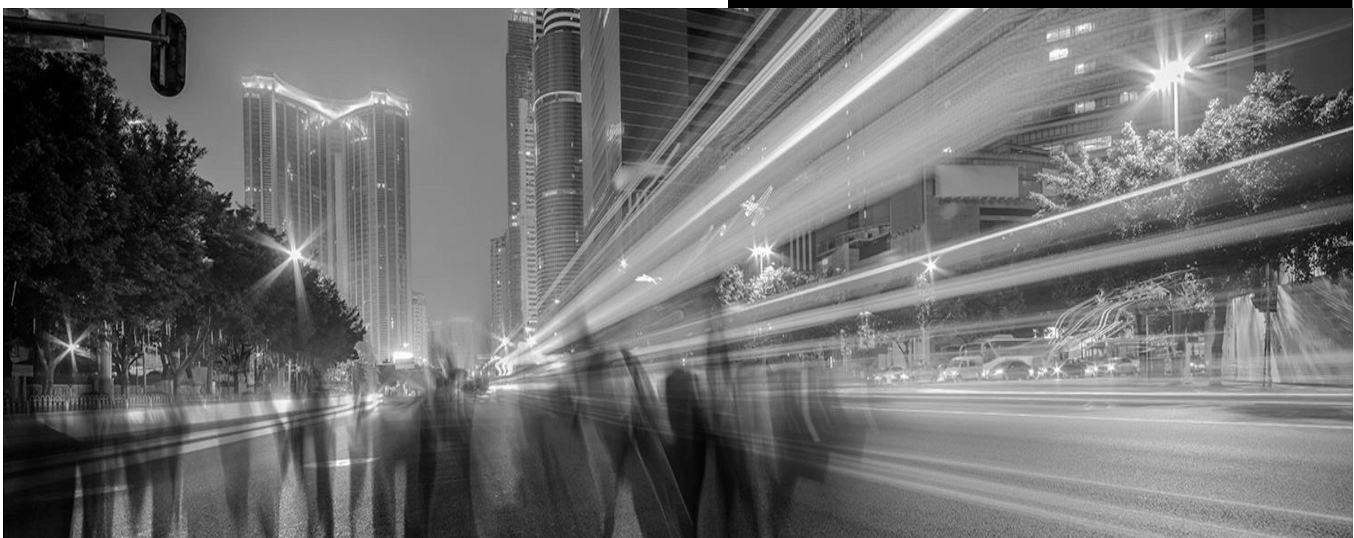
2021

# Árainn Mhór Energy Group Energy Master Plan



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# Árainn Mhór Energy Group Energy Master Plan

## Árainn Mhór Energy Group

## Document Control Sheet

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## Contents

# 1 SEC & EMP Context

Ireland's commitment to meet international energy reduction targets is fundamental to achieving a sustainable and energy efficient future. As a member of the EU, and as a responsible nation, Ireland has committed to transitioning to a low carbon economy by 2050, and to becoming carbon-free by 2100. These commitments were stated in the December 2015 Energy White Paper titled "Ireland's Transition to a Low Carbon Energy Future 2015-2030".

Up to this point, the National Energy Efficiency Action Plan mandated Ireland's commitment to a 20% energy savings target by 2020, outlining the delivery of the national energy savings targets implemented under EU requirements as well as energy efficiency policy priorities to 2020.

In 2019, Ireland became only the 2nd country globally to declare a climate emergency when the Dáil voted to amend the Oireachtas report on Climate Action. In 2019 the Minister for Communications, Climate Change and Environment introduced the **Climate Action Plan** which sets out 183 actions setting out responsibility for different departments and government agencies with quarterly reporting requirements across the different sectors to reduce carbon emissions. The actions include several tasks focused on the built environment including the renovation of 500,000 homes to a BER B2 standard by 2030 and the installation of 400,000 heat pumps to replace fossil fuel boilers.

The targets set out in the CAP however would only achieve a 3.5% reduction in carbon emissions per year, this is in contrast the UNEP's annual Emissions Gap Report from 2019 stating that a 7.6% cut in emissions per year will be needed to meet the Paris Agreement to restrict a global climate temperature rise to 1.5 °C. This is currently a matter for discussion in the Government so it is likely the Climate Action Plan will need to be radically revised again to raise the level of ambition (IGBC, 2021).

Progressing from this, the current Programme for Government sets out the Government's commitment to achieve an average 7% annual reduction in overall greenhouse gas emissions from 2021 to 2030 (a 51% reduction over the decade) and to achieving net zero emissions by 2050. The Climate Action and Low Carbon Development (Amendment) Bill was subsequently published in October of 2020. The Bill is a major piece of potential legislation that commits to dramatically migrate Irelands existing economy to that of achieving carbon neutrality by the year of 2050.

The Bill names this programme the 'National 2050 Climate Objective'. The definition of a 'climate neutral economy' provides that by 2050 all greenhouse gas emissions in Ireland are balanced or exceeded by removal of emissions. To facilitate the targets in terms of reducing the emission of greenhouse gases the Bill mandates that the Minister for the Environment, Climate and Communications must submit several documents to Government for approval which are:

- a series of national long-term climate strategies
- a Climate Action Plan (which is required to be revised annually)
- a national adaptation framework
- sectoral adaptation plans
- a series of carbon budgets (Goodbody, 2020)

The Climate Action Plan puts in place a decarbonisation pathway to 2030 which would be consistent with the adoption of a net zero target in Ireland by 2050. The Plan also commits to evaluating in detail the changes which would be necessary if Ireland is to achieve this target (DCCAE, 2019).

In February 2018, The Irish Government unveiled the Project Ireland 2040 initiative, a €116 billion plan which aims to guide Ireland's development to 2040. The Plan prioritised €22 billion for climate action. This substantial investment will both require and support behavioural change in individuals and communities across all of Ireland. The Climate Action Fund was established in 2020 to support projects that will assist Ireland in reaching its new climate action targets. With at least €500 million made available, this fund will support innovative solutions to bring Ireland towards its overall objective of carbon neutrality (DECC, 2020).

Energy consumers must be empowered to play a more active role in our low carbon transition. In the future, individual citizens will be able to exert a much greater influence on the broader energy market because of rapid technology advances and the policy and market evolution that will surround them. However, there is a significant challenge around giving citizens and communities the knowledge and confidence to engage with, and ultimately benefit from this change.

SEAI's activity in consumer insight research, piloting new technologies, developing citizen and community focused supports and the Sustainable Energy Communities (SEC) programme provides the platforms to engage with consumers and build that confidence. Since the last strategy was published, the SEAI have invested over €400 million in sustainable energy projects throughout the country. This has saved the Irish economy over €1 billion in that time. Now it is time to be even more ambitious as the challenge set out in the Government's White Paper remains stark. It will require citizens, businesses, policy makers and regulators to work together in pursuit of this shared goal.

A key vehicle for citizens and communities in Ireland to take ownership of energy use is through local, sustainable renewable energy. The Renewable Energy Support Scheme (RESS) is a support scheme to help community participation in new local energy projects. Every year Ireland spends almost €6 Billion on imported energy. The RESS will help communities retain some of this money locally and reduce reliance on carbon intensive fuels. The SEAI recently published a Five-Year Strategy 2017 – 2021; and in it 'communities' are the forefront of change. The importance of community involvement in this change was also explicitly detailed in the Climate Action Plan.

Recognising the scale of the task ahead, the SEAI will focus on several critical areas such as empowering citizens by giving them the means to use less energy and use clean energy at an individual level, raising awareness of sustainable energy, and increasing the impact from grant schemes. SEAI will also target DEEP retrofit of our building stock, greater uptake of electrical vehicles, further development in the public sector, provision of expert and authoritative analysis and enhancing the value derived from energy research and innovation.

At a local level, Donegal Count Council (DCC), as leaders and key influencers within the region, are aware of the role that the community can play in Climate Action. Having recognised that Climate Action involves collaboration from various sectors and stakeholder such as local business, government, communities, and individuals. The Climate Ready Donegal report, issued by DCC in 2019, highlights the requirement for further community engagement, empowering them to use the local knowledge to progress for action on climate change. The commitment from local authority to support communities in this task, along with the SEAIs Sustainable Energy Communities programme, provides an appropriate resource to empower local citizen to increase energy efficiency awareness, develop a strategic roadmap, and ultimately take forward action in the process of reducing greenhouse gas emissions within the region (Donegal County Council, 2019).


*Figure 1: Climate Ready Donegal*

# 2 Introduction

## 2.1 Árainn Mhór Energy Group SEC

Árainn Mhór Energy Group includes a wide variety of members from throughout the community including from within the Co-Op, community centre workers, men's sheds, ferry service, homeowners, and local businesses. The groups work in collaboration with the community to increase energy usage awareness, promote energy efficiency and sustainability measures as the islands seeks to adapt to the evolving challenge of climate action and reducing carbon emissions in a way that positively affects the lives of all inhabitants of the island.

Árainn Mhór Island, including some mainland population, have experience in this movement having explored the area of energy efficiency through previously received SEAI Better Energy Communities scheme funding in 2016 in collaboration with Northside Community Enterprise (NCE). This project included the retrofit of 47 island dwellings as well as the community hall. The group wishes to maintain the momentum of this project and complete more energy upgrades across the community.

The island of Árainn Mhór also recently opened a modern digital workshop known as MODAM. A collaboration and initiative between the Árainn Mhór Island Community Council in partnership with Donegal County Council, the Department of Rural and Community Development, Three Ireland and Grow Remote. This facility provides local businesses with high-speed internet in a highly efficient environment, promoting the island as a unique digital hub. This project highlights the appetite for sustainable and self-sufficient growth within the community, alongside evidence of robust community structures and partnerships to achieve real change. These will be integral skills as the SEC progresses along its own unique journey of becoming low carbon.

**North West Regional Energy Strategy**

Regionally, the North-West Regional Energy Strategy is a collaboration between Donegal County Council and Derry City & Strabane District Council. The aim of this partnership is to fulfil the goal of transitioning toward a smart, low carbon economy which can deliver sustainable prosperity for individuals, communities, businesses, and the local environment within the North-West Region (Donegal City Council, 2020)

Embedded within the vision of the North-West Regional Strategy is the ambition to achieve carbon neutrality by 2045. This is from an established carbon baseline of 3,407 kTCO2eq. Utilising a themed map, the North-West Regional Energy Strategy illustrate the opportunities identified that will assist in meeting national and EU carbon reduction targets.

The implementation of this strategy, in tandem with the efforts of the Árainn Mhór SEC, highlights the central focus of climate action within the area. The collective support across the range of sectors and stakeholder including local citizens, its community, cities towns, and county councils, can ensure forward drive is achieved toward this shared objective of net zero carbon by 2045.

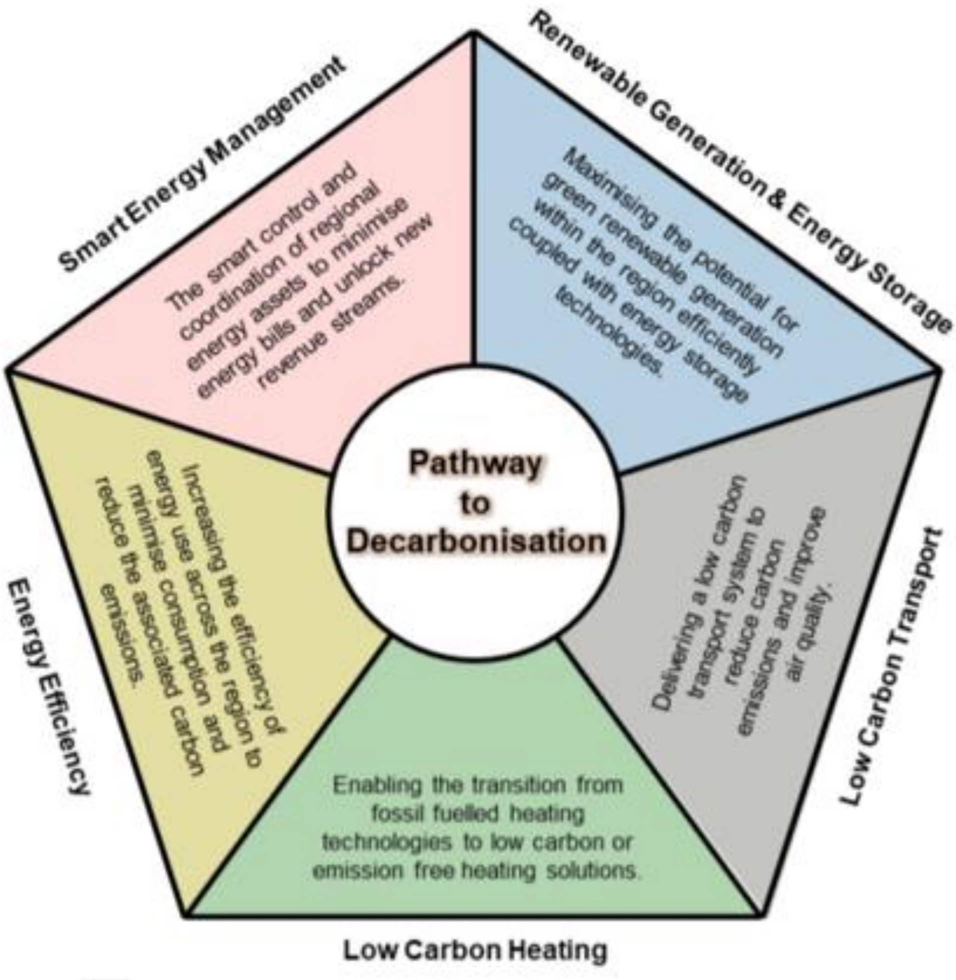



*Figure 2: North West Regional Strategy*

# 3 EMP

## 3.1 Aims and Objectives

This Energy Master Plan will provide a comprehensive overview of energy consumption and energy generation on the island of Árainn Mhór. Publicly available datasets and energy use estimates from a range of source including but not limited to the Sustainable Energy Authority of Ireland (SEAI), Central Statistics Office (CSO), Donegal County Council, and Teagasc will be used. The requirements of the EMP are set out below:

(1) Quantify the current energy consumption of Árainn Mhór Island including a baseline of electrical, thermal and transport energy consumption.
(2) Create a Register of Opportunities (RoO)
    - Identifying projects that can avail of the Communities Energy grant.
    - Identifying projects that can avail of the Better Energy Homes grant.
    - Propose actions, based on baseline figures, to achieve a 10% reduction in energy usage over a 3 & 4- & 5-year period
(3) Carry out Energy Audits of domestic and non-domestic buildings

The Energy Master Plan will be used as a roadmap for Árainn Mhór's progression towards sustainable energy and can be used to apply for capital grants to upgrade existing housing and commercial stock.

## 3.2 Approach

Results for average BER certificates (measured between 2009 and 2020) are available for the region but to gauge a more specific understanding of the energy performance of the variety of buildings within the study area, ORS conducted a detailed analysis a selection of existing Building Energy Rating assessment. Recommendations are made on achieving upgrades on these homes, given the current dwelling status, with a comprehensive summary of how each measure will impact the dwellings energy performance. These sample houses are intended to be representative of the broader housing stock within the area whereby the recommendations for these can be extended to other domestic dwellings throughout the Island.

The results of the energy saving opportunities for the dwellings assessed are tabulated in sequential order, beginning with what would be considered low level measures. These would include measures that may have a minimal impact but will also have a low investment cost and may include behavioural changes, how the homeowner interacts and interprets energy, to simple physical measures such as improved draught stripping and upgrading to low energy lighting. The scope of the recommendations would develop to further mitigate carbon emissions associated with the dwellings energy consumption and would include upgrading the buildings external fabric with higher performing insulation, improving heating, ventilation systems and controls alongside introducing renewable energy technologies where suitable.

ORS also performed energy audits on several community and commercial sector buildings to identify energy saving measures. These audits are to the level of Type 1 in Annex A of ISO 50002 and are suitable to act as supporting information for SEAI grant applications such as the Communities programme. As with the domestic buildings, a series of energy saving opportunities are produced, defining the carbon, energy and cost savings associated with each upgraded. Indicative costs are outlined, and a simple payback highlighted to help gauge the scale of the measure and an approximate time for a return of investment.

The EMP will also be used as a mechanism to increase awareness in energy efficiency. This process begins through the interactive community survey issued, and webinars with the community/SEC alongside the launch of the report at its conclusion. This report includes recommendations, based of existing case studies, that a community can do to change behaviour and increase the understanding of climate action and how those involved can contribute toward this shared objective. This can be achieved through workshops and training modules supported through the various partnerships established such as with the SEAI, ETB's and Local Authorities. Engaging with the schools and local business provide a platform for the SEC to reach a wider audience and can offer unique environments for positive marketing material to be distributed such as flyers and posters on initiatives, SEC progress, energy saving tips etc.

This study also reviews the natural resources available to the community, with a high-level analysis provided on the various renewable energy technologies that the area could further pursue, alongside the "Next Steps" in this process. A wide range of natural resources are often within a community's grasp, however the understanding of how to progress from a concept through to reality can be an enormous barrier. This EMP will aim to define the processes required by the SEC to initially absolutely quantify what these resources can offer, alongside how such projects can transition from an idea to a system that is owned by the community, contributing to a number of ways to the sustainable, decarbonisation of the area.

# 4 Profile of Árainn Mhór

## 4.1 General

Árainn Mhór is located off the north west coast of county Donegal, approximately five kilometers from the mainland. The islands community have been innovators in several areas having previously upgraded housing stock and more recently developing a connectivity and digital hub that will allow a greater population of remote workers to live on the island. The enthusiasm and vigour of the community is apparent through their resilience to population decline by making the island an attractive place to relocate to.

The island of Árainn Mhór, like so many islands along the west coast of Ireland, are hugely popular throughout peak summer periods with large volumes of tourists visiting each year. And while this EMP will focus on the community and its primary inhabitants, it must also be cognisant of the large inflex of people through these periods who will of course contribute towards the island's energy consummation and carbon emissions. As well as ensuring a positive path is paved for long term island dwellers, to ensure stable low carbon emissions are achieved, solutions must also be considered to facilitate these guests.

## 4.2 Residential

The residential profile of Árainn Mhór is dominated by one off dwellings with a high proportion of holiday homes present (33% were reported as unoccupied holiday homes on Census night in 2016 compared with a state average of 3%). Many of the homes lack sufficient insulation and consume carbon heavy fuels in providing for all heat and hot water needs. Further analysis is provided within Section 5. As part of this study a sample of dwellings were assessed from a Building Energy Rating perspective. The specific measures associated with these dwellings can be found within the Register of Opportunities which supplements this report. However, an example of a typical dwelling on the island is located within section 5.4 and the steps a typical homeowner would need to take to achieve an A rated dwelling are explained.

## 4.3 Agriculture

Árainn Mhór is dominated by a topography that makes traditional intensive farming difficult. Agriculture is not a primary sector of employment for the island with sheep the predominant livestock on the island. From the 2010 framing CSO data a total 35 farms are located on the island, 32 of which are fewer than 10 hectares, with 3 between 10-20 hectares.

