in the average household carbon emissions. These values displayed in terms of percent decrease from the current baseline emissions are as follows:

- Shallow ~28% decrease in emissions

- Medium Boiler: ~56% decrease in emissions
- Medium Heat Pump: ~76% decrease in emissions
- Deep+: ~88% decrease in emissions

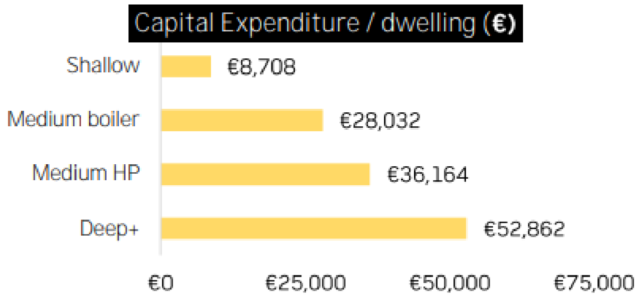


Figure 27: CAPEX associated with each Energy Upgrade Scenario

As can be seen from the above table each energy upgrade scenario would come with a significant capital expenditure for the average resident (CAPEX - Capital Expenditure: funds a company/personnel invests in acquiring, upgrading, or maintaining physical assets such as buildings, equipment, or infrastructure, with the expectation of generating future benefits or revenue). However, it is important to note that the above values do not include the grants that are available when undertaking such energy upgrades. This coupled with a reasonable payback period still means that energy upgrade should be feasible for many residential households in Enniscorthy.

7.1.3.2. Additional Key Performance Indicators

RetroKit also enabled the high-level comparison of the scenarios across a range additional metrics:

- Heat Pump Readiness: this is the likelihood of dwellings in the scenario having a suitably low heat loss for a heat pump to perform effectively in the dwelling. This is needed if seeking grant funding for heat pumps. A dwelling should have additional fabric or airtightness measures applied if a heat pump is to be installed and if it isn't heat pump ready.
- Reduction in final energy use shows how far 'energy usage' is reduced compared to the baseline.
- Total annual energy savings shows the fuel cost savings per measure broken down by age bands of dwellings in the study area.
- Total annual costs, tallies the overall energy costs. These total annual costs include fuel costs, estimated carbon tax (based on government projections) and annualised CAPEX. Lifespan for CAPEX (yrs)= 25. The figures assume no grants are available. The scenarios will only become more attractive if grants are obtained.

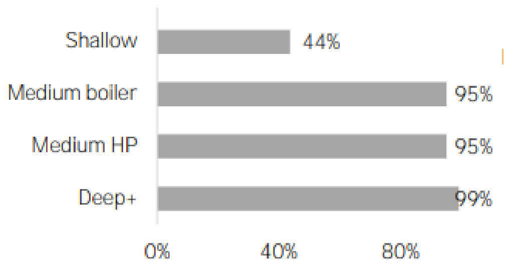


Figure 28: Heat Pump Readiness per Scenario

The above figure displays the heat pump readiness per scenario. As discussed in the previous section, currently 84% of the of housing stock in Enniscorthy are not heat pump ready. However, with the implementation of the energy upgrade scenarios would mean that with the implementation of the "Medium Boiler" scenario or higher would result in 95% or more of the housing stock being heat pump ready.

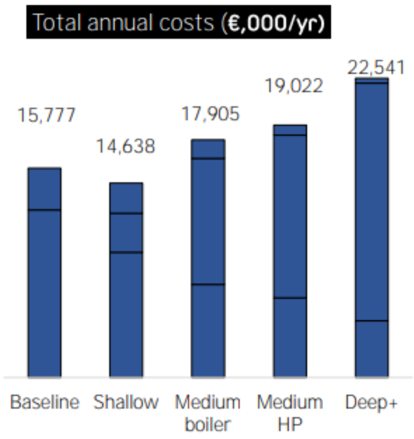


Figure 29: Estimated total annual energy cost for Enniscorthy for each energy scenario (In Thousands of Euro per yr)

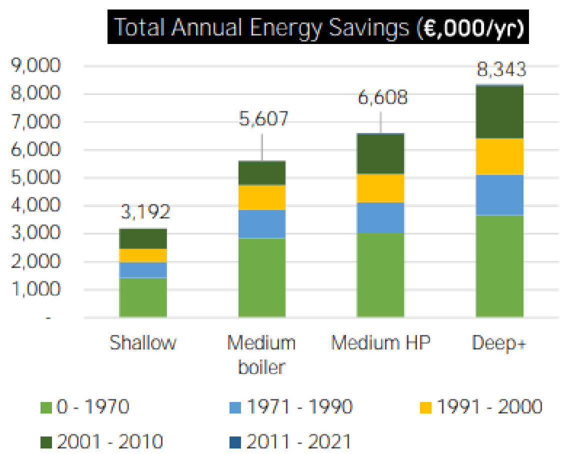


Figure 30: Estimated Total Annual Energy Savings for Enniscorthy for each Energy Scenario (In Thousands of Euro per yr)

The above image displays the estimated annual energy savings across the Enniscorthy housing stock in thousands of Euro. The chart is further broken down by the housing age bands. As can be seen the age band that benefits most from all energy upgrade scenarios is the pre-1970's band. Each subsequent energy upgrade scenario results in greater energy savings for Enniscorthy.

7.1.3.3. RetroKit Scenario Analysis - Archetype Case Studies

RetroKit also generated 6 case studies that each cover one of the 6 most common housing archetypes in the Enniscorthy region and discusses how each one would benefit from implementing each of the 4 energy upgrade scenarios. The full 6 case study reports can be found in Appendix A. This section will briefly summarise the main findings of these reports however, it is recommended that the reader evaluate the full reports found in the appendix.