# 5 Analysis of Residential Sector

## 5.1 Analysis of CSO Data

Analysis of CSO data along with general statistics from the SEAI and Donegal County Council has been combined to produce a background picture of the housing sector throughout Árainn Mhór. Data from the 2016 Census has been extracted and displayed below while data from the completed BER analysis are detailed in Appendix A. This data along with the results of the BER surveys build a solid understanding regards energy efficiency in Árainn Mhór and how it can be improved.

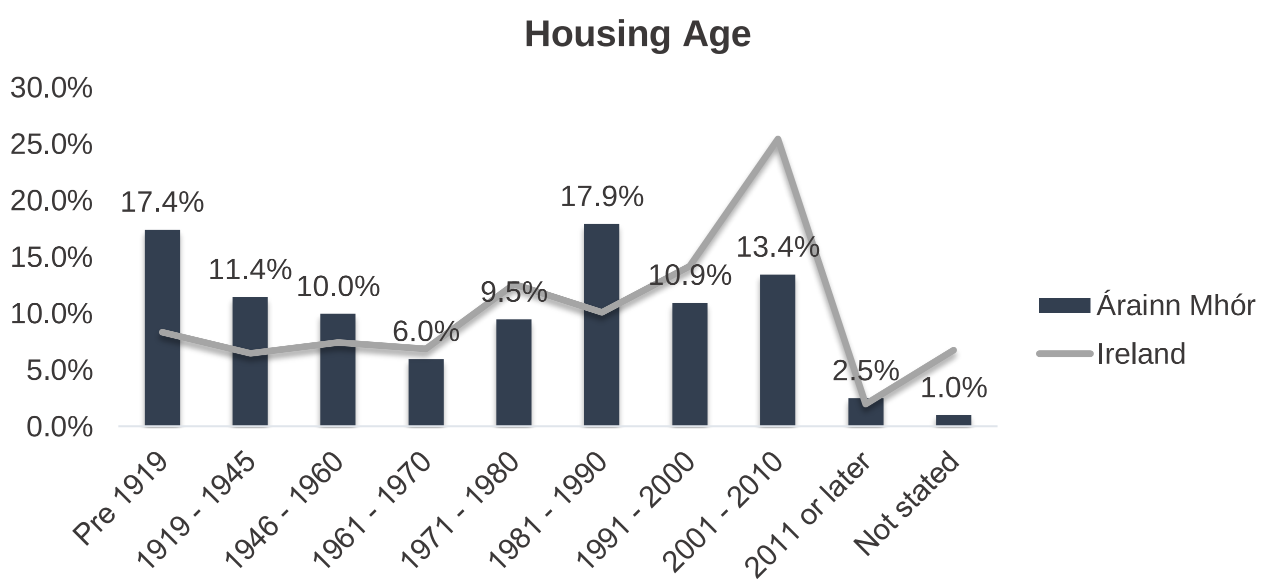



*Figure 3: Dwelling Age*

Recently constructed dwellings are expected to yield a relatively high level of energy efficiency, and therefore are typically not the focus in respect to retrofits. This is due to the requirement for new dwellings, particularly post 2011 constructions, to have to comply with modern building regulations for energy performance. The chart above indicates that 2.5% of homes within the region are constructed post 2011, while the remaining are scattered from pre 1919 to 2010. This indicates that a very large number of homes will present opportunities to improve energy efficiency and reduce their energy requirements.

From the findings above, a large proportion of homes were construed between 1981-1990 at 17.9%, with a similarly high number constructed pre-1919. These types of buildings present many challenges due to the historic construction methodologies applied from their era and the materials used. Specialist heritage audits would need to be complete on each home to ensure the correct measures are applied, which may be very limited due to structural, planning and moisture ingress/egress concerns.

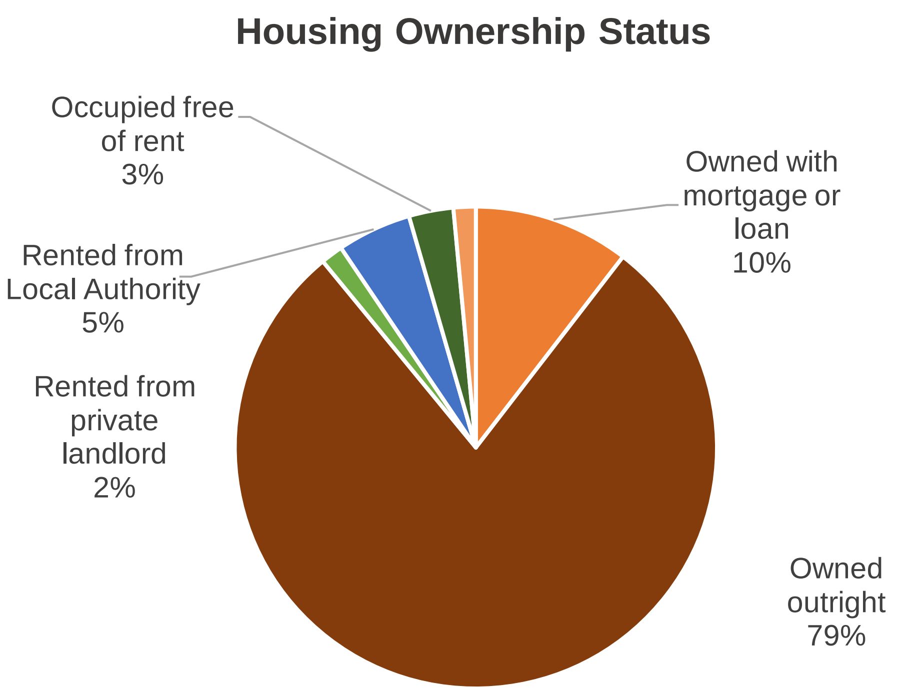



*Figure 4: Dwelling Owner Status*

A large proportion of homes on Árainn Mhór are owned outright without a mortgage. This can imply a greater appetite for home energy upgrades with individuals under less financial pressure than homeowners with mortgage repayments, or those who maybe renting accommodation and faced with many barriers as a result. Homes rented from private landlords can suffer from a phenomenon called split incentives where landlords do not feel the benefits from improving energy efficiencies as tenants pay electricity and heating bills. A strong strategy of engagement and encouragement will be required for landlords until obligatory measures are put in place around rented accommodation upgrades.

This trend of outright ownership also supports the findings that homes within the region are of an older building stock (Pre 1985). This is period before which building control regarding energy efficiency was enforced. As a result, a large proportion of homes have very poor insulation, with external walls containing little to no insulating material which would limit heat loss. The same would apply to roof spaces such as attics and ground or exposed floors. More complex building design such as dormers would be very problematic in this regard also. Typically, basic double-glazed windows were installed, but limiting strategy was applied to reduce draughts, this extended beyond the entire dwelling which would very often lead to high levels of heat loss from unwanted air infiltration.

Homes constructed around this time also used carbon heavy fuels such as oil, gas and/or solid fuel while open fires as secondary heaters were very common.

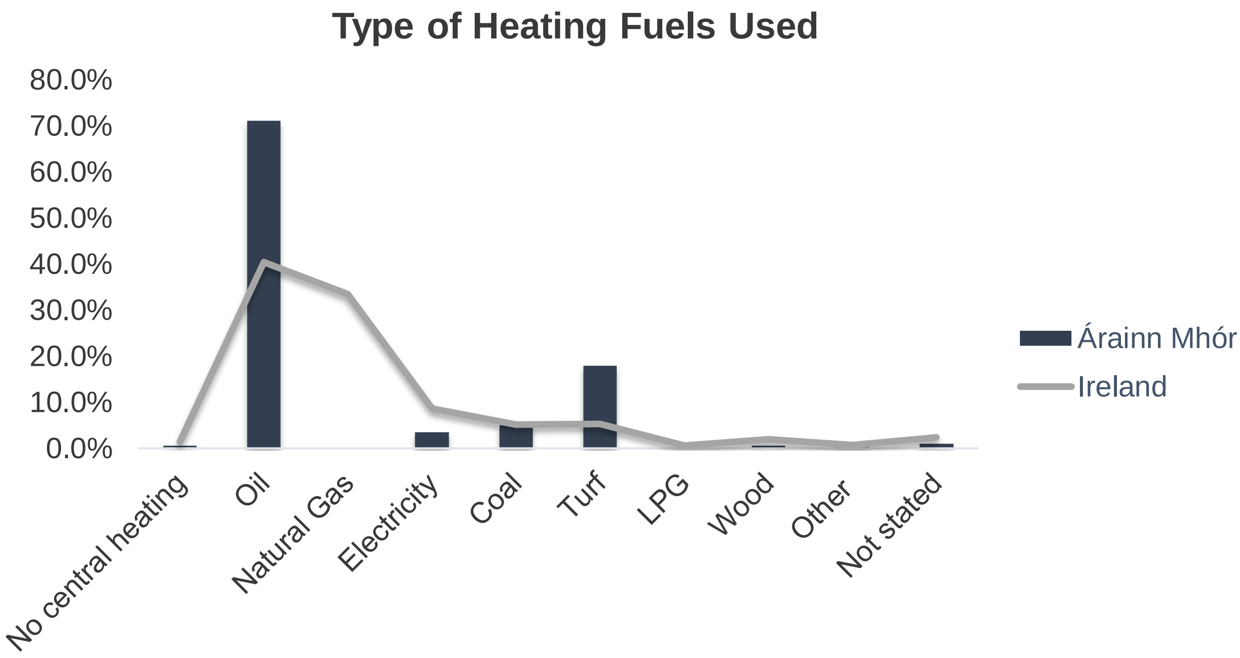



*Figure 5: Fuels Used within Dwellings*

Oil is the primary source of fuel for central heating throughout Árainn Mhór which is typical for the large proportion of houses built pre-2011. Central heating is defined as a system that provides heat to the entire internal volume of a building from one point to multiple points. The finding of this graph, although unsurprisingly, do raise cause for concern. However, they also demonstrate the huge level of potential for improvement within the residential sector across the island.

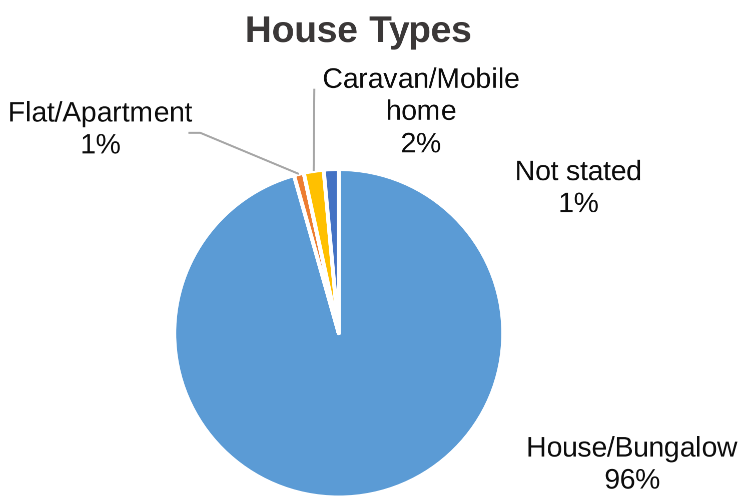



*Figure 6: Dwelling Types*

The CSO data file for the Island also indicates to the reader, the types of homes that are scattered throughout the location. The largest majority of these, at 96%, are one-off dwellings primarily stated as bungalows. The remaining 4% range from flats to caravans and mobile homes. The total number of permanently occupied dwellings throughout the island of Árainn Mhór, based on the 2016 CSO data, is 205.

However one of the key sectors within the island of Árainn Mhór is tourism, where in the region of an additional 1,000 to 1,500 people come to live on the island for an approximate 30-day period throughout the summer in holiday homes. There is also in the region of 33,000 single day visitors to the island each year. According the CSO data, these additional homes account for further 138 houses on the island. However, the condition of these dwellings is unknown in respect to primary heating systems used, alongside the original year they were constructed. These dwellings will, however, not be used for large parts of the year, therefore minimising the impact they will have on the communities' carbon emissions. Nevertheless, there are several actions that could be implemented to ensure that use during the summer period has the least impact on the island's emissions profile. This may include ensuing all homes have adequate insulation alongside heating system control. Ensuring these temperately occupied dwellings are insulated reduces the requirement for space heating, while adequate heating control ensures hot water can be produced without wasting energy to heat radiators that may not necessarily be needed during the warmer summer periods.

## 5.2 Analysis of BER Data

The Sustainable Energy Authority of Irelands (SEAI) Building Energy Rating (BER) Map below displays colour coded 'Small Areas' for the island of Árainn Mhór. The colour of a given *Small Area* represents the BER of the median geo-located dwelling in that *Small Area*. The map only contains Building Energy Rating Information at the *Small Area* level for dwellings that have had an actual BER certificate published. The medians were derived from all geo-located dwellings with a BER in that *Small Area*. For example, *Small Areas* that are green represent areas with a 'good' median BER. *Small Areas* with dwellings that have a poor median BER are either red or purple.

It is important to note while this BER data is available, it represents only the proportion of dwellings within the region that have had a certificate published. Therefore, the analysis and findings of same should consider this.

By analysing the Building Energy Rating data files for all the small areas throughout Árainn Mhór, the following information was observed

*Table 1: BER Summary*

| Table 1 – Árainn Mhór BER Data | | |
|---|---|---|
| Median BER | Minimum BER | Maximum BER |
| 210 (kWh/m²/year) | 95 (kWh/m²/year) | 668 (kWh/m²/year) |
| C3 | B1 | G |

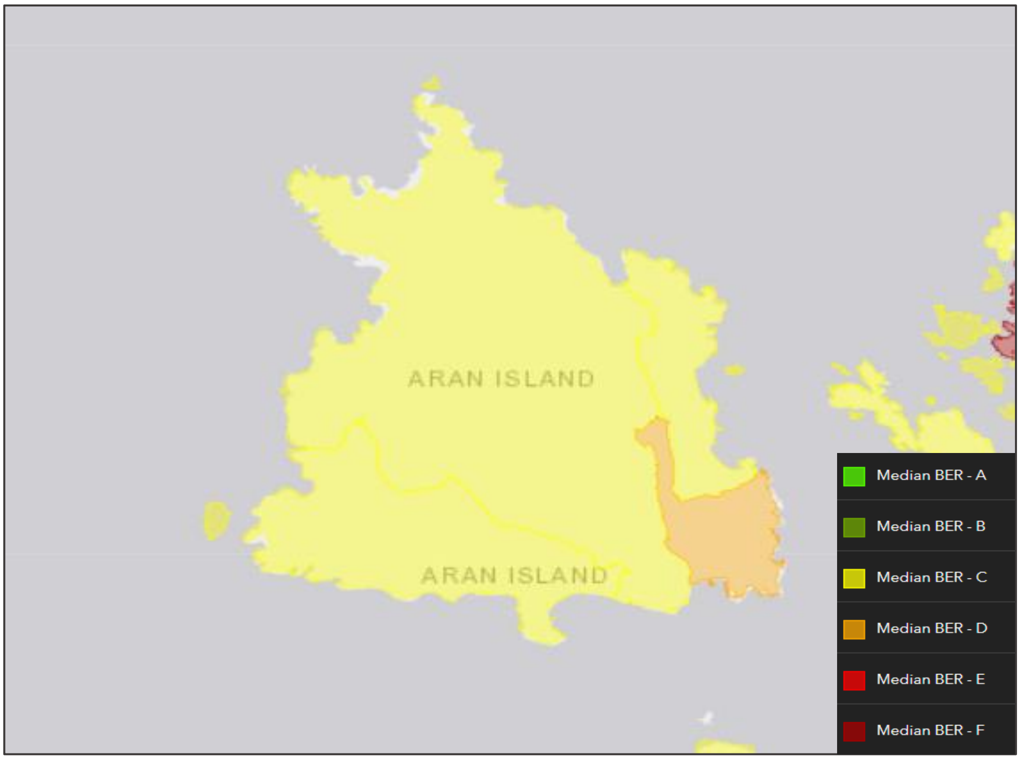



*Figure 7: BER Summary*

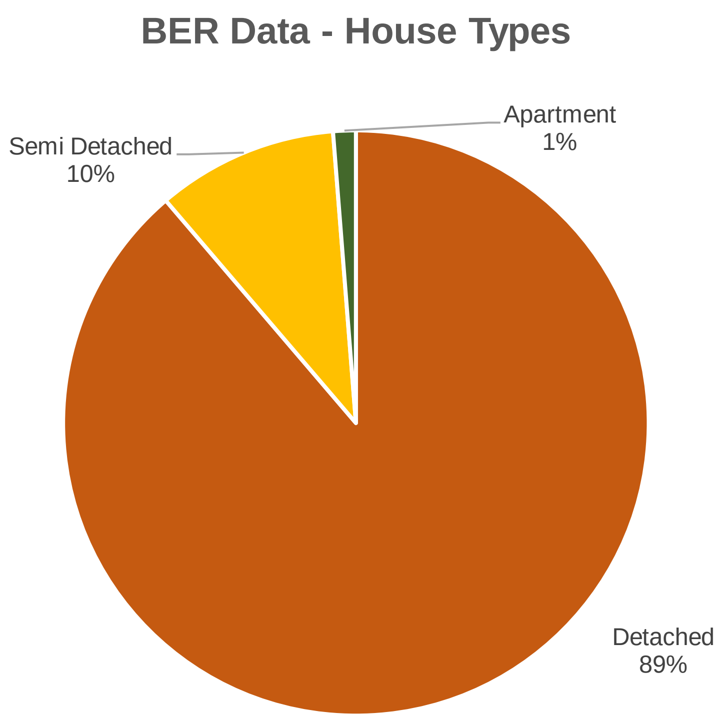



*Figure 8: BER Data - House Types*

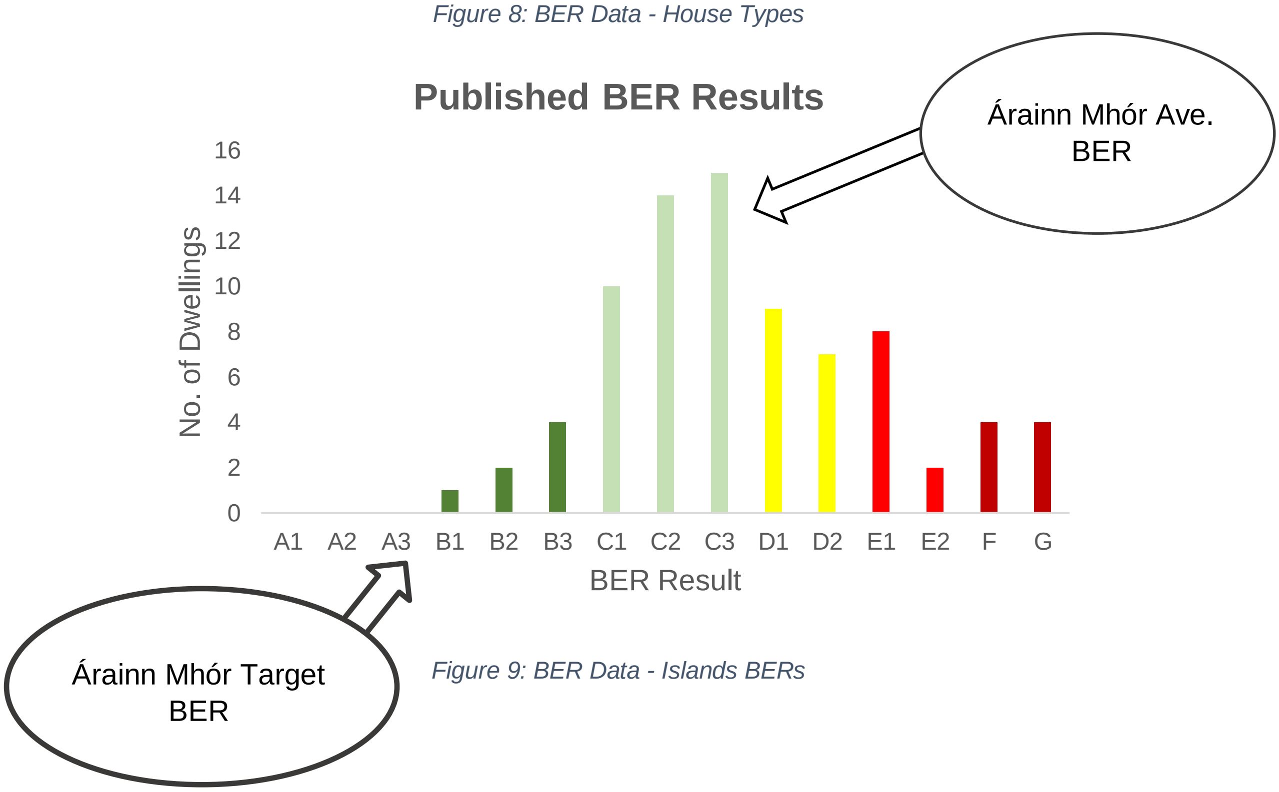



*Figure 9: BER Data - Islands BERs*

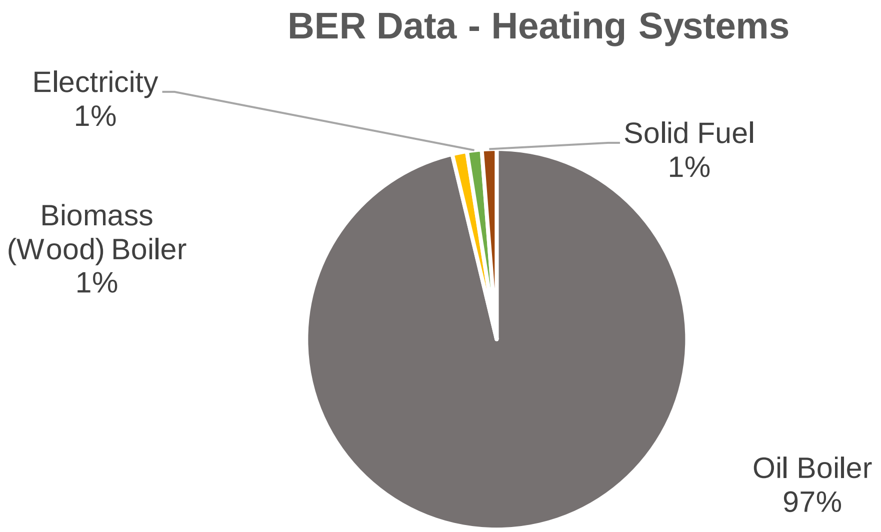



*Figure 10: BER Data - Heating Systems*

The data above indicates that the average Building Energy Rating for homes throughout the island of Árainn Mhór is a C3, with a typical dwelling requiring between 200-225 kWh/m$^2$/yr of energy. This is based on a sample of circa 80 dwellings, relative to approximately 40% of the full-time occupied houses on the island. The CSO data indicates that over 70% homes in this area are fuelled through heating oil, corresponding with the findings of the SEAI's BER data indicating that 97% of dwellings with a BER certificate published are fuelled through oil. The CSO data indicates that a large proportion of dwellings within this region were also constructed between 1981-1990 alongside much older stock constructed pre-1919. From the SEAI statistics, the average dwellings BER throughout the island is marginally better than the national average energy rating for oil fired centrally heated homes relative to the age band. See figure below as reference.

| Oil/gas central heating | | Standard electric heating | | Solid fuel central heating | |
|---|---|---|---|---|---|
| Year of construction | Typical energy rating | Year of construction | Typical energy rating | Year of construction | Typical energy rating |
| 2012+ | A3 | 2012+ | A3 | 2012+ | A3 |
| 2010-2011 | B1 | 2010-2011 | B1 | 2010-2011 | B1 |
| 2008-2009 | B3 | 2008-2009 | C3 | 2008-2009 | B3 |
| 2005-2007 | C1 | 2005-2007 | D1 | 2005-2007 | C2 |
| 1994-2004 | C3 | 1994-2004 | E1 | 1994-2004 | D1 |
| 1978-1993 | D1 | 1978-1993 | E2 | 1978-1993 | D2 |
| Pre 1978 | D2/E1/E2 | Pre 1978 | G | Pre 1978 | F |

*Figure 11: Typical BER - Central Heating System*

While Appendix A demonstrates the register of opportunities for specific dwellings that were analysed as part of this Energy Master Plan study, the following will indicate typical energy efficiency steps that the average homeowner and dwelling type in Árainn Mhór could take to achieve a Building Energy Rating of an A3. This segment of the report is designed to act as a general informative piece to assist in understanding the broad range of services the typical dwelling within the region would need to consider. However, if the reader is considering options specific to their home, a bespoke energy assessment is advised and should be completed by a reputable professional with a detailed report provided. A BER certificate, air tightness test, thermal imaging and visual assessment may be complete as part of this service which may range from €750-€1,500 (excluding VAT) in cost depending on the size of the dwelling and the full scope of works. The information from this assessment will support the SEAI grant documentation required if considering such financial supports for retrofits.

In line with the CSO & SEAI BER Heat Map data, the type of dwelling will be a detached bungalow, constructed in circa 1985 with a Building Energy Rating of a D1. The floor area is approximately 160m$^2$ with a total of 3 bedrooms. The central heating system for the dwelling is a medium-low efficiency standard oil boiler, with a single channel programmer for both space heating and hot water control. There is an open fire in the living room served by a standard chimney, regular solid fuel is used. The external walls are of cavity wall construction with a low level of insulation installed. There is a pitched roof throughout, with 100mm of aged mineral wool installed between the timber joists, many sections are missing insulation due to poor installation. The original windows are double glazed PVC, which are performing poorly and are the source of many draughts. All internal lighting is provided through 100W tungsten bulbs. An air tightest test was conducted and identified many draughts most notably around window and external door revels, services penetrating the external fabric (Wall, floor, and roof) such as water pipes and electrical cabling. General ventilation within the building is also quite poor with many permanent vents blocked/sealed by the homeowner.

## 5.3 Home Energy Surveys

A key objective of an Energy Master Plan, and indeed an SEC, is to engage the wider community and begin the conversation of energy efficiency and opportunities that they may pursue to further reduce the carbon emissions associated with their homes and businesses. To assist in this process, an online interactive survey was prepared, and through the help of the SEC members, distributed throughout the community of the island.

Aside from engaging the community, the survey is also a useful source of information in establishing more detail on the current condition of homes throughout the area. This allows the SEC to develop a better understanding of what areas the primary focus should be for homeowners, allowing support to be tailored specifically to this. Questions are asked regarding house types, materials used to construct homes, insulation installed, alongside heating systems and renewable energy technologies used. A total of 49 participants took part in this survey which closed for responses on 02/03/2021.

The first question from the survey asked respondents to clarify what year their homes were originally constructed. A significantly large proportion at 51% stated their homes were originally built between 2000-2006 which does not correlate with the CSO data, however the proportion of dwellings constructed pre-1920 is very similar to the findings from the CSO. Homes constructed between 2000-2006 would expect to yield a BER of between a C2-C1, as Building Regulations in respect to energy performance were in its early stages during this period. This would essentially mean that homes within this age band would require retrofit works, but the scale of same may not be as large as anticipated for the average dwelling age stated within the CSO.

Figure 12 below illustrates the overall breakdown of responses to this question.

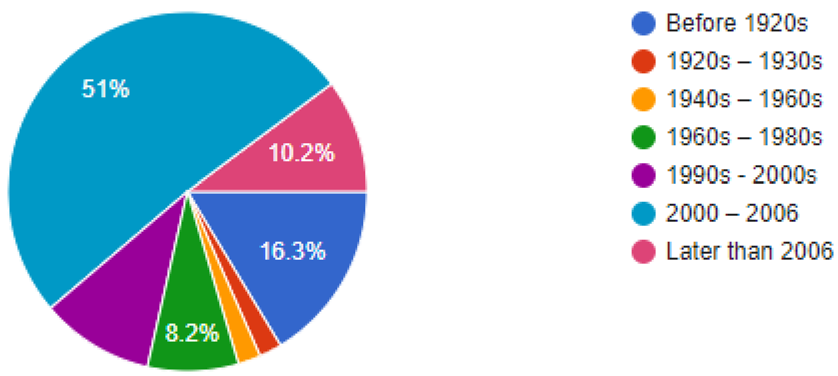



*Figure 12: Home Energy Survey - Dwelling Age*

In respect to heating systems and fuels used, as expected, and vast majority of homes are heated using oil boilers. At almost 86%, this fuel source is shaping the carbon footprint of the local residential sector and highlights the requirement to further investigate retrofit options in a bid to adopt low carbon heating systems and in turn alter carbon emissions associated with the island. Making up 6% each, electricity and solid fuel are also used while 1 dwelling state to have no central heating installed whatsoever.

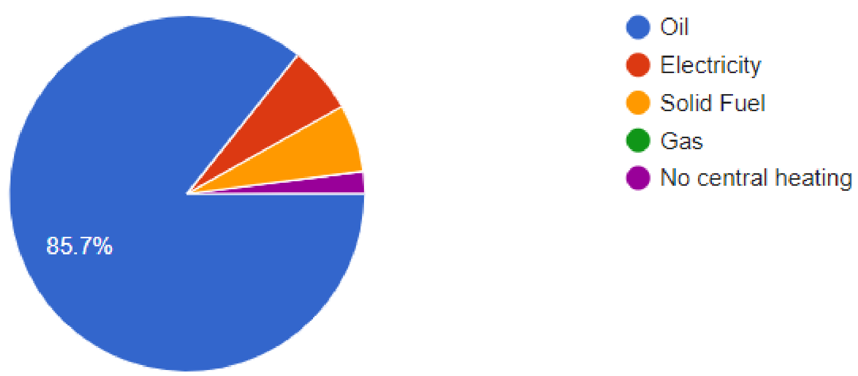



*Figure 13: Home Energy Survey - Heating Fuels*

Following on from this, participants were asked about heating controls for their heating systems. The responses were varied, with many homeowners having medium to low levels of control over the boilers in their homes, with almost 30% of respondents having no heating controls at all.

The survey also enquired about the quality of building fabric such as construction types for external wall, and details on any upgrades such as insulation applied to same. From the 49 participants, 71% state to have a cavity block external wall, with 14% having a solid stone finish. This is typical of a housing stock in rural Ireland, particularly where dwellings are pre-1920 (referencing stone specifically). Figure xx below illustrates the breakdown in more detail for typical construction types for external walls of houses across the island.

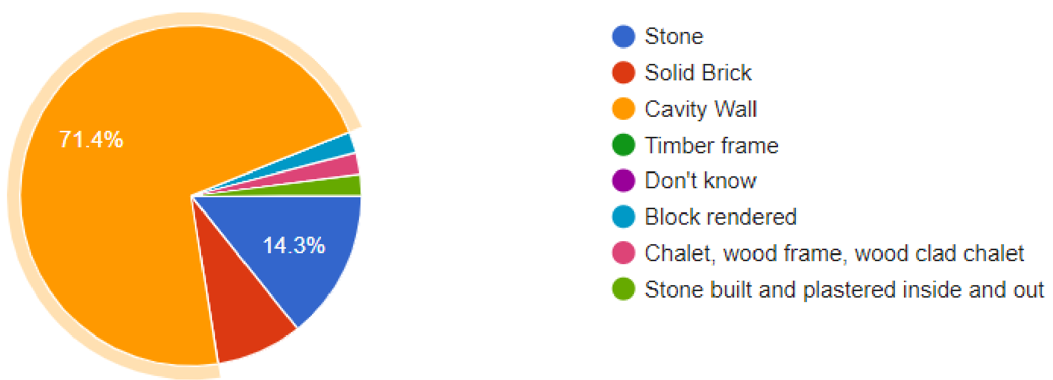



*Figure 14: Home Energy Survey - Wall Type*

Of the 49 respondents, 53% confirmed that they did in fact upgrade the insulation associated with their external walls which is very positive. The main insulation methods used was identified as cavity wall insulation, likely a bonded pumped bead, while external wall insulation was incorporated in 8% of homes. Only a small faction, comprising 2 homes, opted for internal drylining.

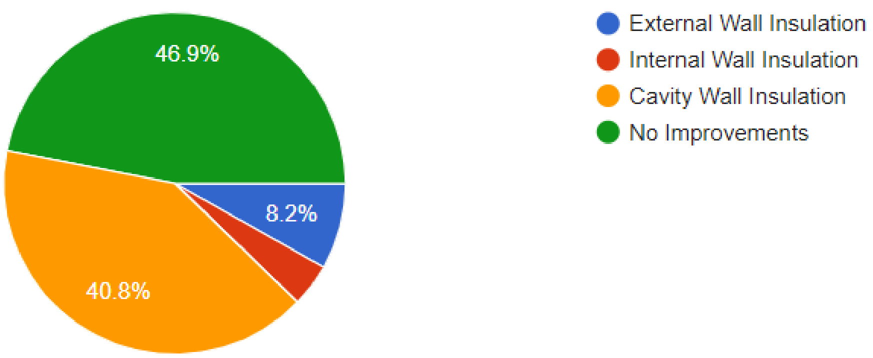



*Figure 15: Home Energy Survey - Wall Insulation*

Further to the specifics of the external walls, participants were also asked about roof insulation. A relatively high number of homes, at 37%, have no insulation installed throughout the attic spaces. This will result in very high levels of energy wasted and it is advised that this is addressed as a priority for the SEC and all residents effected. Of the 63% of homes that have roof insulation, the quantity of this varies significantly. 24% have less than 150mm of mineral wool insulation, 10% between 100-200mm, while 18% have more than 200mm toward the ideal target of 300mm.

Glazing, such as windows, are also a very large contributor to heat loss within a dwelling and can also be the result of significant draughts due to poor air tightness. 98% of respondents to the survey defined having double gazed units installed, while a very small proportion of 2% have single glazed. This is positive but does not guarantee quality in heat retention. Many factors such as age, operational quality, glazing thickness, gas filling, draught stripping and installation impact how each window unit will perform. Older double-glazed units may have a U-value as high as 3 $W/m^2.K$, while new modern standard units, also double glazed, would have a whole unit U-value as low as 1.0 $W/m^2.K$. If the homeowner wishes to exceed these performance standards, then they may opt to install triple glazed windows where U-values can be as low as 0.50 $W/m^2.K$. Where limitations present themselves for older dwellings (Pre 1920) that may be subject to strict planning restrictions due to their historical status, options such as shutters alongside traditional thick and heavy curtains may be used alongside, in some instance, secondary glazing solutions.

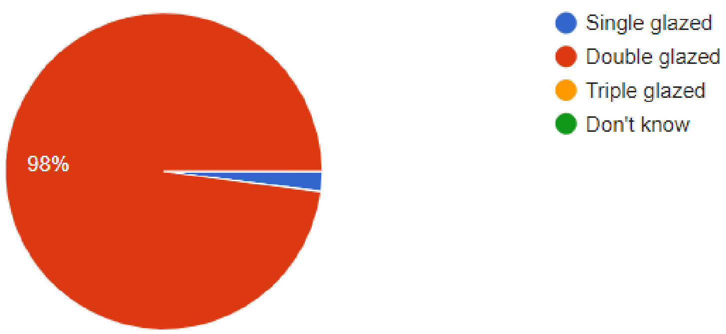



*Figure 16: Home Energy Survey - Windows*

The aims of the Community Survey go beyond establishing in more detail the conditions of the residential setting within the area, it's also an effective tool at engaging the locals as to what the Energy Master Plan study is about. It is the first step in the process of any project of this nature, in that it is asking questions of the people and making them consider how their lifestyles may be impacting carbon emissions. The last number of questions within the survey aim to truly define how engaged and interested the community are in respect to decarbonisation, energy efficiency, smart and renewable energy technologies.

Participants were asked about the types of technologies they would like to further pursue to make their homes more energy efficient. The vast majority are interested in upgrading their homes insulation first. Which is very positive, as this is, in principle, the most effective method of reducing your energy demand. 67% of responses are interested in improving insulation alongside replacing the windows and doors already installed. There is also an appetite to install solar panels, upgrade heating controls, with 12% interested in heat pump systems. This type of information can shape the material and learning that the SEC should focus on within the community. The focus should be on delivering further material, or perhaps webinars in partnership with your SEC County Mentor and the SEAI on insulation technologies, and heating system upgrades such as heat pumps.

Further to this, almost 94% of respondents to the survey expressed an interest in receiving further information on the Energy Master Plan, the Árainn Mhór SEC and home energy audits in general. The SEC should use this demand to ensure a platform is available for these people to receive regular updates on the progress of the SEC such as through a social media page, a website, or a mailing list alongside the opportunity to join and support the committee. During the launch of the EMP, the SEC should look to ensure that a local contractor, or energy consultant is available to discuss home energy surveys and answer any questions the people within the community will have. This may present an effective strategy to bringing more people to the next step of identifying projects specific to their homes.

Finally, the participants of the survey were asked about a community owned renewable energy generating site, and specifically the preferred technologies that they would like to see used on their Island. Wave/Tidal was the most popular technology at almost 43%, with wind and solar the next most desirable options coming in at 33% and 18% respectively. This feedback is integral to ensuring community buy in is achieved into such an initiative. One of the most powerful takeaways from the responses to this question is that nobody chose 'None' (No renewable technologies) as an option. This highlights the strong commitment the community has to improve their impact on global warming, but also the development of this island's self-sufficiency, building on the very successful digital hub project.

The following is a flow of the typical works that the homeowner could complete to bring the home from its current position through to a higher performing Building Energy Rating. More details on each of these upgrades can be found within Appendix A and following on the visual below.