Each report estimates the energy use in the home, fuel bills and carbon dioxide emissions using the Building Energy Ratings (BER) assessment methodology. The cost and impact of proposed retrofit strategies are detailed however the upgrade costs displayed in this section are indicative and should only be used as a guide. Contractors should be consulted in order to give tailored costs for a specific property and its proposed upgrades.

Table 35: BER & Annual Energy Cost Summary of Retrokit's Archetype Scenario Case Studies

	Current (BER Grade & Annual Energy Bill)	**Shallow** (BER Grade & Annual Energy Bill)	**Med Boiler** (BER Grade & Annual Energy Bill)	**Med HP** (BER Grade & Annual Energy Bill)	**Deep+** (BER Grade & Annual Energy Bill)
Pre 1970 / Terraced / Oil	E1	C3 €2,103	B2 €1,173	B1 €1,111	A2 €699
Pre 1970 / Semi-D /Oil	E1	D1 €2,601	B3 €1,427	B1 €1,315	A2 €848
Pre 1990 / Terraced / Solid Fuel	D2	C3 €1,462	B2 €1,085	B1 €1,005	A2 €599
Pre 2000 / Detached / Oil	C2	B3 €2,552	B2 €1,963	B1 €1,782	A3 €1,459
Pre 2010 / Terraced / Oil	C2	B3 €1,396	B3 €1,583	B1 €1,135	A2 €840
Pre 2010 / Semi-D /Solid Fuel	D2	D1 €1,461	B3 €1,218	B1 €1,104	A2 €805

9. Sustainable Energy Roadmap

The Sustainable Energy Roadmap is an important output of the sustainable Enniscorthy SEC EMP and is built upon the Register of Opportunities. The roadmap gives the community an informed perspective on the scale of the challenge faced by their community in moving from their baseline to achieving 2030 reduction targets. The roadmap provides a general path or plan for the SEC to reach each reduction target (2030 reduction targets). This comprehensive roadmap is designed to offer a structured and holistic plan for the SEC to navigate its journey towards meeting these 2030 reduction targets. It encompasses an array of essential analyses, with the following key highlights:

Energy Retrofit for Buildings: A roadmap for energy retrofit of residential and non-residential buildings in the study area, with the potential to reduce energy use in buildings by 30% by 2030.

Transport Emission Reduction: To curtail emissions stemming from transportation, the roadmap explores various options. These include promoting carpooling schemes and implementing effective cycling pathways and pedestrian routes. In addition an emphasis is give on EVs and EV charging stations, thus steering the community towards sustainable and eco-friendly mobility solutions.

Solid Fuel Utilisation: In the short term, the roadmap presents feasible options for reducing the use of solid fuels. These options centre on enhancing the efficiency and environmental friendliness of appliances, aligning with the community's immediate sustainability goals.

Renewable Energy Expansion: An integral component of the roadmap is a high-level analysis of the potential to increase renewable energy resources, with particular focus on wind and solar energy, within the study area. This analysis utilises SEAI's LARES Sieve methodology where applicable, thereby charting a course towards a greener and more sustainable energy mix.

Identifying Feasibility Studies: The roadmap also serves as a guidepost for identifying potential areas of future feasibility studies. This forward-looking approach ensures that the SEC remains agile and adaptable, ready to explore emerging opportunities and technologies as they evolve.

Based on the objectives outlined in the EMP scope, each technology or proposal identified for the Enniscorthy SEC region is evaluated and categorized into one of three project categories:

1. RES Projects (Renewable Energy Projects): These projects involve a high-level analysis of the potential to increase renewable energy resources. This analysis makes use of SEAI's LARES Sieve methodology whenever applicable.
2. EE Projects (Energy Efficiency Projects): These projects focus on enhancing energy efficiency, particularly within commercial and public sector buildings. Their aim is to reduce energy consumption effectively.
3. BE Projects (Behavioural Impact Projects): Projects falling into this category concentrate on behavioural aspects. They aim to raise awareness about sustainability, promote sustainable practices both within the community and beyond, and demonstrate the long-term benefits of sustainability.

In this way, each proposal is systematically categorised based on its alignment with the EMP goals and its potential impact within the Enniscorthy SEC region.

Table 36: Local Renewable Energy Suitability

Technology/ Proposal	Scale range (kW, MW)	Target application and assumption	Annual savings (Electrical/ Fossil thermal) kWh	CO2 saving	Suitability term (RYG rating)	Rationale
Community Owned Solar Photovoltaic (PV) System	1 MW	Auto production	~1 GWh in first year	~300 tonnes in first year	Medium term	Great solar potential. In line with Enniscorthy's climate ambitions and EMP goals
Rooftop solar installations for public/commercial properties	20 MW (34kWp systems across 608 locations)	7-day retail, leisure, hospitality businesses and industries.	13GWh in first year	4000 tonnes in first year	Short term	These buildings have good electrical demand match with Solar PV output. MSS will improve the business case for self-consumption with a tariff for excess.
Community scale wind project	125 MW	Auto production	536 MWh in first year	177 tonnes in first year	Long tern	Good wind potential In line with Enniscorthy's climate ambitions and EMP goals
Small-scale wind turbines (behind the meter)	N/A	7-day retail, leisure, hospitality businesses and industries.	Yet to be determined	Yet to be determined	Long term	These buildings have good electrical demand match with potential wind output.
Implementing microgrids for localised renewable energy distribution	N/A	Distributes electricity independently or in conjunction with the main power grid	N/A	N/A	Long term	particularly effective in integrating renewable energy sources
Switch to Biogas / Greengas/ BioLPG	N/A	Alternative to current home and commercial fossil fuel heating	Yet to be quantified	Yet to be quantified	Long term	Boilers may be the only option for home heating for many households
Transport: Increase EVs &	N/A	All areas of local transport	Yet to be determined	Yet to be determined	Long term	Reduces ICE's on the roads thus reducing emissions