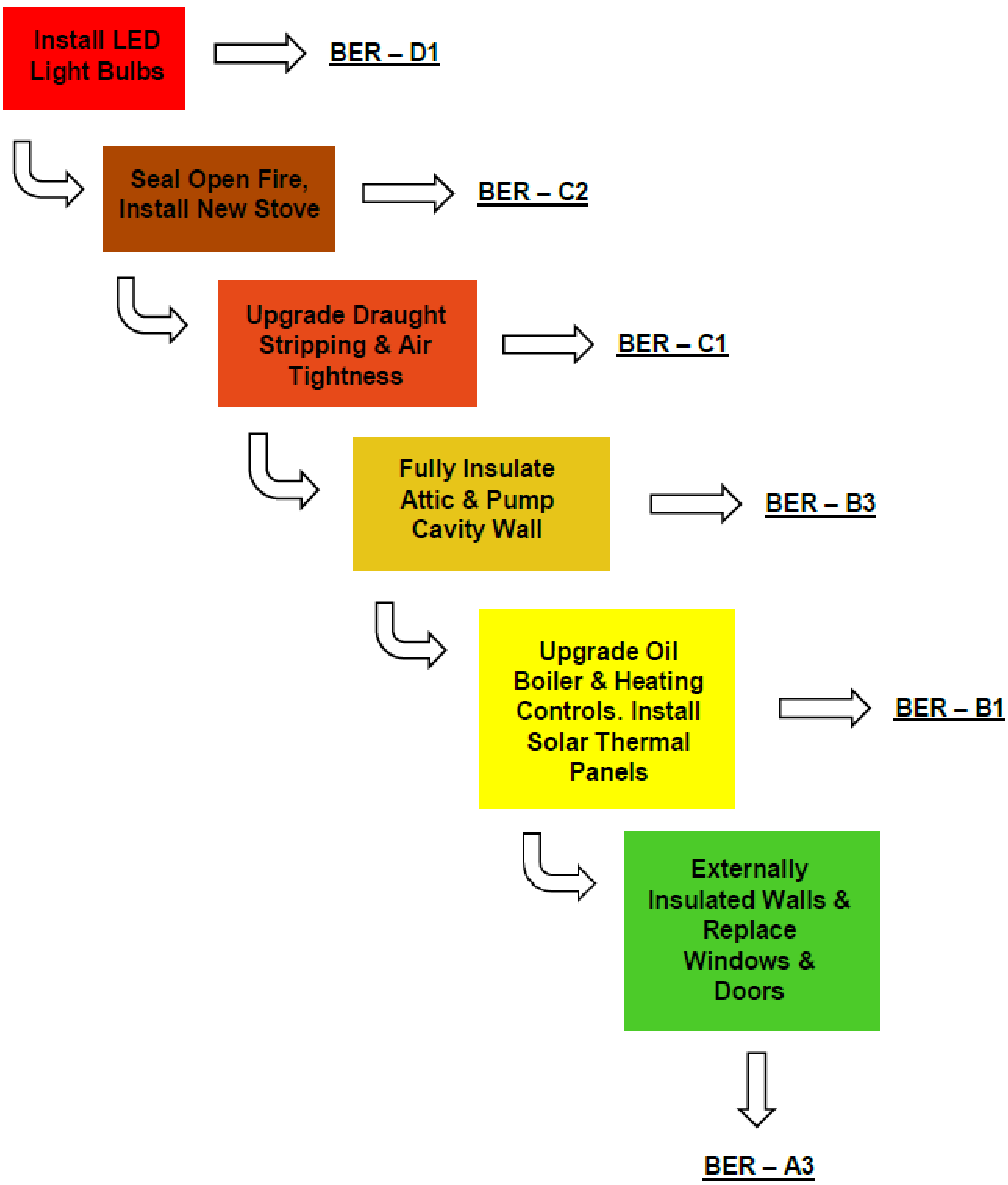



*Figure 17: BER Flow Map*

## 5.4 Typical Costs Vs. Energy Measures

This flow of energy upgrade works is typical for a residential dwelling expected within the island of Árainn Mhór. The following builds upon this to demonstrate typical costs that a homeowner may need to make to realise same. Please note, the prices and works referenced below are estimates based on our experience with such projects. The SEC, and indeed homeowners/business owners are advised to contact an approved contractor and receive an exact quote and scope of works.

By way of contrast, the following defines the type of house that the indicative prices and works below are based on.

- Detached Bungalow
- 160m$^2$ Floor Area
- Constructed Circa. 1985
- Solid Ground Floor
- Cavity External Wall (Twin Leaf)
- Pitched Roof
- 3 Bedrooms, 1 W/C, Kitchen & Living Room
- Oil Boiler (Non-condensing)
- Timeclock for Control Only
- Open Fire in Grate

- **Measure No. 1: Upgrade to Low Energy LED Lights**

The house type used in this example has approximately 15 light fittings, with each taking one bulb per fitting. The cost of replacing 1 bulb to LED is approximately €5. Total cost to replace all the original bulbs will be in the region of €75.

- **Measure No. 2: Seal Open Fire, Install New Stove**

The existing dwelling has a traditional open fire in a grate acting as a secondary room heater within the living room. This is a highly inefficient system with up to 70% of the heat generated, lost through the chimney. The chimney is also a source of frequent down drafts making the space difficult to heat. To improve the energy efficiency, the grate is to be removed with an insert, wood only fired, sealed stove installed. The new stove will be of a much higher efficiency. The cost of these works is approximately €700.

- **Measure No. 3: Upgrade Draught Stripping & General Airtightness**

This involves ensuring all draught striping associated with window, door and attic hatch opens are not only installed, but effectively working. The cost of this can vary, but generally it is a simple measure with effective results. For the purposes of this dwelling type, we will assume a cost of €250 for a contractor to make good any damaged draught stripping, it is advised a balloon is installed to any additional chimney opes other than the ope serving the new room heater. Poorly installed natural ventilation covers can also be problematic. A cheap but effective method is to ensure all internal vent covers are fully functioning and are controllable, allowing them to be both manually opened/closed. External anti-draught covers can also be installed where extract fans are used in W/C's & kitchens. All independent mechanical extract fans within kitchens, W/C's and utilises should be examined to ensure they are effectively operating at sufficient rates of extraction with appropriate time delay switches ensuring they operate for period enough to clear high levels of moister from said space.

General air tightness can be a significant problem if a large volume of services penetrates the external boundaries of the house. This would typically occur through pipe work or electrical cabling. Measures should be put in place to seal any obvious and easily detectable penetrations which can be found in the ceiling to the attic, or the external wall. An air tightness test could be utilized as a means of formally identifying where many of these problems are. The cost of a typical quality air tightness test could range from €200-350, however it is difficult to clarify the cost of making good any defects identified. Using simple sealants etc may cost the homeowner between €100-300, while more effective solutions such as installing membranes, downlight covers, and tapes are more intrusive and will likely increase cost to over €1,000.

- **Measure No. 4: Fully Insulate Attic & Pump Cavity (Where Permissible)**

A significant proportion of the energy from our homes heating is lost through poorly insulated attic spaces. A relatively straight forward job, insulating this space can be expected to cost approx. €1000-1500. This would include rolling out a minimum of 300mm, or 12 inches, of high-quality fibre insulation. The works should include installing walk boards to services such as water tanks etc for optimal access and safety. The attic hatch should also be insulated using a rigid board and should be cosy fit within its frame.

The twin leaf cavity wall can be pumped at a cost ranging from €7-10 per $m^2$ of exposed surface area. The detached dwelling used in this example has a measured external wall of $120m^2$. Based on this, the expected cost of pumping a bead would be in the region of €1,200. Pumping the cavity with an expanded bead can also be a very effective solution to reducing unwanted air infiltration, improving the dwellings airtightness.

- **Measure No. 5: New Oil Boiler with Solar Thermal Panels**

Removing and replacing the existing medium efficiency, non-condensing oil boiler with a low level of control would cost in the region of €3,500 – €5,000. The homeowner should look to install a new condensing oil boiler with an efficiency of between 92-95%, ensuring all pumps used to operate the system are A+ rated. Heating controls should also be upgraded, these alone can cost up to €1,500 but can be combined with the oil boiler package to save costs, both material and labour.

Solar thermal panels will help in the production of hot water for showers, wash hand basins and taps. There are different types of solar thermal panels on the market, but the most efficient are known as an evacuated tube collector system. The homeowner would be advised to install in the region of 6m$^2$ of solar thermal collectors at a cost of approx. €4,500.

- **Measure No. 6: External Wall Insulation & Replace Windows & Doors**

Insulating the cavity of the external wall, as defined in measure 4, is not the only upgrade that can be applied to the external walls. And while the bead will reduce both heat loss and air draughts, another level of thermal performance can be gained through external wall insulation or EWI. Considered the best performing solution for this type of wall, the external wall insulation will wrap the entire dwelling in up 4 or 6 inches of high-quality rigid insulation, bringing the home to modern building regulation standards in terms of U-value. EWI is however one the most expensive upgrades for walls costing in the region of €120 per m$^2$ of exposed external wall. Based on this, and the indicative measurements determine in measure 4, this typical detached dwelling would expect to cost approx. €15,000.

Windows and doors can often be difficult to assign a cost to without a direct quotation from a supplier/installer, however for the purposes of this study a homeowner would be expected to pay approx. €650 for a typical double glazed uPVC window. The house type used in this example has in the region of 9 external windows, therefore bringing the cost to circa €6,000. Both external doors will cost between €1,000-1,500 bringing the total cost for all windows and doors to €7,500.

- **Additional Measure: Install Air Source Heat Pump**

The dwelling used in this example opted to replace the existing non-condensing, medium efficiency (75%) oil boiler with a new, high efficiency, condensing oil boiler. While this will have a positive impact on the dwellings BER and reduce energy waste, oil is still considered a carbon heavy fuel. With all the fabric upgrades defined above, this home would likely be suitable to house an air source heat pump, a system which is considered a renewable energy technology, and is also highly efficient. Powered through electricity, the heat pump will take free energy from the air outside. Using electricity as its fuel, the system will increase the temperature of that air and exchange it with the water feeding radiators and the hot water cylinder within the dwelling.

This type of system is however significantly more expensive than a conventional oil, gas, biomass, or solid fuel boiler costing in the region of €8,500-10,500 to install and commission but will offer high savings on energy bills and much more comfort to the homeowner. One point to note is that the SEAI does provide a grant for heat pumps, and have since stopped supporting fossil fuel systems such as oil, gas etc.

Referenced when suggesting a heat pump is that the dwelling must be significantly insulated. This is known as the *Fabric First Approach* and essentially ensures the dwellings heat loss is completely minimized before a heat pump is installed. Typically, in Ireland we are used to using high temperature systems to warm our homes, meaning they have enough strength to heat the house even when the insulation is poor. Heat pumps however will only achieve this high efficiency when installed within a very well insulated house as it is opposite to our conventional methods and considered a low temperature system. This means that the low output temperature would not be sufficient to heat the uninsulated and draughty house, subsequently putting the system under high pressure, damaging components, and dramatically increasing the dwellings electricity bill.

## 5.5 Domestic Retrofit Case Study – Loughbollard Estate (Clane SEC)

To further illustrate an example of retrofit options to the participances and stakeholders associated with the Árainn Mhór Sustainable Energy Community programme, a sample dwelling that is considered representative of a wide majority of homes throughout Ireland is reviewed from an energy retrofit perspective. In this instance, a series of home energy improvements were made to the dwelling, with a noticeable improvement in energy performance achieved.

The dwelling chosen is from the Loughbollard Estate, pictured below, located in the town of Clane, Co. Kildare. This estate has just less than 200 dwellings comprising of a mixture of 2 storey semi-detached homes and detached bungalows. According to the Building Energy Rating data, these dwellings were originally constructed in circa 1978.

*Figure 18: Case Study Estate*

The specific dwelling assessed as part of this case study, is a 2-storey semi-detached type with a total habitable floor area of 82$m^2$. Before the upgrade works, this building, which is likely to represent most of the dwellings developed throughout the estate, consists of a solid ground floor with low levels of insulation. There is a pitched roof with only 100mm of mineral wool installed. The external wall consists of a hollow block, with a very low level of insulation installed. Due to the non-destructive nature of the home energy audit, it could not be confirmed if the external walls were lined internally with mineral wool. The pictures below, while not completely representative of this house, demonstrate a pitched roof and hollow block construction. There are double glazed windows installed alongside a solid door.

The purpose of exhibiting this case study is to demonstrate how a homeowner that occupied a dwelling which has a poor energy performance, acted, and implemented positive changes. The objective is to provide the reader with a comfortable understanding of what a retrofit consists of, and the processes involved.

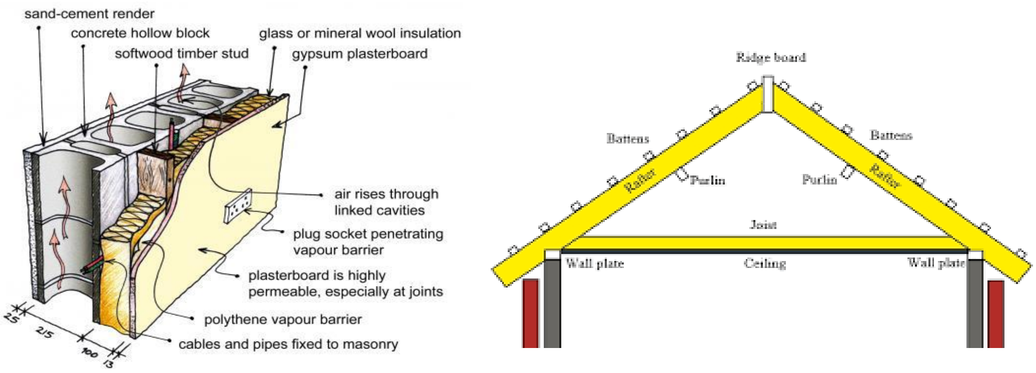



*Figure 19:Typical Hollow Block & Pitched Roof*

The primary, or main source of heating for the house is through an oil boiler. This provides heat to the radiators and the hot water cylinder. There is a poor level of heating system control with no room or cylinder thermostats and only a basic timeclock. The result of this means the homeowner will use excessive amounts of energy during off peak times and will struggle to maintain thermal comfort in an efficient manner. It was also noted that a significant amount of pipework in cold spaces linked to hot water supply were uninsulated, again creating more losses and inefficiencies.

There is one open fire in the living room, with a standard chimney designed to exhaust smoke. This type of heating is very inefficient where most of the energy generated is lost to the chimney itself. An additional issue linked with the open fire is the high draughts from the chimney ope, making the internal space more difficult to heat. Figure 16 demonstrates typical patterns of heat loss associated with a dwelling of this type.

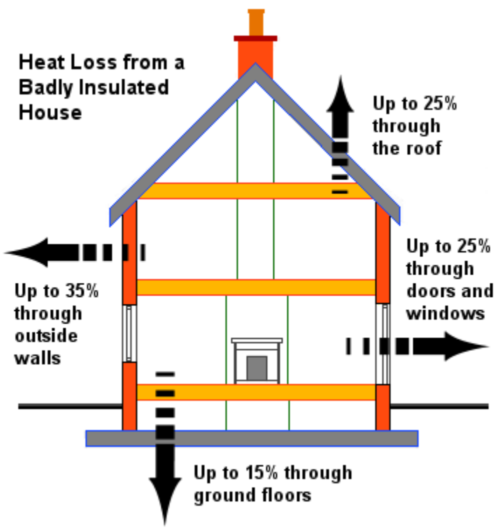



*Figure 20: Dwellings Heat Loss*

As part of this exercise, a Building Energy Rating certificate was produced for the house just described. The result in summary is as follows.

- BER Rating: E2
- Energy Consumption: 344 kWh/m$^2$/yr
- Carbon Emissions: 85 kg$CO_2$/m$^2$/yr
- Estimated Annual Energy Costs: €2,971

A range of options presented themselves when conducting a BER inspection and energy audit of the dwelling just described. In this instance, a range of measures were identified, and changes were made to suit the specific characteristics of this house. These include the following.

- Upgrade attic insulation.
- Upgrade external wall insulation.
- Improve draught stripping
- Upgrade oil boiler.
- Upgrade heating controls.

Initially it was identified that only 100mm of low-grade mineral wool was installed throughout the attic space of this dwelling. This would be considered a poor level, and alongside the deteriorating condition of what was there, very significant levels of heat loss were occurring through the roof. To remedy this the contractor removed the original insulation and safely disposed of it. In its place, 300mm (12") of high-quality mineral wool was installed bringing the roof space to modern building regulation standards. This measure alone significantly improved the buildings energy performance, by as much as 20%. An integral aspect of ensuring attic insulation, or indeed all insulation, performs to its highest level is in respect to the consistency of which it is installed. Ensuring that the 300mm of mineral wool is evenly installed throughout the attic will reduce cold bridges, maximizing the performance of the upgrade.

The next measure complete was the external wall insulation. As referenced earlier, the existing wall construction associated with this dwelling is a hallow/cavity block, with a small section of the front elevation finished with a decorative brick (twin leaf cavity). There are various forms of wall insulation available, but the primary wall build-up may limit the homeowner to certain types. While pumped bead is very common and cost effective, it cannot be applied to this construction type (hallow/cavity block), therefore the options are limited to either internal wall or external wall insulation systems. The deciding factor may depend upon budget, alongside the destructive nature of internal wall insulation during its install such as removing kitchens and other fixed furniture, electrical and plumbing alterations, replastering, and painting etc.

In this instance the homeowner opted for external wall insulation, installing 100mm (4") of EPS board with a standard render finish. As the homeowner wished to maintain the decorative brick finish to the front of the dwelling, bead was pumped where the cavity was present ensuring a more consistent thermal performance was achieved. These works improved the U-value of the external wall from 1.10 W/m$^2$.K to 0.27 W/m$^2$.K resulting in much less heat loss.

Incorporating a bead and external wall insulation can also significantly reduce air draughts which are large contributors to a poor energy performing house. Figure 19 illustrates the external wall insulation system with both a standard render and brick slip finish. EWI allows the homeowner to dramatically alter the external appearance of the dwelling through these variations in finish and are considered one of the advantages of adopting such a system. The homeowner and contractor must also be aware to ensure adequate ventilation is achieved with any alterations to the building fabric and air tightness. This may be achieved by installing better quality natural vents, ensuring new windows have controllable trickle vents or considering mechanical ventilation where appropriate. When altering more than 25% of the external building fabric, the homeowner may trigger the requirement to comply with TGD L 2019, Major Renovations for Dwellings. There are several conditions the contractor must then meet if this is the case. Please refer to **TGD L 2019** for further details.

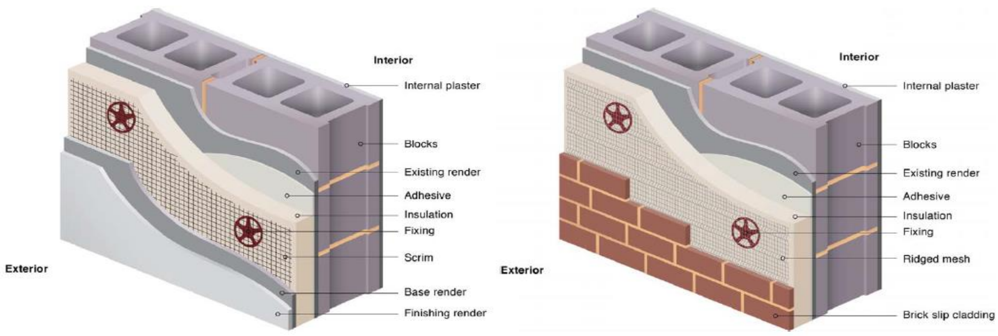



*Figure 21: External Wall Insulation*

The primary heating system was also upgraded as part of the works carried out to the dwelling. While controlling heat loss through the fabric is essential, ensuring the most optimum heating system is installed ensures additional energy is not wasted. As a result, a new 92% Grant condensing oil was installed.

As a result of these measures the dwelling achieved the following improvement in the BER.

- BER Rating: D1
- Energy Consumption: 237 kWh/m$^2$/yr
- Carbon Emissions: 57 kgCO2/m$^2$/yr
- Estimated Annual Energy Costs: €1,979

In summary, these measures improved the dwellings energy performance by 31%, saving the homeowner potentially €992 a year on energy costs. While the full cost of works is unknown, it can be assumed that the breakdown is as follows.

- Attic Insulation: €1,300
- External Wall Insulation: €9,500
- Oil Boiler: €3,500

Assuming the above, the total cost of the works would be expected to be in the region of €14,300. From figure 20, we can determine the amount of grant support that was provided by the SEAI under the Better Energy Homes scheme. This would include funding for the attic insulation and external wall insulation only as fossil fuel systems are no longer grant funded by the SEAI, meaning the oil boiler must be paid for fully by the homeowner. Therefore, the homeowner would have claimed €400 for the attic insulation and €4,500 for the external wall insulation as this is a semi-detached dwelling. The total grant aid would be in the region of €4,900 resulting in the cost of works, to the homeowner, to be at €9,400. Assuming the homeowner saves €992 a year on energy related costs, these measures may pay for themselves in 9.5 years.

| Measure | Maximum grant value |
|---|---|
| Attic insulation | €400 |
| Cavity wall insulation | €400 |
| Wall insulation - internal dry lining<br>- Apartment (any) or mid-terrace house<br>- Semi-detached or end of terrace house<br>- Detached house | <br>€1,600<br>€2,200<br>€2,400 |
| Wall insulation - external<br>- Apartment (any) or mid-terrace house<br>- Semi-detached or end of terrace house<br>- Detached house | <br>€2,750<br>€4,500<br>€6,000 |
| Heat pump systems (available from 16 April 2018)<br>- Air to water<br>- Ground source to water<br>- Exhaust air to water<br>- Water to water<br>- Air to air | <br>€3,500<br>€3,500<br>€3,500<br>€3,500<br>€600 |
| Heating controls upgrade | €700 |
| Solar water heating | €1,200 |
| Bonus payment after 3rd measure | €300 |
| Bonus payment after 4th measure | €100 |
| A BER assessment after works are done (maximum of 1 grant payable per home) | €50 |

*Figure 22: SEAI Better Energy Homes Funding*

This dwelling still presents a range of energy related upgrades that could be incorporated to build upon the success of the works complete to date. One such measure would be the upgrading of heating controls to automatically control time and temperature outputs across the entire dwelling. As it stands, a poor level of heating system control exists which is impacting how efficiently the homeowners can regulate and use the system. The recommendation would be to install a 3-channel programme, 2 room thermostats (install one in the living room and the other in the main bedroom), TRV's (Thermostatic Radiator Valves) to most radiators and a cylinder thermostat to the body of the hot water cylinder. It was also noted that the hot water cylinder had a poor level of insulation. This will contribute to a high degree of energy losses resulting in the oil boiler working harder and consuming more fuel to ensure the required hot water temperature is achieved for showers and taps. The figure below illustrates what these components look like.


*Figure 23: Advanced Heating Controls*

The end goal for all dwellings, and commercial buildings, is to become more efficient, use less energy, remove any fossil fuels onsite and bring in renewable energy technologies where practical. The BER is a simile guide we are using to determine how close we are to this solution, and while the home has made significant improvements to demonstrates a BER of D1, the additional measure mentioned above will likely still not be enough to bring the house into the B1 or A rated space. The more advanced steps that may be considered are as follows.

- **Replace all existing windows and external doors.**

The windows and doors that are installed now, and which are modelled in the BER calculation, show a significant amount of heat loss. The recommendation would be to remove all of these and install new A+ rated double/triple glazed windows. The existing windows have a heat loss U-value of between 2.70 and 3.40 W/m$^2$.K. New units can dramatically reduce this with U-values as low as 1.00 to 0.70 W/m$^2$.K. Aside from the glazing, works can be done to improve air tightness and air leaks between the window frame and the revels of the external wall. There are approximately 8-9 windows of various sizes in this house. Based on this it would cost an estimated €7,000 to install new double-glazed windows. The external doors may cost in the region of €1,000 - €1,500. These measures may be covered under the SEAI's Communities grant programme (rather than the SEAI's Better Energy Homes programme).

- **Install Air Source Heat Pump.**

The homeowner recently opted to replace the original oil boiler with a new, high efficiency condensing oil boiler. This certainly made a positive impact on the homes carbon emissions and efficiency. However, oil is still a “dirty” fuel, and as we progress toward zero carbon, such systems must be phased out of the domestic setting. The next question then is how we heat our homes and provide hot water for showers etc. One answer is heat pump systems. These are a relatively new system that are highly efficient, use much less energy and cost significantly less to run when compared to oil, gas, and solid fuel in certain circumstances. Powered by electricity, heat pumps work only within the right internal environment. This is a home which is very well insulated and has very few draughts. When considering a heat pump for an existing building many questions must be asked, such as how well insulated is this house. To help in this process a homeowner can have a Technical Assessment complete. This is completed by a registered Technical Advisor (see link). They will assess if your home is already fit for a heat pump, and if not, what measures must be taken to ensure it is.

Based on the work carried out on this dwelling, and on the condition that the additional measures mentioned are complete, it is likely that this home would be ready for a heat pump. The homeowner would be recommended to install an air source heat pump and ensure all radiators in the house are sized to suitably heat the home through a distribution temperature of 45-50 °C. A heat pump installer will support you in this design process. A new cylinder would be installed, along with more advanced heating controls designed to maximize your thermal comfort and reduce unnecessary energy use. The image below demonstrates a typical air source heat pump installed throughout Ireland for such homes.

*Figure 24: Air Source Heat Pump*

- **Renewable Energy Technologies.**

Renewable energy technologies should be used where there is a requirement for the energy, and where measures have been taken to first reduce energy demand and losses. At this stage of the retrofit for this dwelling, renewable systems to assist in energy generation onsite may be utilised. For a dwelling of this type, the advice would be one of two systems, both using solar (sun) as the source. The homeowner could opt to install solar thermal panels which will assist in hot water production only for showers and wash hand basins. This would be of benefit here as the hot water demand should not be excessive considering the quantity of rooms in the building and the expected number of occupants in same. The solar thermal panels will assist the air source heat pump by providing pre-heated water to the hot water cylinder, reducing the amount of electricity used to get the water up to a usable temperature.

Alternatively, the homeowner may decide to install solar photovoltaic panels. These panels convert the suns light into electricity. This is of great benefit here as the energy used to heat the entire house is electricity. Essentially the PV panels will help run the heating system for the entire dwelling. A battery could also be considered and installed to store electricity that may be produced during times when it cannot be used instantly.

# 6 Analysis of Commercial Sector

## 6.1 Energy Audits

ORS completed several energy audits in public and private organisations throughout the island of Árainn Mhór providing reports for each. The aim of the reports is to assist the facilities with the identification of energy efficiency measures. ORS recommends that the organisations implement the measures identified in their reports to contribute towards the energy consumption reduction goals, as set out in the Climate Action Plan (CAP). The recommendations within the reports are based on utility data, a site audit, and related engineering calculations. Each site audit consisted of a walk-through of the facility and review of the electrical and mechanical systems and equipment.

An important theme throughout all these reports is the importance to engage employees and the public regarding good energy management and wastage reduction. Education of all building users on the simple ways in which everyone within the building can contribute towards saving energy. Simple measures, such as switching lights off when exiting a room, or switching off TV's, and computers rather than leaving on standby, have proven to be successful in saving energy.

A summary of each report and recommended energy efficiencies is displayed below.

### 6.1.1 An Naíonra Arranmore

The following table represents the Energy Efficiency Measures recommendations for An Naionra Arranmore, as well as the approximate cost and projected savings for the measures.

| Ref | Opportunity | Estimated Annual Savings | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Fuel Type | [kWh] | [€] | [kgCO2] | Estimated Cost (Excluding VAT) | Simple Payback (yrs.) | Payback w/30% (yrs.) |
| 1 | Replace existing Internal lights with LED equivalent | Electricity | 384 | €242 | 199.3 | €1,236 | 5.10 | 3.57 |
| 2 | Pump Cavity Wall | Oil | 3,536 | €265 | 933.4 | €1,600 | 6.03 | 4.22 |
| 3 | Roof Insulation | Oil | 3,732 | €280 | 985.2 | €1,800 | 6.43 | 4.50 |
| 4 | Replace Windows | Oil | 2,357 | €177 | 622.3 | €6,300 | 35.64 | 24.95 |
| 5 | Replace Entrance Door | Oil | 1,964 | €147 | 518.5 | €2,000 | 13.58 | 9.50 |
| 6 | Install Wood Pellet Boiler | Oil | 11,785 | €884 | 3,111.3 | €10,384 | 11.75 | 8.22 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 7 | Carry out energy awareness days for staff. Employ a switch off policy on all plug loads after hours and holidays. | Electricity | 300 | €189 | 155.7 | €0 | 0.00 | 0.00 |

### 6.1.2 Arranmore Cultural Centre

The following table represents the Energy Efficiency Measures recommendations for the Arranmore Cultural Centre, as well as the approximate cost and projected savings for the measures.

| Ref | Opportunity | Estimated Annual Savings | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Fuel Type | [kWh] | [€] | [kgCO2] | Estimated Cost (Excluding VAT) | Simple Payback (yrs.) | Payback w/30% (yrs.) |
| 1 | Replace existing Internal LED equivalent with sensors | Electricity | 391 | €97 | 202.9 | €576 | 5.95 | 4.16 |
| 2 | Pump Cavity Wall | Oil | 7,955 | €597 | 2,100.1 | €2,700 | 4.53 | 3.17 |
| 3 | Install Wood Pellet Boiler | Oil | 15,910 | €1,193 | 4,200.2 | €10,835 | 9.08 | 6.36 |
| 4 | 2.4 kWp Solar PV System | Electricity | 2,090 | €517 | 1,084.7 | €4,000 | 7.73 | 5.41 |
| 5 | Carry out energy awareness days for staff and volunteers. Employ a switch off policy on all plug loads after hours and holidays. | Electricity | 300 | €74 | 155.7 | €0 | 0.00 | 0.00 |

### 6.1.3 Arranmore Hostel

The following table represents the Energy Efficiency Measures recommendations for the Arranmore Hostel, as well as the approximate cost and projected savings for the measures.

| Ref | Opportunity | Estimated Annual Savings | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Type | [kWh] | [€] | [kgCO2] | Estimated Cost (Excluding VAT) | Simple Payback (yrs.) | Payback w/30% (yrs.) | Comments |
| 1 | Pump Cavity Walls | Oil | 6,531 | €549 | 1,724.2 | €4,000 | 7.29 | 5.10 | The rear of the building has cavity walls partially filled with insulation. It is recommended to pump the entire cavity wall with polystyrene beads that expands when injected into the cavity. |
| 2 | Internal Dry Lining | Oil | 7,464 | €627 | 1,970.5 | €9,000 | 14.35 | 10.05 | The wall at the front of the building is solid concrete with minimal insulation. It is recommended to install insulated dry lining plasterboard to the inside of the walls. |
| 3 | Roof Insulation | Oil | 4,665 | €392 | 1,231.6 | €3,000 | 7.66 | 5.36 | The attic of the building has no insulation in place. It is recommended to install insulation above the ceiling with 300mm of rockwool or equivalent insulation. This will help the building retain heat and require less heating to maintain comfort levels. |
| 4 | Air to Water Heat Pump | Oil | 9,330 | €784 | 2,463.1 | €23,000 | 29.35 | 20.54 | The oil boiler will need to be replaced soon. An option is to install an air-to-water heat pump which would provide heat at a lower cost and provide improved controls. The building needs to have the insulation upgrades done to make it suitable for a heat pump. |
| 5 | Wood Pellet Boiler | Oil | 7,651 | €643 | 2,019.7 | €16,000 | 24.90 | 17.43 | Another option to replace the oil boiler is to replace it with a wood pellet boiler. Wood pellet boilers can achieve very high efficiency levels of up to 96%. |

| Ref | Opportunity | Estimated Annual Savings | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Type | [kWh] | [€] | [kgCO2] | Estimated Cost (Excluding VAT) | Simple Payback (yrs.) | Payback w/30% (yrs.) | Comments |
| 6 | Lighting Upgrade | Electricity | 4,747 | €963 | 2,463.9 | €4,000 | 4.15 | 2.91 | It is recommended that the older lighting fixtures are upgraded to LED equivalent units with occupancy motion sensors. LEDs typically have a longer life span than traditional lighting sources and will also reduce maintenance costs. |
| 7 | 2.4 kWp Solar PV System | Electricity | 2,090 | €424 | 1,084.7 | €4,000 | 9.44 | 6.61 | A solar PV system installed on the roof would convert the sunlight into electrical energy, that can then be used in the building |
| 8 | Energy Monitoring Equipment | Electricity | 300 | €61 | 155.7 | €100 | 1.64 | 1.15 | Monitoring of energy is an excellent method to reduce inefficient energy use . There are a number of tools that can be used to quantify energy use from single plug monitors to entire system monitors that measure real time electricity usage into an entire building. |

### 6.1.4 Chrois Bhealaigh Community Centre

The following table represents the Energy Efficiency Measures recommendations for the Ionad an Chrois Bhealaigh Community Centre, as well as the approximate cost and projected savings for the measures.

| Ref | Opportunity | Estimated Annual Savings | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Type | [kWh] | [€] | [kgCO2] | Estimated Cost (Excluding VAT) | Simple Payback (Yrs.) | Payback w/50% (yrs.) | Comments (yrs.) |
| 1 | Internal Dry Lining | Electricity | 3,425 | €750 | 1,777.5 | €7,500 | 10.00 | 5.00 | To improve the performance of the heat pump, the area it serves could be insulated with dry lining plasterboard. The area includes the |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | office and the recreation/meeting room. |
| 2 | Spray Foam Roof Insulation | Electricity | 799 | €175 | 414.7 | €2,000 | 11.43 | 5.71 | The roof of the men's shed room is uninsulated. Spray foam insulation is by far the best material for insulating corrugated roofs. It forms an airtight, insulating barrier from the external environment. This will help the building retain heat and require less heating to maintain comfort levels. |
| 3 | Lighting Upgrade | Electricity | 2,055 | €450 | 1,066.5 | €2,500 | 5.56 | 2.78 | It is recommended that the older fluorescent lighting fixtures are upgraded to LED equivalent units with occupancy motion sensors. LEDs typically have a longer life span than traditional lighting sources and will also reduce maintenance costs. |
| 4 | Install Infrared Heaters in the hall and warehouse room | Electricity | 0 | €0 | 0.0 | €4,000 | 0.00 | 0.00 | Note: these rooms are currently unheated so adding the heaters will not provide any energy savings, which means it would not qualify for the SEAI community energy grant.<br>Radiant heating produces infrared rays that heat people and objects directly, not the air. Radiant heating is extremely efficient for large spaces that are used intermittently. |
| 5 | 2.4 kWp Solar PV System | Electricity | 2,090 | €458 | 1,084.7 | €4,000 | 8.74 | 4.37 | A solar PV system installed on the roof would convert the sunlight into electrical energy, that can then be used in the building |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6 | Energy Monitoring Equipment | Electricity | 300 | €66 | 155.7 | €200 | 3.04 | 1.52 | Monitoring of energy is an excellent method to reduce inefficient energy use . There are a number of tools that can be used to quantify energy use from single plug monitors to entire system monitors that measure real time electricity usage into an entire building. |

### 6.1.5 Arranmore Island Development Co-Operative

The following table represents the Energy Efficiency Measures recommendations for the Arranmore Island Development Co-Operative, as well as the approximate cost and projected savings for the measures.

| Ref | Opportunity | Estimated Annual Savings | | | | Estimated Cost (Excluding VAT) | Simple Payback (yrs.) | Payback w/30% (yr) | Comments (yrs.) |
|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Type | [kWh] | [€] | [kgCO2] | | | | |
| 1 | Pump Cavity Walls | Oil | 1,642 | €141 | 433.5 | €1,000 | 7.08 | 4.96 | The office part of the building presumably has cavity walls partially filled with insulation, based on the age of construction. It is recommended to pump the entire cavity wall with polystyrene beads that expands when injected into the cavity. This will help the building retain heat. |
| 2 | External Wall Insulation | Oil | 8,210 | €706 | 2,167.5 | €8,000 | 11.33 | 7.93 | Another option to insulate the office part of the building is to install external wall insulation. The walls are not in a great state due to weather damage. With external wall insulation, the entire exterior surfacing of the walls of the building, are wrapped in a seamless blanket of insulation. This will increase the thermal performance, and also improving the overall airtightness of the building by eliminating air leakage through the external walls. |

| Ref | Opportunity | Estimated Annual Savings | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Type | [kWh] | [€] | [kgCO2] | Estimated Cost (Excluding VAT) | Simple Payback (yrs.) | Payback w/30% (yr) | Comments (yrs.) |
| 3 | Roof Insulation | Oil | 5,131 | €441 | 1,354.7 | €3,000 | 6.80 | 4.76 | The attic of the building has no insulation in place. It is recommended to install insulation above the ceiling with 300mm of rockwool or equivalent insulation. This will help the building retain heat and require less heating to maintain comfort levels. |
| 4 | Replace windows | Oil | 1,437 | €124 | 379.3 | €3,150 | 25.49 | 17.84 | Some of the windows in the building are in a poor state and are allowing draughts in and heat to escape. The windows in two of offices, the men's and ladies' toilets, and the front office all need to be replaced. It is recommended that the windows are upgraded to energy efficient double-glazed windows. |
| 5 | Lighting Upgrade | Electricity | 4,747 | €963 | 2,463.9 | €5,000 | 5.19 | 3.64 | It is recommended that the fluorescent lighting fixtures are upgraded to LED equivalent units with occupancy motion sensors. LEDs typically have a longer life span than traditional lighting sources and will also reduce maintenance costs. |
| 6 | 2.4 kWp Solar PV System | Electricity | 2,090 | €424 | 1,084.7 | €4,000 | 9.44 | 6.61 | A solar PV system installed on the roof would convert the sunlight into electrical energy, that can then be used in the building |
| 7 | Energy Monitoring Equipment | Electricity | 300 | €61 | 155.7 | €100 | 1.64 | 1.15 | Monitoring of energy is an excellent method to reduce inefficient energy use . There are a number of tools that can be used to quantify energy use from single plug monitors to entire system monitors that measure real time electricity usage into an entire building. |

The following information is extracted directly from the results of the survey.