EV charging stations						
Car Microgrid	N/A	Abbey shopping Centre	Yet to be determined	Yet to be determined	Medium term	enables EV charging and establishes a bi-directional flow of electricity between the stations and the rest of the grid
Smart Meters	Implemented per building	Businesses Public Spaces & Offices	Yet to be determined	Yet to be determined	Short term	Help the business to make informed decisions based on their consumption patterns
LED lighting and efficient lighting controls	Implemented per building	Businesses Public Spaces & Offices	Yet to be determined	Yet to be determined	Short term	Reduce the energy consumption especially during the time of inactivity
Building fabric improvement (eg. Roof insulation, energy efficiency glazing)	Implemented per building	Business Public Spaces & Offices	Yet to be determined	Yet to be determined	Medium term	Improves the ability of the building to maintain temperature for longer durations
Heat pumps for commercial and public buildings	N/A	Business Public Spaces & Offices	Yet to be determined	Yet to be determined	Medium term	Boosts energy efficiency, lowers carbon emissions, and promotes environmentally friendly heating and cooling options
Process integration and heat recovery for low temperature processes	N/A	Agricultural and Industrial processes	N/A	N/A	Long term	To minimise energy consumption and reduce waste heat in agricultural and industrial processes
Transport: Increase public transportation use	N/A		N/A	N/A	Medium term	
Evaluation of the effectiveness of pedestrian and cycling pathways	N/A		N/A	N/A	Short term	
Implementing congestion pricing and	N/A		Yet to be determined	Yet to be determined	Short term	

parking policies to reduce car usage						
Conduct workshops and training programs to educate locals and businesses on sustainable energy practices and their implementation	N/A		N/A	N/A	Short term	
Community-wide ridesharing/ Carpooling Scheme	N/A		N/A	N/A	Short term	

9.1. Road Map

9.1.1. Residential

Table 37: Potential impact if scenarios are implemented across the whole housing stock within the study area

Energy upgrade scenario implemented	Energy Saving (MWh/yr)	Renewable energy used (MWh/yr)	Emissions avoided (tCO2/yr)	Capital Cost (€,000/yr)
Baseline	96,227	1,053	31,579	
Shallow	22,445	3,360	8,956	41,555
Medium boiler	44,374	2,034	17,571	133,767
Medium HP	74,897	27,051	23,922	172,576
Deep+	85,161	31,773	27,910	252,256

Table 38: Potential impact of energy upgrade scenarios depending on their level of implementation across the housing stock in the study area

Energy upgrade scenario implemented	% of housing stock upgraded	#dwellings upgraded	Energy Saving (MWh/yr)	Renewable energy used (MWh/yr)	Emissions avoided (tCO2/yr)	Capital Cost (€,000/yr)
Shallow	20%	954	4,489	672	1,791	8,311
Medium boiler	10%	477	4,437	203	1,757	13,377
Medium HP	20%	954	14,979	5,410	4,784	34,515
Deep+	15%	716	12,774	4,766	4,187	37,838
Total	65%	3102	36,680	11,051	12,519	94,041

Based off the above level of implementation, outlined in table 17, the resulting level of impact on the baseline levels would be:

- 38% decrease in energy consumption
- 949% increase in the share of renewable energy
- 40% reduction of overall carbon emissions for the Enniscorthy region

This 40% reduction in carbon emissions is in line with the government's 2023 Climate Action Plan for sectoral emission reduction targets. The excel document from which these values were obtained is attached alongside this report for the purpose of allowing the user to edit the level of implementation of each scenario to see what effect on the baseline would be.

9.2. Delivery Models

9.2.1. Residential Housing Energy Retrofit Delivery Model

9.2.1.1. Grant schemes for energy retrofits in Ireland

There are a number of grants available through the Sustainable Energy Authority of Ireland (SEAI) to assist with domestic retrofit and to tackle fuel poverty. These include the Home Energy Grants, which offers a cash grant to help homeowners installing energy saving measures and typically covers 30-40% of the cost. In a number of cases, customers availing of this grant can receive additional credit against their bills or funding from energy companies on top of the BEH grant. The Better Energy Warmer Homes Scheme, (BEWH) grant offers free energy efficiency upgrades to homeowners who receive certain welfare payments such as; fuel allowance, job seekers, working family etc. The Community Energy Grant is available to communities to supports new approaches to achieving energy efficiency and typically covers 30-50% of the costs. The National Energy Retrofit Scheme is a new government grant scheme designed to encourage the development of One-Stop-Shops and engage groups of private households, registered Housing Associations and Local Authorities who wish to participate in delivering energy efficiency upgrades, specifically in domestic buildings. The scheme aims to bring together groups of homes under the same retrofit programme to facilitate energy improvements in an efficient and cost-effective manner and provides grants of between 35% to 80% depending on the nature of the beneficiaries.