(4) Use this form of outline numbering

# 7 Strategic Roadmap (Residential & Non-Residential Upgrade Works)

The following provides a strategic roadmap for Árainn Mhór as they transition from the Plan to the Do phase of the SEC programme. The aim of this visual is to illustrate the respective stages the SEC is advised to take in the development of various initiatives identified throughout this study. The initial stage involves bringing the wider community with the SEC through raising awareness and understanding in the core areas of energy efficiency and sustainable development. The second stage involves obtaining commitment from local homeowners and businesses to partake in projects like those identified through the various audits and assessment in this report. Stage 3 involves the project management and completion of these projects and measuring the reduction of the areas carbon output

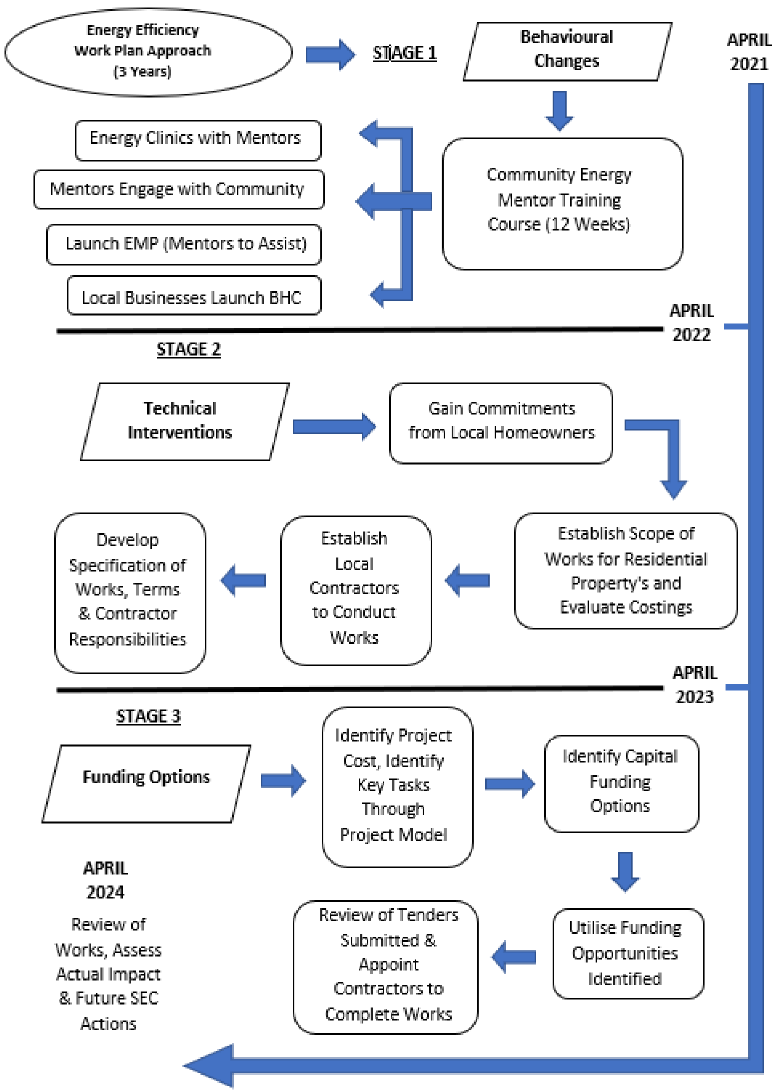



*Figure 25: SECs Strategic Roadmap*

# 8 Transport

Transport in Ireland is currently deeply dependent on imported fossil fuels. Emissions from road transport fuelled by fossil fuels is contributing to significant air quality issues and subsequently to associated health issues.

## 8.1 Transport Baseline

Based on the 2016 CSO data, driving by car is the primary method of transport throughout the Árainn Mhór island, however upon a more thorough investigation, marine diesel is by far the largest transport fuel associated with the island. Based on 2015 data, road diesel accounted for up to 250 MWh, while marie diesel accounted for over 2,790 MWh, resulting in this mode of transport being the 2nd highest energy user on the island emitting 745 $tCO_2e$ in carbon in the same period.

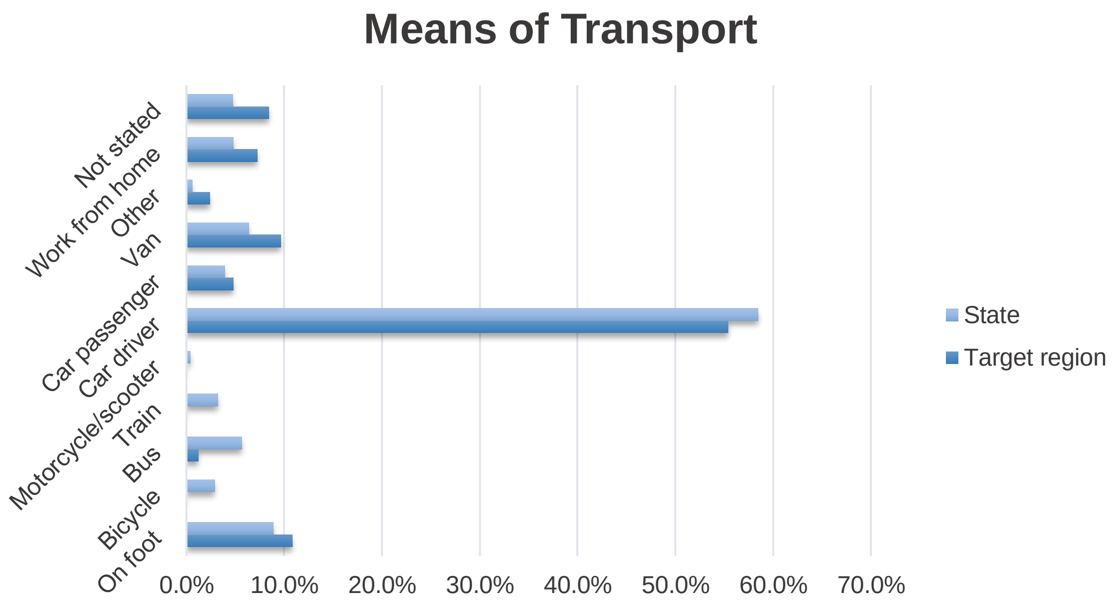



*Figure 26: Transport Profile*

## 8.2 Sustainable Transport Strategy

Sustainable transport is central to efforts to control greenhouse gas emissions, air pollution and environmental damage. The benefits of sustainable transport, however, extend beyond environmental considerations, delivering improvements in congestion, productivity, health, and quality of life.

In general, there is a high degree of car dependency in small Irish towns and throughout rural areas. In general, the people who live in small towns and rural regions use their car to a higher degree than people who live in cities or bigger towns. Reversely, they walk and cycle to a lesser degree. A big reason for this might be due to car centred spatial planning in Ireland, with new housing developments often placed quite far from existing town centres. This makes many Irish towns quite unattractive for walking and/or cycling.

Public transport can assist in reducing the number of private, single use cars. Such services as Local Link operate very successful services to isolated and vulnerable people within the community, as well as offering an alternative means of transport within a region. Ensuring regular, consistent, and reliable operation of such services can help in increasing the number of locals who will use it. It is also important to circulate the operation of the service through as many means as possible such as social media, local newsagents etc.

Of all travel modes, cycling and walking have the lowest environmental impact. To successfully promote cycling and walking as realistic alternatives to the private car, it must be a safe and pleasant experience for the locals. Pedestrian and cycle facilities will be most successful where they form a coherent network, place an emphasis on safety, directly serve the main areas where people wish to travel, provide priority over vehicular traffic at junctions, are free from obstructions and have adequate public lighting. In addition, support facilities such as secure parking and changing/showering facilities at places of employment are a key determinant in encouraging people to cycle.

The development of a good quality walking and cycling network that is legible and provides safe and attractive connections for pedestrians and cyclists, particularly along key desire lines is essential for Árainn Mhór to have a more sustainable transport infrastructure. It should be the aim to get at least some of regions residents, where practical, to change to walking or cycling, reducing car emissions throughout the island.

## 8.3 Electric Vehicles Uptake

The use of electric vehicles has the potential to mitigate some of the negative effects typically associated with transport. Electric vehicle efficiencies have evolved since their first inception but a high purchase price and uncertainty around charging infrastructure has delayed widespread uptake. Electric vehicles are significantly cheaper to run, with SEAI reporting running costs for a diesel car as €600 more expensive annually than an electric vehicle[1]. While reports of fuel costs for electric vehicles vary from €2.81/100km (home charging) to €4.64/100km (network charging) to €10.80/100km[2] for diesel cars.

Sufficient infrastructure is a prerequisite for substantial uptake of electric vehicles and as such an extensive charging network is required. The cost of commercially available e-chargers ranges from €785 to €29,995 depending on the type and speed of charging required from the basic home charger to the more powerful high-speed charges operating at higher outputs allowing for full charge in a matter of minutes. This price does not include civil work that may be required to connect electricity or that require restructure of walls or paths. A full in-depth feasibility study would be recommended to analyse the associated costs of installing charge

[1] https://www.seai.ie/technologies/electric-vehicles/compare-and-calculate/
[2] https://www.theaa.ie/aa/motoring-advice/cost-of-motoring.aspx

points as there are significant additional initial and ongoing costs that need to be considered. These include civil costs associated with installation, ongoing maintenance costs etc. EV Charging Stations require an annual service to ensure the unit is operating as it should, which is essential due to the units being exposed to outside weather conditions and having an electrical supply. Repair or maintenance services may also be required at times due to possible issues such as power failures, shorts, slower than normal charge times, power malfunctions, or excess energy consumption.

This is a developing field where Local Authorities have been tasked with the install of 1,000 on street e charging points over the next 5 years. To support the roll out of this, the SEAI have a grant for public EV charge points designed specifically for Local Authorities. The grant payments are capped at 75% per charge point, or €5,000. In the scenario where a charge post contains 2 charge points, the post in its entirety would be eligible for €10,000. The Local Authority is also limited to 20 EV CPs per application, however once approved, they can apply again. The types of e charger typical of the application ranges from 3-22kW via lamppost chargers and charging posts. The SEC would be encouraged to develop a positive relationship within the respective departments within the Local Authority to ensure the SEC's vision is considered in the rollout of this infrastructure. This would initially include utilising the voice of a local elected representative. However, the SEC could also seek to meet with Donegal County Council Climate Action Team.

Currently Árainn Mhór island has no public electric vehicle charging points. Furthermore, no plans have been established to install charging points soon on the island . The ESB have recently stated, 'ESB is continuing to assess other suitable sites on motorways and national road networks, with the aim of delivering over fifty high power (50-150kW) charging hubs. These hubs can provide up to 100km of driving range in as little as six minutes. Final sites are based on a range of factors including current charge point usage, traffic volume, accessibility, amenities, and grid capacity. More site locations will be announced in the coming months.'

There may be potential to engage with private installers and operators of charging infrastructure to enhance the charging network on the island. Private companies can assess sites and determine if installation of a charge point is feasible, further information is available here.

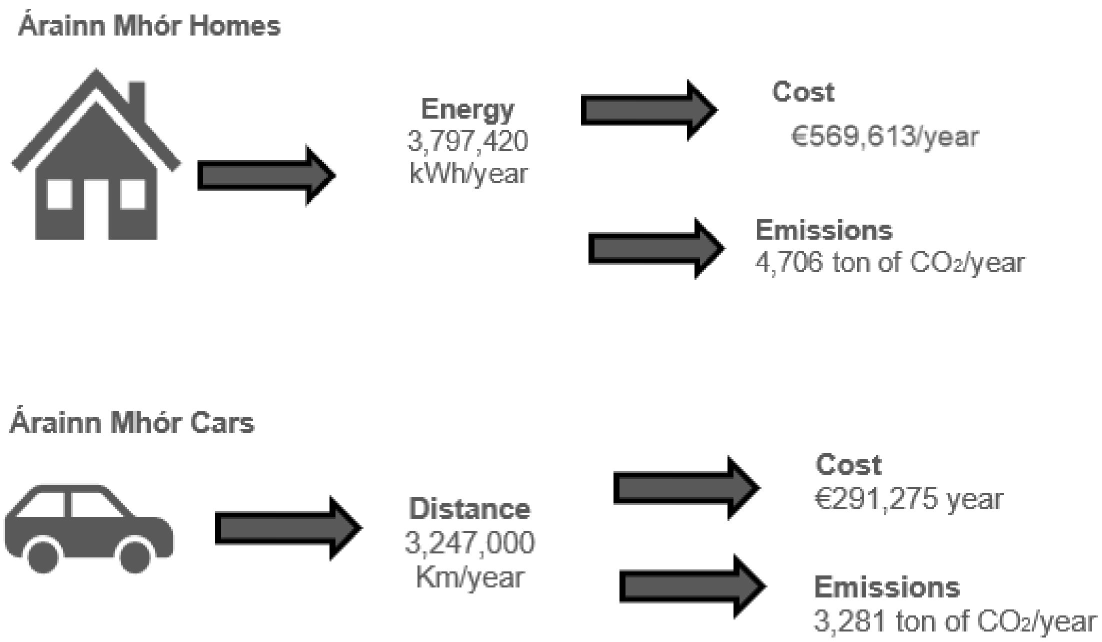
## 8.4 Transport Opportunities

Based on the reduced scale of road network throughout the island, a potential exists for the utilisation of electric vehicles for private users and light commercial fleet. The SEC is advised to support raising awareness of electric vehicles and charging from a private perspective encouraging homeowners to understand the benefits and financial supports available to assist the installation of charging points within dwellings. A local business may also wish to pilot EV through its fleet with the infrastructure strategically located to showcase the visuals of the system. The digital hub may also explore the installation of an EV charging point to facilitate staff and occupants who use the facility regularly, promoting the use of such modes of transport.

# 9 Energy Baseline

## 9.1 Domestic Spend on Energy in Household and Car

The average Irish Household consumes approximately 18,524 kWh of energy, 58% of which was direct heating fuel (primarily oil and gas) and 25% of which was electricity. The average Irish private motorist usually drives 17,000 kilometers on average for petrol vehicles. Using current average fuel prices this equates to an annual spend of €1,525 per car for petrol vehicles. Based on these figures the spend and the $CO_2$ emissions were calculated for Árainn Mhór (Council, 2016).



# 10 Renewable Energy Potentials

Several key factors need to be considered for large renewable energy projects on the island. A key factor for any commercial renewable energy project is distance and access to the grid. The ESB have conformed through the following Map that there is some capacity available at the four LV/MV substations/ transformers (orange) in the below map. An ECP 2.2 application would be required to assess the extend and cost of access to the grid for any of the below points[3].

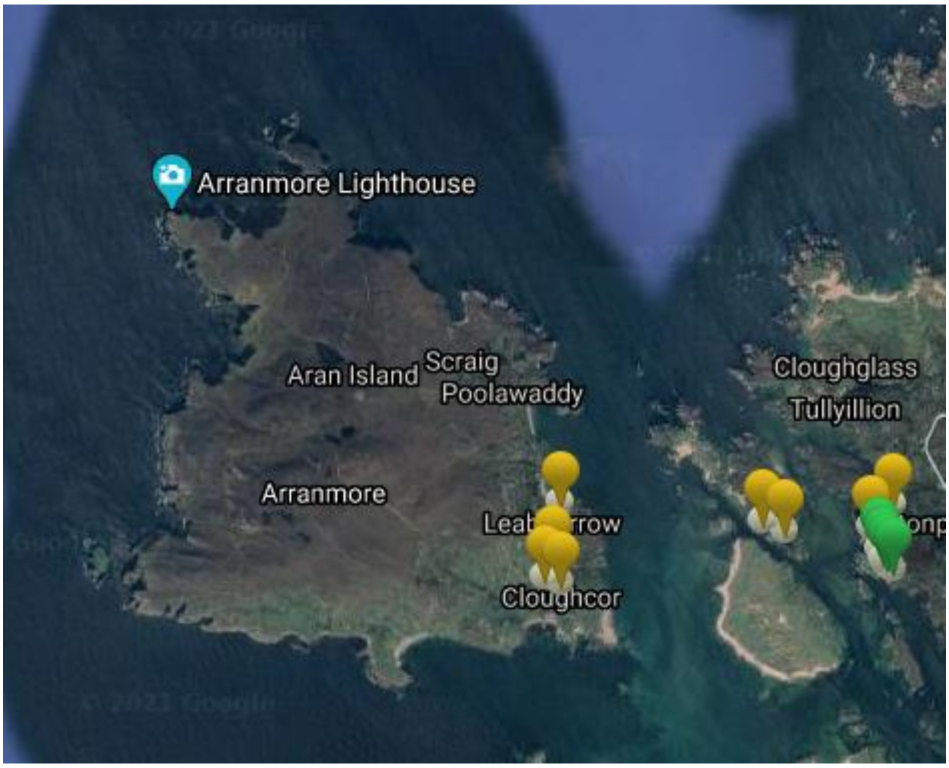



*Figure 27: ESB Substation Locations*

Community owned renewable energy projects are in their infancy in Ireland, but some excellent examples have paved the way for the wider community like Templederry Community Wind Farm[4]. The Renewable Energy Support Scheme (RESS) has also been developed to support communities to bid for access to the grid. This has improved the process by which community groups can plan and develop locally owned renewable energy systems ensuring renewable energy creates positive economic benefits for the locality. The new allocation of community focused projects in the bidding process has removed some of the gamble for communities. Planning permission is not required for community groups before bidding and

[3] https://www.esbnetworks.ie/new-connections/generator-connections/community-led-renewable-energy-projects
[4] https://tippenergy.ie/projects/templederry-community-wind-farm/

therefore removes the financial risk for communities before they know they will get grid access. SEAI offer support to communities who intend on establishing community owned renewable energy enterprises[5] in the upcoming RESS auctions.

There are several steps required for Árainn Mhór to develop their own community owned renewable energy project. The initial steps are outlined below and in the Register of Opportunities:

- Establish a steering group to identify the local appetite for a community owned renewable energy project. There will be a significant initial financial capital outlay required to buy and fund the technology for the project. Typically, this is funded through local investors (from small to large contributions) and funding institutes, although there may be some opportunities to include outside investors, the community must own greater than 51% of the enterprise to qualify for the community RESS auction places. An initial meeting with experienced communities in this area would be recommended at this stage to get advice on community/company structure.

- Complete a feasibility study to identify a suitable site for the community energy project, size of the project and the initial capital outlay and return on investment for the community (some good examples of community renewable energy feasibility studies can be found at https://localenergycommunities.net/feasibility-studies/).

- Application to the RESS auction to ensure there is capacity on the grid for the proposed enterprise (this step can be carried out before the feasibility study or in conjunction with it).

- An example of a community wind turbine sized at 1.5 MW would result in an electricity contribution of 3,547,800 kWh/year (27% capacity factor) resulting in sufficient energy to offset the requirement of all homes locally, the remaining energy generated may be offset to the grid at the fixed rate secured through the RESS action process referenced above. Generating excess electricity also has the added benefit of ensuring sufficient capacity is available within the locality to access energy for electrically driven heating system (heat pumps) and electric vehicles.

## 10.1 Wind

Donegal, and indeed Árainn Mhór, is ideally located on the North-West Atlantic coast for optimisation of wind energy. Throughout the county and region this wind energy resource has already been harnessed to a significant degree. Donegal already generates significant wind energy outputs relative to other counties in Ireland and is an energy exporter, despite the

[5] https://forms.office.com/Pages/ResponsePage.aspx?id=RuNk9vvW5UOFuowECBAjVQknnvuwFxFGr-DEQWPUn3lUOVZRNElOVkgyV0ZGWDNNSTBUSFpMSjZYNy4u

limited available electricity grid infrastructure in the County and significant environmental and heritage designations covering over one-third of the County. Donegal County Development Plan has identified that it is challenging to achieve a balanced approach to the identification of further suitable locations that will not detract from the scenic and environmental resource of the County.

The below map shows the wind energy resource for the island of Árainn Mhór. The map shows the Weibull layer, which is a distribution layer that shows the variation in wind speeds in each area over time. There is a great wind resource throughout the island of Árainn Mhór (Islands, 2019).

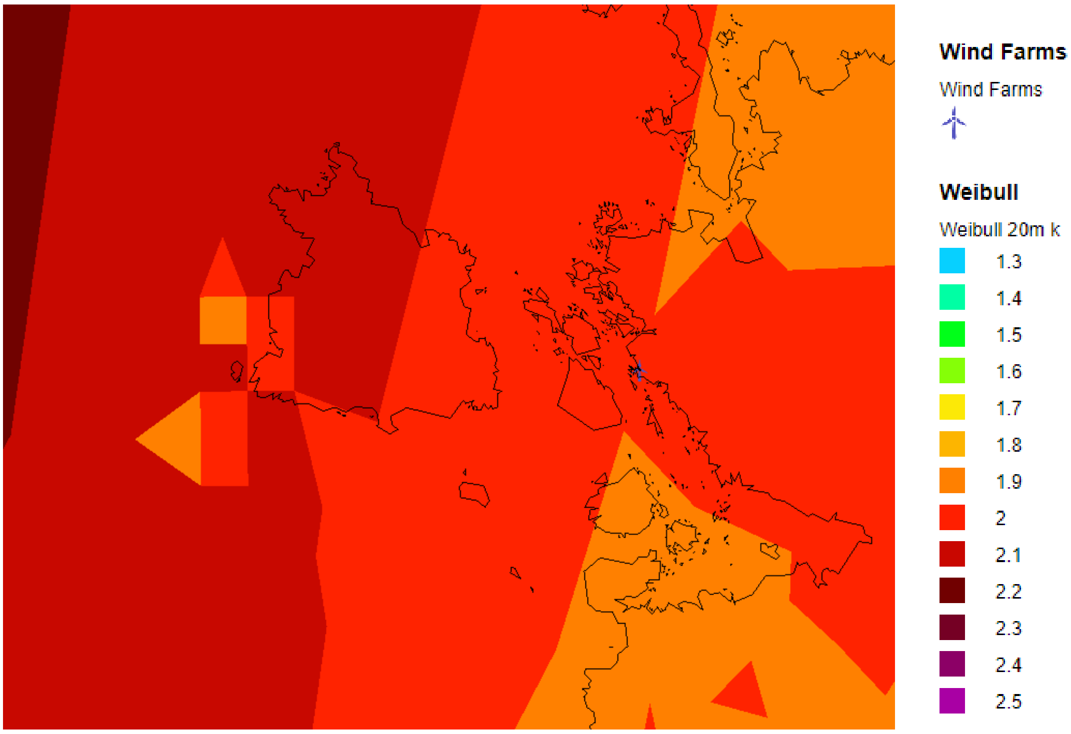



*Figure 28: Weibull*

The SEC is advised to investigate the exact potential for wind by conducting a bespoke feasibility study of wind energy throughout the island to establish the most appropriate site and determine expected yield from the system aside highlighting the financial aspects associated with the projects.

### 10.1.1 Small Scale Wind Potentials

Installation of small wind turbines for domestic and commercial applications has become popular in Ireland. Several factors need to be investigated before a wind turbine can be considered for a site such as use of electricity, site suitability and planning requirements. Surrounding buildings and obstacles can affect efficiency of turbines profusely and at last 10m clearance is recommended. Prices for small scale turbines have been reported in the region of €20,000 for a 5kW system with payback periods of approximately 10 years.

### 10.1.2 Offshore Wind Farms

Ireland has one of the best resources in Europe for harnessing offshore wind energy. Floating structures may be more appropriate for sites off the north west coast due to deeper water depths than that of the east coast. According to the Offshore Renewable Energy Development Plan (OREDP) Ireland has the potential for up to 4.5GW installed capacity of offshore wind by 2030, without having a likely significant impact on the environment. Scotland's Orkney Islands have an over-abundance of renewable electricity mainly from, which at present is wasted or lost when the electricity grid reaches capacity. One way in which they have negated this waste of electricity is to produce Hydrogen through electrolysis. This allows the surplus renewable energy to be stored and used later to produce heat, power, and fuel for use as a low carbon transport – since Orkney started planning its hydrogen-based economy in 2016 they now have several vehicles and the world's first sea-going car and passenger ferry fueled only by hydrogen. The islands have been awarded €100,000 as part of the inaugural EU RESponsible Island Prize, funded by Horizon 2020, the EU research and innovation programme.

## 10.2 Solar

The island of Árainn Mhór has potential to generate electricity and hot water form solar energy. There are two methods that could be adapted by households, community centres, and businesses within the region, mainly.

- Solar Photovoltaics (PV) which converts the sun's light into electricity to help move away from carbon-based generation

- Solar Thermal converts the sun's radiation into heat to use for residential and commercial space heating and hot water.

Traditionally Solar Energy has not been a prevalent renewable energy source in County Donegal, however, advances in technology mean that the capacity for production of electricity from light (photovoltaics) to electricity and solar thermal for heat, has increased. From a Solar PV potential perspective, if it is assumed that every permanently occupied dwelling installed 6, 350W PV panels, a total of 331,657 kWh of electrical energy would be generated each year. An in-depth feasibility study is advised in respect to a larger scale community owned solar PV farm. The map below highlights the area relatively close in proximity to LV/MV substations which are indicating capacity. The volume of energy these could take however is unknown. The in-depth analysis of a solar farm for this location would identify same. It would also identify if any of the land around this location is suitable to house such technology and all associated components while also investigating environmental considerations. .

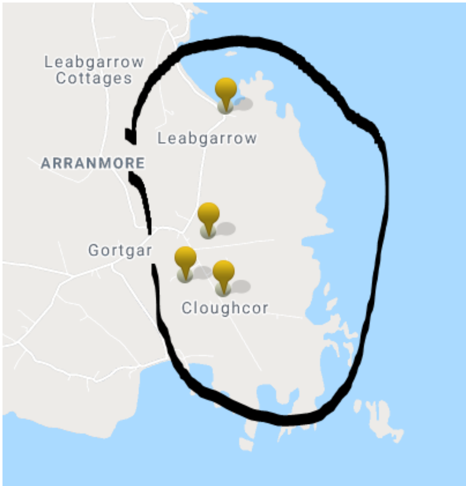



*Figure 29: Potential Solar PV Locations*

## 10.3 AD

Anaerobic Digestion (AD) is a biological process in which microorganisms break down biodegradable material in the absence of oxygen. One of the end products is biogas which can be combusted to generate electricity and heat or can be processed into renewable natural gas and transportation fuels.

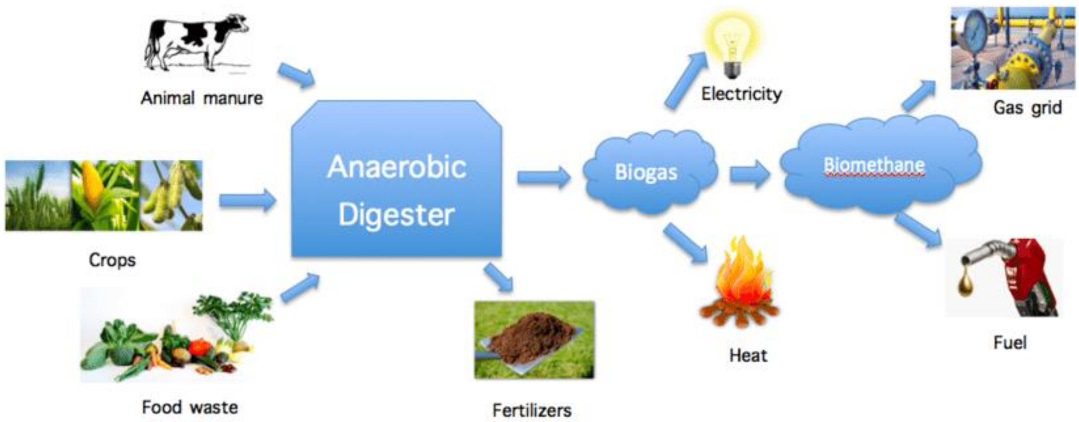



*Figure 30: AD Process*

AD has several associated environmental benefits. Energy from AD is effectively carbon neutral. AD also lowers the organic pollution potential of slurries resulting in water quality benefits, the by-products result in better quality fertilisers and reduces the need for artificial fertiliser use. The process also has the advantage of utilising waste substances that are otherwise difficult to dispose of in an environmentally acceptable manner.

There are a small number of AD digesters in operation in Ireland however the viability of these systems is dependent on access to an adequate and consistent quantity of suitable wastes, which can require large storage areas. Ideally, digesters should be located in close proximity to both a supply of raw materials and a demand for the energy outputs. A small AD plant may be a suitable way of treating waste on the island. Some interesting research is being carried out on using algae as a feedstock for AD plants also.

The Support Scheme for Renewable Heat (SSRH) has introduced mechanisms to support heat from renewable sources, like biomass boilers and AD plants, for a 15-year period in specific areas. Anaerobic Digestor plants require large capital investment and the SSRH scheme intends to help businesses and individuals overcome this stumbling block. Further information on the scheme can be found here. A thorough feasibility study was undertaken on introducing AD on the Dingle Peninsula and is available here for further information.

A feasibility study like Dingle would be required for the area to study the potentials regards feedstocks and capital/ongoing investments in such a system.

## 10.4 Geothermal

Geothermal energy relates to the thermal energy that is both generated and stored below the Earth's surface. This energy can be used for heating homes, alongside commercial premises such as water for swimming pools. Using electricity, the quantity of energy within the earth can be increased to ensure it is suitable for the end application. The source of this energy can originate from two primary sources, the Earth's crustal, or the solar energy supplied by the sun.

Ireland has an excellent source of shallow geothermal energy reserves. Our shallow groundwaters provide a stable resource of thermal energy that can be used to provide heating at very high efficiencies. Ground Source Heat Pumps (GSHPs) are becoming more and more popular and with sufficient insulation it can be a very efficient method of heating the home (DECC, 2021).

According to a report issued by the Department of Environment, Climate & Communications, titled Geothermal Energy in Ireland, Ireland has under utilised geothermal resources onshore. The report claims that a significant proportion of Irelands energy needs (heating) requirements could be met by same, however there are currently no district heating/cooling geothermal projects operating within the country

The image below demonstrates that the island of Árainn Mhór has significant potential for vertical geothermal systems with the region predominantly classified has having highly suitable land .

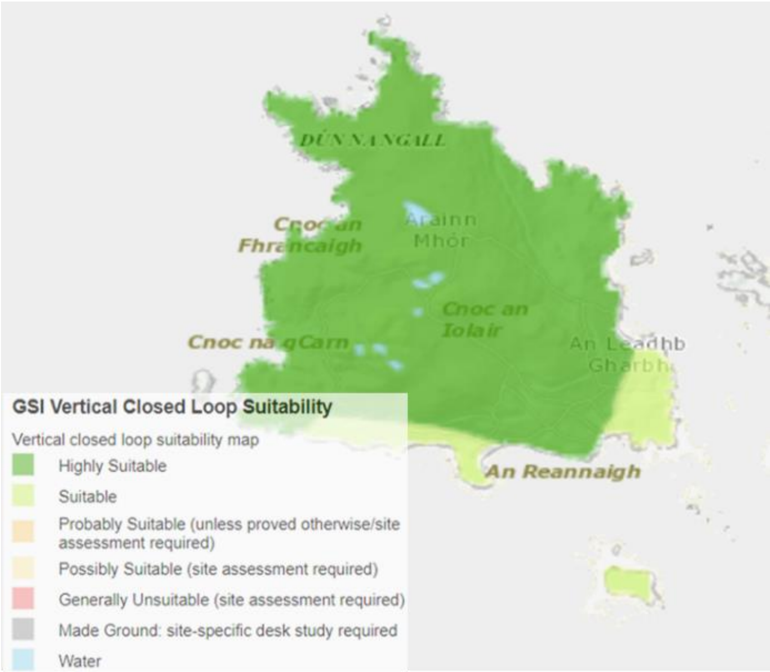



*Figure 31: Geothermal Potential*

Further analysis through the SEAI GeoMAP indicated that to a dept of 100m, the source temperatures range from 0-20°C. Based on the table below, ground source heat pumps operating within these conditions may yield high CoPs (Coefficient of Performance) otherwise known as efficiency. Installed within the correct dwelling or building, a very efficient low carbon solution presents itself for the community (Action Renewables, 2010).

*Table 2: GSHP Performance*

| Ground Temperature (°C) | CoP of Average System |
|---|---|
| 1 | 3.5 |
| 7.5 | 4 |
| 15 | 4.5 |

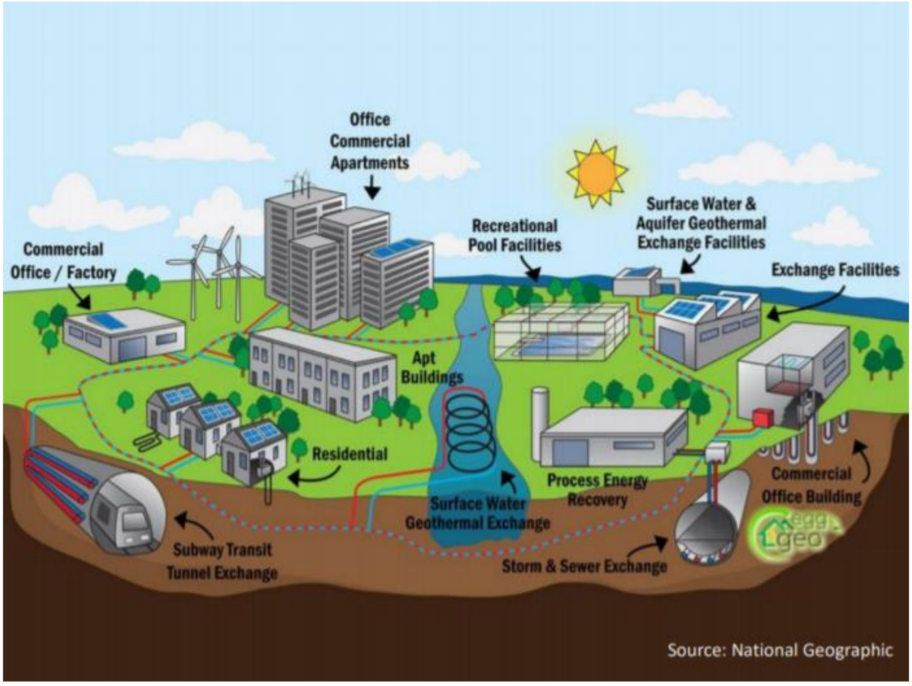



*Figure 32: Geothermal Applications*

## 10.5 Hydrogen

The Energy Master Plan developed by the Árainn and Inis Meáin Islands highlights an INTERREG study which was through the NUIG. The purpose of this study was to assess a hydrogen production facility on the island. This type of technology works alongside renewable generators such as wind or solar. When these systems generate an excess of power, the plant produces Hydrogen and Oxygen. This hydrogen can then be exported or utilised as an energy storage system during periods of higher demand than the existing generators can support within the region (Energy, 2018).

Considering the opportunities that may present the island regarding wind and solar energy generating sites, potential may exist for the island of Árainn Mhór to further investigate hydrogen as an avenue. Further information on how Scotland's Orkney Islands incorporate hydrogen can be found here (Ortiz, 2019) (NUIG, 2019).

## 10.6 Blue Economy - Energy

Ireland has made significant advances in the research and development of wave-generated energy and the islands coastline exposure has potential for this form of development. Development proposals should avoid locations that are immediately adjacent to coastal settlements or significant tourist attractions. Detailed visual, ecological, archaeological heritage and social impact of such proposals should be assessed in determining their acceptability.

While significant technological advances have been made in tidal and wave energy they are still not as advanced as other renewable energy technologies. There are several research projects underway in improving the technology and identifying suitable sites for ocean energy. SEAI and the Marine Institute have published a dataset to identify suitable locations for marine energy. This map identified that there is wave potential off the south/west coast through to the north/east coast of Árainn Mhór with potential energy resources of up to 2.5 MW possible within a feasible distance of the shoreline.

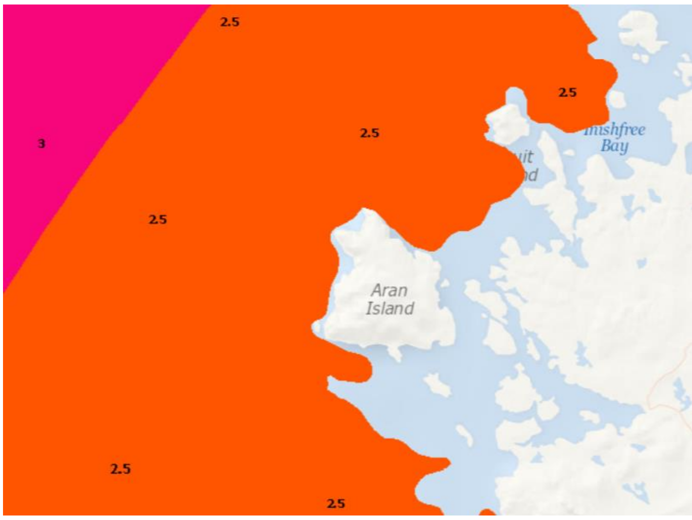



*Figure 33: Wave Potential*

# 11 Energy Efficiency Potentials

Utilising energy in the most efficient manner is an excellent approach to reducing $CO_2$ emissions and assisting the sustainability of an area.

Implementing an energy management system like ISO 50001 can be an excellent way to quantify and measure energy use in businesses. Benefits reported from the certification include:

- Energy reduction of up 10% within first 12 months.
- Reduced greenhouse gas (GHG) emissions and carbon footprint.
- Globally recognised International Standard.
- Assist in compliance with current and future voluntary and/or mandatory energy efficiency targets.
- Improved corporate image and credibility among customers, clients, and stakeholders.
- Excellent marketing tool.
- Informed decision-making processes from system design through to operation and maintenance.
- Increased energy awareness among staff members at all levels.
- Improved operational efficiencies and maintenance practices.