Quality assurance for the SEAI grant funded work is provided by an installer accreditation scheme and all work must comply with The National Standards Association of Ireland, (NSAI) Code of Practice for the Energy Efficiency Retrofit of Buildings, SR54. SEAI also requires compliance with its Domestic Technical Standards and Specifications. However SEAI do not provide any warranty for the work completed and only carry out spot checks on a sample of installations.

9.2.1.2. Recommendations for an integrated energy retrofit delivery model at community level

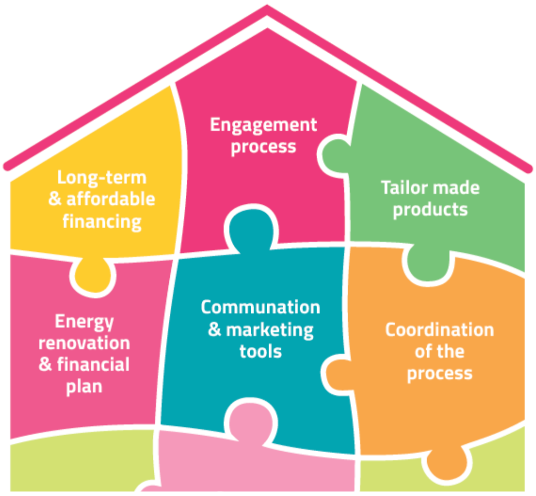


Figure 31: Key Functions of a Energy Retrofit One-Stop-Shop

A coordinated approach to develop and deliver energy retrofit projects would help achieving scale and impact in your community. The 'energy retrofit one-stop-shop' is an emerging model in Ireland, bringing under the same roof a range of support services for community-scale retrofit projects, going from awareness-raising and advice to project management and finance. This is illustrated in the graph herewith.

The core function of such an organisation is to support householders and other beneficiaries in the community along their 'customer journey' and to act as a co-ordinator between all the stakeholders involved. The diagram below explains the typical steps for a "one stop shop" customer:

- Awareness-raising in the community around the benefits energy retrofits, the funding available and the services provided by one stop shop, using social media, local media, information evenings, and other relays in the community.
- Once the customer contacts the "one stop shop" a Retrofit Coordinator (RC) needs to be appointed, a home survey and BER assessment completed and a project budget established, with information on relevant grants.
- Once the customer is on board, the RC then needs to complete the project design and specification including a whole house retrofit plan and procure the work through accredited installers, likely through competitive tendering.
- Work is completed by the installer quality assurance provided by the RC. Once finished there needs to be a formal handover including any necessary user training for the customer and on a broader scale feedback and evaluation of the retrofit work.

The one-stop-shop model often includes coordination of project funding e.g. from SEAI under schemes such as the Community Grants and the National Housing Retrofit Scheme. The services provided in that regard would include preparation and submission of funding applications, management of payments to contractors and funding claims.

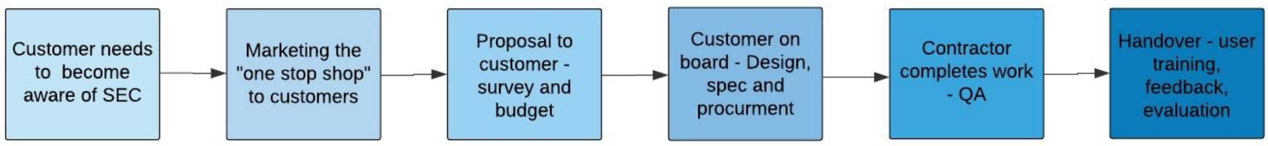
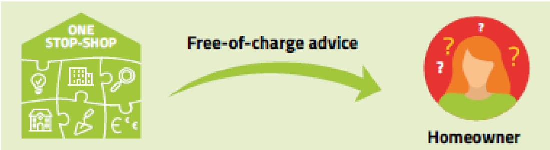


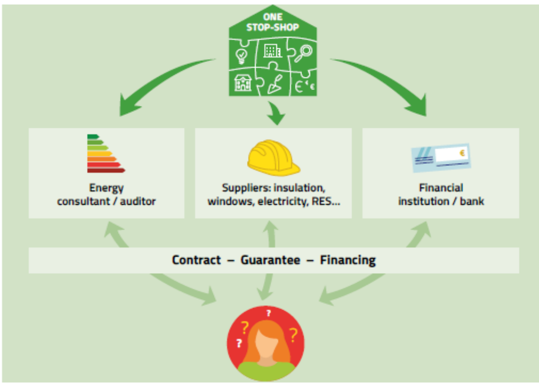
Figure 32: Customer journey through the "one stop shop" retrofit model.

The one-stop-shop model is flexible. The range of services and the delivery model can evolve with the needs and capability of your community. Here is an outline of a few options:



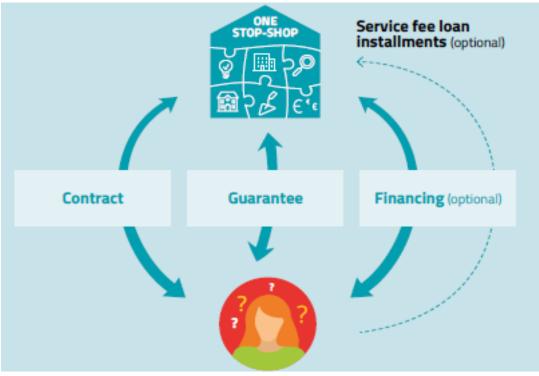
Facilitation Model:

Offers initial retrofit advice to homeowners, sign-posts towards available supports but responsibility for the retrofit process lies with the property owner



Coordination Model

Offers advice, co-ordinates funding applications and possibly finance. Might assist with overall project management, but contractual responsibility for retrofit works rests with property owner and contractors.



Integration Model

Full one stop shop offer under one roof, providing a single point of contact for property owner. One stop shop provides advice, contract management & quality assurance, funding & finance offering, etc.

The next key steps towards the establishment of a community based one-stop-shop for energy retrofit include:

1. Feasibility/market research
2. Business Plan
3. Coordinate Stakeholders
4. Secure funding for scheme setup
5. Launch the one-stop-shop

10. Conclusions and Recommendations

The goal of this Energy Master Plan was to provide a method for the Sustainable Enniscorthy SEC to become a Sustainable Enniscorthy to transition towards a more energy efficient community and a decarbonisation zone that reduces its carbon footprint We identified obstacles that the community currently faces in its effort to be sustainable and have developed a range of possible solutions to aid this process.

- The EMP began by establishing an energy baseline that comprehensively analysed energy consumption across residential, commercial, industrial, and transportation sectors.
- ASHRAE Level 1 energy audits were conducted to identify opportunities for energy optimization within key community buildings.
- The strategic approach of Backcasting was employed to envision a sustainable future and develop strategies to work backward toward achieving this vision.
- A range of actionable solutions was proposed, considering their impact on social, economic, and environmental aspects, and evaluated using a Balanced Scorecard framework.
- The Balanced Scorecard and Register of Opportunity were introduced as essential tools for monitoring progress and identifying opportunities for sustainable growth.
- Integration strategies were developed to ensure a cohesive approach to sustainability.
- Scenarios for sustainability were constructed to categorise technologies and proposals, providing a structured path towards sustainability.
- The 2030 sustainable roadmap design plays a pivotal role in realising the goal of an energy-efficient community with reduced carbon emissions.

The selected actionable solutions are envisioned to have a profound impact on the community at large. Their successful implementation will necessitate collaborative efforts with key stakeholders, including Wexford County Council, SEAI (Sustainable Energy Authority of Ireland), and various community groups and government bodies.

The table below outlines the preliminary steps that the Enniscorthy SEC can embark upon for each recommended actionable solution:

Actionable Solutions	Steps for the Enniscorthy SEC
Community Owned Solar Photovoltaic (PV) System	- The SEC has the opportunity to establish its own **Renewable Energy Community (REC)** and, can collectively apply for the **Small-Scale Renewable Electricity Support Scheme (SREES)**. Under this scheme, projects ranging from 1 to 6 MW will receive support through a two-way floating feed-in premium throughout the scheme's duration. Projects that are 100% owned by the REC will qualify for support for installations up to 6 MW. - The SEC can apply for **Community Benefit Funds (CEF)**, projects that have been successful in RESS and ORESS auctions are required to establish a CEF with a mandated contribution of €2/MWh of electricity produced. The CEF can support not-for-profit community enterprises where the focus is aligned with UN sustainable development goals. - **Contact Energy Co-operatives Ireland** for guidance on community-owned solar PV systems, which offer off-the-shelf renewable energy solutions and full-spectrum support to community-based renewable energy co-operatives, including legal setup, government interactions, networking, and communication. In addition, consideration for a **Power Purchase Agreement (PPA)** for the recommended community solar

	project with energy companies/ businesses. This will enable affordable clean energy access, foster shared ownership, and financially support the establishment of a local solar power plant, benefiting both the community and the environment.
Rooftop solar installations for public/commercial properties	- Compile a Mailing List of businesses, SMEs, and other energy consumers who are potential candidates for solar PV installations. Keep them informed about available support and grants from SEAI through regular email updates or newsletters (Publicise SEAI's support for small businesses interested in solar microgeneration through the Non-Domestic Microgen Scheme). - In addition to that, creating a list of local contractors, consultancies, and businesses is essential as well to advance community renewable energy projects. This list keeps stakeholders informed about upcoming opportunities and enables collaboration for sustainable energy installations, fostering a cleaner, more efficient renewable technology in the community.
Community-scale wind project	- Contact Energy Co-operatives Ireland, same recommendation as above for the community-owned solar PV system.
Small-scale wind turbines (behind the meter)	- This proposed solution received a lower score, approximately 3, in the balanced scorecard evaluation, and as a result, it is not recommended for further advancement. One of the primary factors contributing to this decision is the technological immaturity and limited availability of small-scale wind turbines designed specifically for Irish environmental conditions.
Implementing micrograds for localised renewable energy distribution	- (This proposed solution received a lower score, lower than 3, in the balanced scorecard evaluation, and as a result, it is not recommended for further advancement.)
Switch to Biogas / Greengas	- This proposed solution received a lower score, lower than 3, in the balanced scorecard evaluation, and as a result, it is not recommended for further advancement. Due to factors such as not knowing the delivery time frame, cost of work, calculable energy savings, overall economic feasibility and overall impact of the solution. - Businesses which are interested in moving from fossil fuel to renewable heat can be informed on financial incentives by the SEAI, Support Scheme for Renewable Heat (SSRH).
Transport: Increase Evs & Ev charging stations	- Highlight SEAI's support for EVs and EV charging stations. - Disseminate valuable information via email updates and community events concerning Electric Vehicle (EV) asset finance options offered by private financial institutions and SEAI's dedicated EV program executives. - Educate the community through public forums and seminars, using fuel cost and emissions comparison studies as effective tools. These sessions will empower individuals with data-driven insights to make informed decisions about adopting environmentally friendly EVs.
Car Microgrid	- Identify the list of potential car-park sites and make preliminary contact with the owners to discuss a car microgrid system. Further, provide them with information on SEAI's support for small businesses interested in solar microgeneration through the Non-Domestic Microgen Scheme.
Smart Metering and Home Self-Assessments	- Educate homeowners and community on the Home Energy Saving Kit, which can be borrowed from selected libraries all around Ireland to assess your energy usage, calculate costs, and discover ways to make savings in your home/facility.
LED lighting and efficient lighting controls	- Establish partnerships with local electrical lighting contractors to offer incentives and discounts for replacing fluorescents and incandescent, enticing the community to transition to energy-efficient LEDs.