# 12 Energy Poor Overview

## 12.1 Energy Poor Communities

Energy poor communities can be defined as areas that spend more than 10% of their household income on fuel. The below graph displays the reported spend on fuel and light from the nationwide Household Budget survey carried out by the CSO. As technology and energy efficiencies have improved since 1980s the amount spent on energy has reduced. Unfortunately, there are still several communities that have not benefited from these efficiencies, these are typically much older houses and housing estates that rely heavily on fossil fuels for energy production.

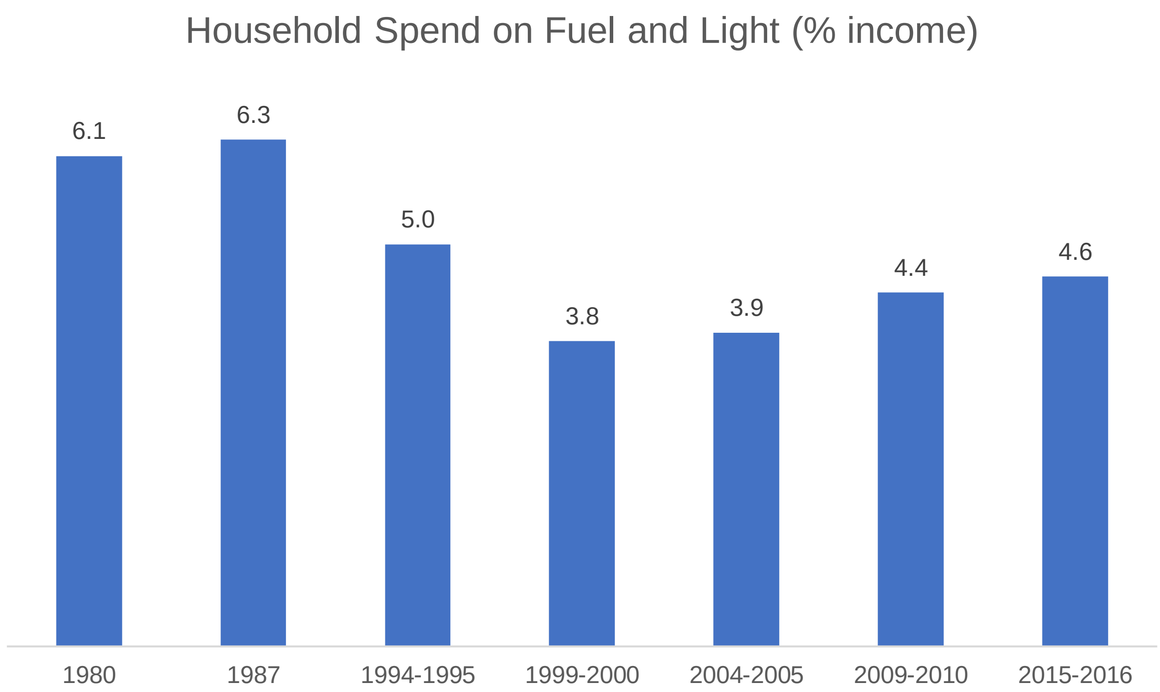



*Figure 34: Reported household spent on fuel and light from last Household Budget Survey (CSO)*

Donegal County Council have made significant commitments to improving the sustainability of their housing stock. From 2020, domestic dwellings provided by Donegal County Council will have been designed to Near Zero Energy Rating (NZEB) standards. Near zero-energy building' means a building that has a very high energy performance. The nearly zero or very low amount of energy required should be primarily covered by energy from renewable sources.

## 12.2 BER

Another key indicator of an energy poor community is the BER rating. Typically, the lower the BER rating the higher the energy bills as displayed below. There is an associated cost with improving the BER rating of a home, but the payback can be significant in the long term.

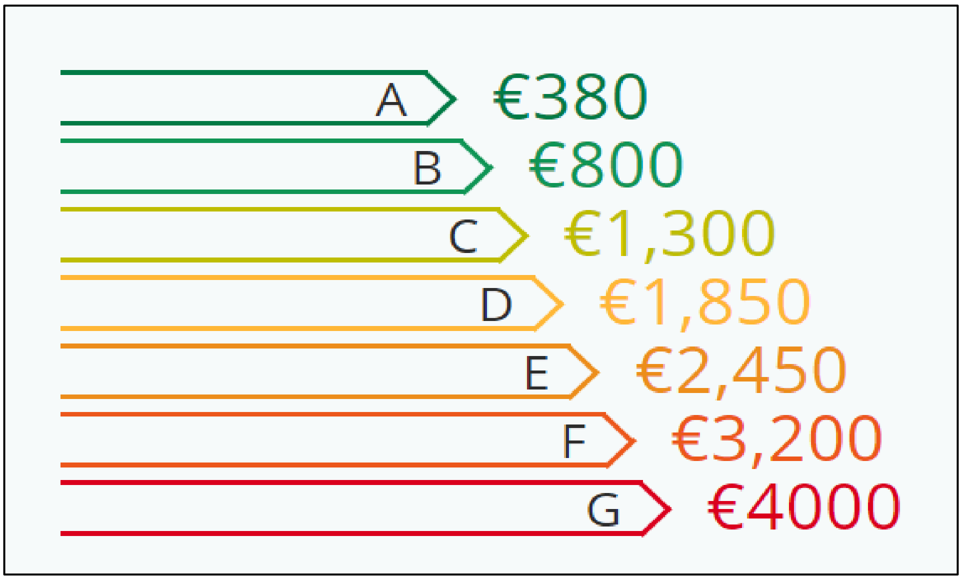



*Figure 35: Estimated annual energy spend for a 3-bed semidetached home with associated BER ratings*

## 12.3 Split Incentives

Another barrier for the region in its move to sustainable energy communities is a potential lack of investment by lessors because of split incentives in the rental sector. A high proportion of the rented household stock in Árainn Mhór is rented from a private lessor.

There are significant benefits for lessors to upgrade the energy efficiency of their rented homes especially regards tenant relations and improving value of their asset. The initial capital cost may be a deterrent for many though so incentives may be required. One example from Australia called Environmental Upgrade Agreement involves local authorities providing funding for lessors to upgrade their houses. These upgrades could include upgrading insulation, replacing lighting with LED, replacing old boilers etc. A finance provider agrees to advance capital to the council to fund the works and the money is repaid to the lender through council rates charged to the lessor.

# 13 Strategies

The most efficient approach to improve energy efficiencies in the Árainn Mhór study area is to start with areas that are particularly high users of energy. Typically, cultural and behavioural changes around energy use are the first steps in achieving a more efficient energy use profile with the least investment and disturbance. This approach can be challenging as habits can be difficult to change, encourage and measure. Science and alternative energies can offer a large contribution of the solution, but behavioural changes regard energy waste must be a founding cornerstone of a sustainable community. Possible approaches to engage communities and mobilise change are detailed below. Some of these interventions overlap and compliment behavioural and technical approaches.

## 13.1 Behavioural Interventions

Providing households with regular feedback on their energy use and encouraging them to set energy saving commitments in public can generate energy savings.

- Incentivise energy saving by use of smart meters and the potential introduction of energy reduction competitions run by local authority and/or community groups. The biggest loser wins (have been carried out by the US-EPA in schools but could be initiated in all areas of Donegal).
- Energy awareness regards turning off lights, plugging out chargers and powering down electrics.
- Encourage public transport use and walk or cycle to work schemes. Promote a competition for most steps walked for staff, students and services users to reduce car use.
- Develop partnership with local Hubs, Local Authorities, PPNs and Education Training Boards. Along with the SEAI consider running an Energy Champion training course for a select number of representatives across the community. With technical assistance from the SEAI and ETB, upskill the Energy Champions in areas of renewable energy technologies, energy efficiency, smart finance and sustainable transport. This can used as a means of filtering the message of the SEC and the EMP to the wider community and increase both awareness and activity in retrofits within the locality. Examples of this model can be seen with the Dingle SEC based in county Kerry.

## 13.2 Technical Interventions

- Low level, low investment upgrades to housing stock like lighting upgrades, attic insulation etc.
- Medium level upgrades like upgrading heating and boiler controls.
- Higher level upgrades like boiler replacement, installing heat pumps or externally

insulating houses.
- Install more e charging points around the peninsula to encourage use of electric vehicles.
- Introduce energy efficiency technologies to industries like solar PV, wind turbines and introduction of low energy lighting and e chargers to sites.

## 13.3 Target Strategies

The Register of Opportunities has identified several projects that are ready to reduce energy spend throughout the island of Árainn Mhór over the next three years. The key recommendations are to upgrade the non-domestic buildings and the domestic homes that were audited using the Community Energy Grant/ Better Energy Communities grant (details below). If these upgrades (or upgrades of similar homes and businesses) were undertaken this could save an estimated 216,817 kWh of energy per year alongside an approximate energy spend of €20,761 on electricity and heating bills per year. This can be achieved in the next 12 months through engagement with all stakeholders and ensuring an application to the below grant scheme is made, when it opens. Communities can undertake this application themselves but usually engage a Project Coordinator who has experience in this area. Details of project coordinators can be found **here**.

A longer-term strategy for Árainn Mhór may be to develop a community owned solar or wind farm that can offset an immense amount of imported fossil fuel derived energy. This will also allow local ownership of these assets and give local opportunities to invest in clean, green technologies. Further details of typical yields can be found within the RoO which supplements this report.

## 13.4 SEAI Grant Funding Opportunities

The Better Energy Communities fund for 2021 is now closed however it may be re-activated toward the end of year as in 2020. This grant aids a proportion of the work needed to upgrade residential and non–residential buildings. A requirement of receiving the grant aid is that the BER must be greater than B2 on completion of work. This report can be used as a key component of the islands SECs application to BEC 2021.

The next steps for the community in pursuing the BEC or SEAI Communities grant would be to first identify projects within the town that are likely to proceed in the coming year. These projects can come from the findings directly established within this EMP, such as from the audits, or they can come from ideas that may have generated because of reading this report. Bringing a Project Coordinator in to speak directly with interested parties may be considered an action in this regard by the SEC. The PC will discuss the specifics of the fund, helping to collate projects and assist in the grant documentation.

It is advised that an SEAI approved Project Coordinator be contacted as they will essentially manage the grant application on behalf of the community. As the community grant is competitive, applications which are submitted must be cognisant of this. The scope of works, carbon reductions and energy savings are factors which all influence how strong a project is. Meeting these criteria can sometimes be difficult for a community as they are only starting out. Engaging with a PC (Project Coordinator) can take this roadblock away from the community by merging their projects with others across the county. In essence, the PC is bundling a series of projects from various regions in to one application to ensure it is strengthened. A list of SEAI approved BEC/Community Grant project coordinators can be found via this link.

The tables below indicate the level of funding that may be available to an individual or entity under the community grant programme, these percentages may vary from year to year, alongside the actual works that are considered eligible under the fund. From more visit the SEAI's Community Grant website via this **link**.

*Table 3: Grant Funding Levels for Residential Homes*

| Home Type | Fuel Type | Funding Level |
|---|---|---|
| Private | Fuel Poor | Up to 80% |
| Private | Non-Fuel Poor | Up to 35% |
| Local Authority | - | Up to 35% |
| Housing Association | - | Up to 50% |

*Table 4: Grant Funding Levels for Non-Residential Projects*

| Type | Funding Level |
|---|---|
| Not for profit/community | Up to 50% |
| Private and public sector | Up to 30% |
| Public sector (exemplar) | > 30% ≤ 50% |

There are also one-off SEAI funds available for homeowners under the SEAIs Better Energy Homes scheme. This is funding available for specific home energy saving measures defined within the table below. This support is very useful where a homeowner wishes to proceed with energy upgrades works without the BER B rating as a restriction and requires less of a financial commitment to fully retrofit the home, where measures can be completed at the homeowners' pace. It is worth noting that this grant does not support the upgrade of windows and doors, alongside ventilation systems and any fossil fuel based central heating systems such as oil, natural gas, or solid fuel. The homeowner will also not require, and subsequently have, the support of a Project Coordinator.

| Measure | Maximum grant value |
|---|---|
| Attic insulation | €400 |
| Cavity wall insulation | €400 |
| Wall insulation - internal dry lining<br>- Apartment (any) or mid-terrace house<br>- Semi-detached or end of terrace house<br>- Detached house | <br>€1,600<br>€2,200<br>€2,400 |
| Wall insulation - external<br>- Apartment (any) or mid-terrace house<br>- Semi-detached or end of terrace house<br>- Detached house | <br>€2,750<br>€4,500<br>€6,000 |
| Heat pump systems (available from 16 April 2018)<br>- Air to water<br>- Ground source to water<br>- Exhaust air to water<br>- Water to water<br>- Air to air | <br>€3,500<br>€3,500<br>€3,500<br>€3,500<br>€600 |
| Heating controls upgrade | €700 |
| Solar water heating | €1,200 |
| Bonus payment after 3rd measure | €300 |
| Bonus payment after 4th measure | €100 |
| A BER assessment after works are done (maximum of 1 grant payable per home) | €50 |

*Figure 36: SEAI BEH Fund*

## 13.5 State Grant Funding Opportunities

The below agencies offer a range of grant aids to organisations involved in improving energy efficiencies.

- SEAI
    - EXEED (Excellence in Energy Efficient Design) - incentivise companies to demonstrate excellence in undertaking energy efficient projects. Further details here.
    - Project Assistant Grant - designed to help companies and organisations evaluate energy efficiency opportunities by funding a feasibility study. Further details here.

- EPA grant
  - Green Enterprise - Grant aid provided to demonstration type projects by organisations that produce goods and provide services in more environmentally friendly ways. Further details here.
- Enterprise Ireland
  - GreenPlus Assignments - assist companies to develop and drive energy and environmental efficiencies and improve sustainability. Further details here.
  - Innovation Voucher - Funding towards collaborating with registered college or knowledge provider to explore a business opportunity or technical problem. Further details here.
  - Green Start - Grant support towards hiring an Environmental consultant/trainer to undertake in-company assessment. Further details here.
  - Commercialisation Funds - Targeted to researchers in third level institutions, non-profit research agencies and organisations . Further details here.
  - Innovation Partnership Grant Programme - Grant aid providing up to 80% of the cost of research work to develop new and improve products, processes, services or generate new knowledge. Further details here.
- NTMA
  - Ireland Energy Efficiency Fund - Energy efficiency funding for larger projects. Further details here.
- Department of Rural and Community Development
  - LEADER Programme – grant aid with a number of themes around community and local business development. Renewable energy is a specific theme for grant funding to both communities and businesses. Further details here.

## 13.6 Matching Funding Opportunities

There are numerous institutes that offer funding to community organisations for SEC work. A brief list of these is outlined below.

- Credit Unions have expressed their willingness to lend to community groups for energy efficiency projects.

- Clann Credo offer loans for community, voluntary and charitable organisations throughout Ireland. They have €10 million to lend to communities involved in climate projects.

## 13.7 Alternative Funding Opportunities

There are some interesting approaches to financing energy efficiency projects throughout Europe and Ireland. A brief summary of these is outlined below;

- Energy Performance Contracting (EPC) or ESCO funded upgrades involve an external organisation financing energy upgrades and the company or organisation repay the ESCO through energy savings. The IEA highlighted this as an excellent way to fund projects with only a small number of ESCO companies presently working in Ireland.

- Pay and Save initiates are a way for residential sectors to save energy like the EPC/ESCO model above but on a smaller scale. Minister Bruton has announced his intention to make money available for this type of scheme as Ireland will not achieve our targets to retrofit the housing stock of Ireland through the proposed methods in the next decade.

- The Innovation Fund is intended to be a key funding instrument for delivering the EU's economy-wide commitments under the Paris Agreement and in support of the European Commission's strategic vision of a climate neutral Europe by 2050. The Innovation Fund along with the EU Emissions Trading Scheme (ETS) will provide long-term incentives for deployment of innovative technologies required to deliver the EU's low carbon transition.

Funding for the Innovation Fund will derive from revenues raised by the EU Emissions Trading System (EU ETS), the world's largest carbon pricing system, and any unspent funds from the NER300 programme.

The Innovation Fund is likely to have a value of approximately €10 billion, depending on the level of the ETS carbon price over the period 2020 to 2030.

The Innovation Fund will support projects in the following areas:

- Innovative low-carbon technologies and processes in energy intensive industries, including products substituting carbon intensive ones.
- Carbon capture and utilisation (CCU).
- Construction and operation of Carbon capture and storage (CCS).
- Innovative renewable energy generation.
- Energy storage.

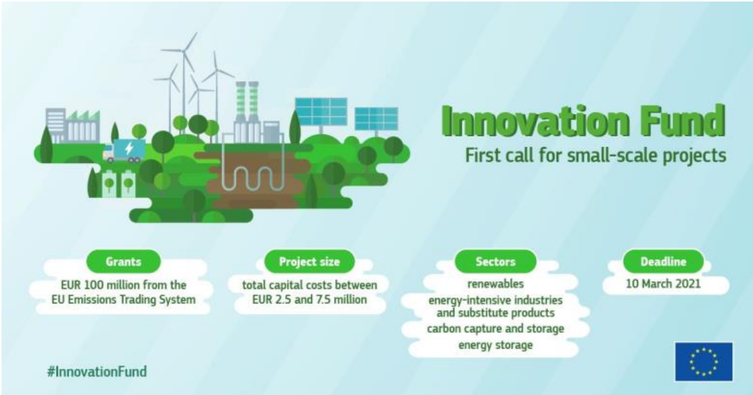



*Figure 37: Innovation Fund*

## 14 Register of Opportunities

The Register of Opportunities is included as part of this report. It is a working document in Excel that can be updated as new opportunities arise by the group. This register will include potential approaches to reduce energy use in the study area and can be used as examples for further opportunities. This will be a guiding document that will be updated as new applicable opportunities arise and can be amended as circumstances change.

## 15 Conclusion

A wide range of energy saving opportunities have been identified through this Energy Master Plan study of Árainn Mhór. The drive and ambition of this very active and engaged Sustainable Energy Community will now have the knowledge to better understand how to make the journey toward reducing their carbon footprint of the island, from the initial steps of engagement, to improving energy efficiency and how to also progress toward more self-sufficient practices to regenerate finance to help support this transition for the benefit of the region.

This Energy Master Plan can be used as a guiding document to facilitate the move from fossil fuel intense energy sources to renewable and sustainable energy from the ground up. It can be used as a framework for initiatives from small cultural changes to more ambitious larger scale approaches. The Register of Opportunities gives specific examples of projects that can be implemented in the short and longer term. The island of Árainn Mhór has immense potential and ample natural resources, from renewable energy to an enthusiastic population which will lead the charge for sustainable energy use.

There are excellent examples of work that has been carried out so far on the island. The energetic and vibrant community in Árainn Mhór have endless capabilities to transition effectively to a lower carbon and energy efficient community