Building fabric improvement (eg. Roof insulation, energy efficiency glazing)	- Promote **SEAI's Support Scheme for Energy Audits (SSEA),** to the established Mailing List of local businesses, offering SMEs a €2,000 voucher for high-quality energy audits[1] - Inform the established Mailing List of local businesses on the **SEAI's Community Energy Grant (CEG)** program. Encourages energy efficiency in communities, enabling group applications for SMEs and businesses. Utilise a consultant to process multiple applications simultaneously within the community, maximising grant benefits. - For the residential sector, use the **one-stop-shop** and residential housing energy retrofit delivery model outlined in the main report.
Heat pumps for commercial and public buildings	- Promote **SEAI's Support Scheme for Energy Audits (SSEA)**, **SEAI's Community Energy Grant (CEG) and one-stop shop** similar to as explained in the above building fabric improvement actionable solution.
Process integration and heat recovery for low-temperature processes	- Identify key industries and manufacturing facilities with substantial thermal energy consumption and demand. (KRA's baseline analysis within the commercial sector can provide the SEC with those properties, which will also be attached to this report). Promote the implementation of process integration and heat recovery strategies in these plants, specifically targeting low-temperature processes for enhanced efficiency and sustainability.
Transport: Increase public transportation use	- Collaborate with Wexford County Council, government agencies, and local climate action teams focused on the transport sector. Initiate local surveys within the community to gain insights into public concerns related to increasing bus frequency and expanding bus routes to enhance connectivity, thereby encouraging greater reliance on public transportation. - Next, establish contact with local public offices, schools, colleges, and major organisations. In coordination with Wexford County Council, introduce incentives for employees and students to use public transport during peak hours. This strategic approach not only helps reduce emissions but also alleviates traffic congestion and enhances overall environmental sustainability.
Evaluation of the effectiveness of pedestrian and cycling pathways	- Collaborate with local stakeholders to establish bicycle facilities and mileage allowances provided by employers in the community. Refer to **case studies** from countries with high bicycle usage, like the Netherlands, for insights into promoting bicycle use effectively. - Additionally, consider implementing a **Primary School Cycle Training** Scheme similar to the one introduced by Dún Laoghaire Rathdown County Council in 2011. This scheme, conducted in partnership with the Cycling Safety School, offers cycling safety training to fifth and sixth-grade primary school students in the administrative area. These classes not only teach safe cycling techniques but also introduce an affordable and valuable form of exercise, addressing concerns about the lack of physical activity. - Promote the **bike-to-work scheme,** in the community.
Implementing congestion pricing and parking policies to reduce car usage	- Engage stakeholders (Public consultation, Wexford County Council), develop policies, launch a public awareness campaign, conduct a pilot program, and continuously monitor and report on the policies impact.
Conduct workshops and training programs to educate locals and businesses on sustainable energy practices and their implementation	- The SEC group, in partnership with Wexford County Council and SEAI, can develop and deliver workshops and training programs. These programs will target residents and businesses, addressing identified needs through engaging, interactive sessions. Further, raise awareness through marketing and outreach, gather feedback for continuous improvement, and provide post-workshop support. Certification and recognition will motivate participation, and long-term sustainability will be ensured. Through these steps, the community can be educated and empowered, fostering sustainable energy practices for a greener future.

[1] Please check the eligibility criteria for the Support Scheme for Energy Audits (SSEA) for SMEs.

Community-wide ridesharing/ Carpooling Scheme	- The SEC with a goal to encourage employees and other organisations to adopt carpooling schemes, instil a sense of social responsibility towards addressing climate change, and contribute to meeting national sustainability targets.

These Actionable Solutions (and the recommended implementation steps for the SEC) are not an exhaustive list, nor do all of them need to be undertaken in the immediate term. SECs are voluntary community groups, with limited time and financial resources, and in KRA's experience focused, consistent action on one or two points at a time is more effective than taking on too much and becoming overwhelmed. “Make haste slowly” tends to result in real long-term results. In conclusion the Energy Master Plan for Enniscorthy serves as a comprehensive and strategic framework that not only identifies opportunities for energy optimisation but also outlines a clear path for the community to embrace sustainability and achieve its long-term goals. This plan paves the way for Enniscorthy to become a beacon of energy efficiency and environmental responsibility.

KRA Renewables will be happy to assist with the implementation of whichever solutions the SEC and community choose to focus on as their next step.

It has been a pleasure to work with the Enniscorthy SEC to date, and we look forward to continued cooperation in the coming weeks, months and years.

11. APPENDIX A

Appendix A - Archetype Scenario case studies

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11.1. Infeasible Technologies

11.1.1.1. Implementing microgrids for localised renewable energy distribution

Microgrids are localised, self-contained energy systems that generate, store, and distribute electricity independently or in conjunction with the main power grid. They are designed to serve a specific area, community, or facility and are particularly effective in integrating renewable energy sources, such as solar panels and wind turbines, into the energy mix.

- **Environmental Impact**

The adoption of microgrids for localised renewable energy distribution carries substantial environmental benefits, including:

  - **Green Energy Integration:** Microgrids facilitate the integration of renewable energy sources, reducing reliance on fossil fuels and decreasing greenhouse gas emissions.
  - **Emission Reduction:** By generating electricity locally from renewable sources, microgrids contribute to lower carbon emissions, helping Enniscorthy achieve its climate goals.

- **Social Impact**

Promoting microgrids for localized renewable energy distribution has positive social implications, such as:

  - **Energy Resilience:** Microgrids enhance energy resilience, ensuring a reliable power supply during grid outages or disruptions.
  - **Community Engagement:** The development of community microgrids encourages local involvement and collaboration, fostering a sense of ownership and pride.

- **Economic Impact**

Encouraging the use of microgrids also has economic advantages, including:

  - **Lower Energy Costs:** Microgrids can reduce energy costs for consumers by utilising cheaper renewable energy sources and increasing energy efficiency.
  - **Job Creation:** The installation, maintenance, and operation of microgrids create local job opportunities, stimulating economic growth.
  - **Increased Property Value:** Homes and businesses connected to microgrids may experience increased property values due to the reliability and sustainability of their energy supply.

Implementing Microgrids for Localised Renewable Energy Distribution

- **Feasibility Studies:** Conduct feasibility studies to identify suitable locations and assess the technical and economic viability of microgrid projects.
- **Public-Private Partnerships:** Explore partnerships between local governments, utilities, and private sector entities to fund, build, and operate microgrid projects.
- **Community Involvement:** Engage the community in microgrid planning and development to ensure projects align with local needs and priorities.

- **Energy Storage:** Include energy storage solutions, such as batteries, to store excess renewable energy for use during periods of high demand or grid instability.

Implementing microgrids for localised renewable energy distribution in Enniscorthy represents a significant step toward achieving a more sustainable, resilient, and economically vibrant community. Microgrids empower us to harness renewable energy sources efficiently, reduce emissions, and enhance energy security.

Table 39:EMP Score Card Analysis for Implementing microgrids for localised renewable energy distribution

General Aspects - Weighted with 1.10	2.4
Environmental Aspects - Weighted with 1.05	2.1
Social Aspects - Weighted with 0.85	2.8
Economic Aspects - Weighted with 1.00	4.0
Priority	2.8

11.1.1.2. Small-scale wind turbines (behind the meter)

Small-scale wind turbines, frequently installed behind the meter, represent compact renewable energy systems that tap into wind power to locally generate electricity. These systems find common applications in domestic and commercial settings, often serving as renewable energy sources for microgeneration schemes.

- **Environmental Impact:**
  - **Clean Energy Generation:** Small-scale wind turbines produce clean, renewable energy, reducing reliance on fossil fuels.
  - **Climate Change Mitigation:** They cut greenhouse gas emissions by displacing fossil fuel-based electricity.
  - **Air Quality Improvement:** This shift towards cleaner energy reduces air pollution, benefiting public health.
  - **Sustainable Resource:** Wind, a sustainable and abundant resource, ensures a long-term supply of clean power.
- **Economic Impact:**
  - **Cost Savings:** Small-scale wind turbines yield long-term cost savings by generating on-site electricity.
  - **Utility Bill Offset:** They can offset utility bills, reducing overall energy expenses.
  - **Revenue Potential:** Surplus energy can be sold back to the grid, creating a revenue stream.
  - **Job Creation:** Installation and maintenance of wind turbines create job opportunities, bolstering local economies.
  - **Renewable Energy Sector Growth:** They contribute to the growth of the renewable energy sector, fostering economic development.
- **Social Impact:**
  - **Symbols of Sustainability:** Small-scale wind turbines symbolise sustainable living practices, promoting eco-conscious values within communities.
  - **Awareness and Education:** They raise awareness about renewable energy, educating and inspiring individuals to embrace clean energy sources.
  - **Environmental Responsibility:** These systems cultivate a sense of environmental responsibility, encouraging communities to reduce their carbon footprint.

- **Energy Security**: By generating local, clean power, wind turbines enhance energy security, reducing dependence on centralized grids.
- **Resilience**: Communities become more resilient, better equipped to handle power disruptions and emergencies.
- **Improved Quality of Life:** Overall, this fosters an improved quality of life and local energy autonomy, enhancing the well-being of community members.

Table 40: EMP Score Card Analysis for Small-scale wind turbines

General Aspects - Weighted with 1.10	2.9
Environmental Aspects - Weighted with 1.05	2.9
Social Aspects - Weighted with 0.85	3.6
Economic Aspects - Weighted with 1.00	4.2
Priority	3.4

11.1.1.3. Transitioning to Green / Bio - Gas: Sustainable Home Heating Solutions/Decarbonisation of Industry.

Switching to green gas or biogas for home heating represents a significant opportunity for Enniscorthy to reduce carbon emissions, improve air quality, and contribute to a more sustainable energy future. By promoting the use of bioLPG/gas in LPG (liquefied petroleum gas) or natural gas boilers, The Enniscorthy community can create a cleaner and more efficient heating system for the area. Green gas can also be used to decarbonise industry, which can have processes which are difficult to electrify.

- **Environmental Impact**

The adoption of green gas for home heating brings forth several environmental benefits, including:

- **Reduced Carbon Emissions**: Green gas is derived from organic sources, such as agricultural waste through anaerobic digestion or organic matter in landfills. It is a renewable and low-carbon energy source, leading to a significant reduction in greenhouse gas emissions compared to conventional fossil fuels.
- **Improved Air Quality:** Using green gas results in cleaner combustion and lower emissions of harmful pollutants, contributing to better air quality in our town.

- **Social Impact**

The transition to green gas has positive social implications, including:

- **Healthier Communities:** Lower emissions from green gas heating systems result in reduced exposure to harmful air pollutants, leading to improved public health and well-being.
- **Local Sustainability:** Investing in green gas infrastructure such as LPG boilers or biogas ready/compatible boilers can create jobs in the community, from the production of biogas to the maintenance of heating systems.
- **Energy Security:** The production of green gas can be localised, reducing reliance on imported fossil fuels and enhancing energy security.

- **Economic Impact**

The adoption of green gas for home heating has economic advantages, such as

  - **Economic Opportunities:** Investing in green gas infrastructure can create jobs in the community, from the production of bio gas to the maintenance of heating systems.
  - **Energy Security:** The production of green gas can be localised, reducing our reliance on imported fossil fuels and enhancing our energy security.
  - **Reduced Energy Costs:** Lower-cost green gas can lead to decreased heating expenses for homeowners over the long term, contributing to economic stability within the community.

By transitioning to green gas for home heating, Enniscorthy can make a significant contribution to reducing carbon emissions, improving air quality, and creating a more sustainable and resilient community. This initiative aligns with the commitment to a greener and healthier future for all residents.

Table 41: EMP Score Card Analysis for Transitioning to Green / Bio - Gas: Sustainable Home Heating Solutions

General Aspects - Weighted with 1.10	2.4
Environmental Aspects - Weighted with 1.05	3.7
Social Aspects - Weighted with 0.85	3.4
Economic Aspects - Weighted with 1.00	2.2
Priority	2.9

Table 42: Balance Scorecard Explanation

Index	Name	Description
General aspects		
IP	Impact on other proposals	Degree of effects between a proposal and others, and whether they are positive or negative. If a proposal does not have any effect on others, it'll be scored a 3.
EI	Ease of implementation	Related to the complexity implied in the proposal. The larger the number of physical changes on the site needed, the lower the score.
DT	Delivery Timeframe	Do we know the delivery timeframe for the proposed project in detail?
CW	Cost of Works	Do we know the full cost of the work? Including VAT, labour, etc
CES	Calculations for Energy Savings	Do we know the calculated energy savings?
Environmental aspects		
COx	Decrease in emissions of Carbon oxides (COx)	Effective reduction of COx emissions associated with fossil fuels. Proposals that only reduce COx emissions marginally are scored a 3, while proposals with significant COx reductions are scored a 4. If a proposal directly generates fossil free energy, or completely replace the need for it, are scored a 5.
DeG	Decrease in gas consumption	Decrease in the need of gas on-site. If a proposal directly replaces gas for a fossil-free source, it scores a 5. Proposals that change the source of gas to electricity but do not reduce consumption score a 3. Proposals that neither reduce nor replace gas consumption score a 1.
DeE	Decrease in electricity consumption	Decrease in the need of electricity on-site. If a proposal directly generates fossil-free electricity it scores a 5. Proposals that neither reduce or replace electricity consumption score a 3. Proposals that change the source of electricity but do not reduce consumption score a 1. If a proposal increases electricity consumption it also scores a 1.
DeW	Decrease in water consumption	
InW	Increase in water reuse	
ReTO	Reduced exposure to noise pollution	
InR	Increase in share of renewable inputs	Amount of carbon-free or renewable inputs to the plant. If proposal replaces an input with a renewable alternative (gas to biogas) it scores a 5. If it reduces non-renewable inputs or increases use of a renewable source, it scores a 4. Proposals that increase use of non-renewable materials score a 1 or 2 depending on the intensity of the increase.
LARES	Local renewable energy production on site	Renewable energy production on site. If a proposal decrease wastes it scores a 5 or 4 depending on its effectiveness. For increases of waste, it is a 1 or 2.
ShRECY	Share of recyclable waste produced	
ShRECY	Share of recycled input materials	
Social aspects		

InA	Increase environmental/sustainability awareness employees	The awareness that a proposal creates on-site, and the shift of perception it can induce. When a proposal influences the behaviour of people it scores a 5. When it has positive impacts, but it can only be indirectly associated to sustainability, it scores a 3. If the idea is generally unseen, it scores a 1.
IBC	Increase of behavioural changes in the community	
GCB	Green certification for buildings (LEED, BREEAM, etc.)	Percentage of supplies with environmental certifications. If the idea implies collaborating with certified suppliers for general processes in the plant, it scores a "Yes". When it does not it scores a "No".
LSCP	% of local suppliers contributing to the project	
Economic aspects		
EF	Overal cost of the solution-economic feasibility	Costs related to implementing an idea. Proposals that imply large technological breakthroughs or that are generally unproven score a 1. Ideas that cost basically nothing or can even reduce expenses score a 5.
IS	Overall energy impact of the solution	
NPV	Payback years	
SR	Directly sustainable revenue created?	If a proposal can generate revenue on its own, it scores a "Yes". Otherwise they score a "No".
EI	Environmental information availability rate	If a proposal can provide better environmental information for tracking the footprint after implementation, then it scores a "Yes". Otherwise, they score a "No".
InT	Increases smart control technologies?	Related to the number of smart technologies on-site. If a proposal implies installing smart-metering systems, or any kind of ICT monitoring, it scores a "Yes". Otherwise it scores a "No". When smart control technologies are a choice during installation it will be specified as "Depends".