



FROM MASTER PLAN TO IMPLEMENTATION: CO-CREATING COMMUNITY-LED ENERGY SOLUTIONS FOR ERRIS

International Community Energy Project 2026



Organized by the Department of Sustainable Energy & Development

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EXECUTIVE SUMMARY

The International Community Energy Project (ICEP), hosted by the Erris Sustainable Energy Community (Ireland), is executed to enable community-led co-creation of sustainable energy solutions for the Erris region based on the masterplan drafted in 2022. This report is a conglomeration of the activities pertaining to the major themes – restoration of the hotel swimming pool through renewable energy solutions, site suitability study, and system designs for community-owned solar and wind farms (below 5 MW), sustainable energy-based solutions for St. Brendan's College, and formulation of implementation strategies for these proposed projects. This is a community-driven initiative, designed to help the region attain fossil independence and transition to sustainable energy-based autonomy. The project aims to move from a purely technical strategy to community-led action with the focus areas of community empowerment, emission reduction, and developing visible landmarks. A phased approach based on five decision lenses – namely, environmental, social, financial, practical, and technical is used to prioritize the identified opportunity themes. A realistic roadmap can be proposed for the Erris region to become a leader in community-driven sustainable energy.

ABOUT ICEP

The International Community Energy Project (ICEP) is a 5-credit module within the Sustainable Energy and Development Master of Engineering programme at Europa-Universität Flensburg.

ICEP moves beyond the traditional classroom setting by engaging students directly with real communities and real societal challenges. Through this practice-oriented module, students apply their theoretical knowledge in real-world contexts while developing essential competencies in research, project management, stakeholder engagement, and interdisciplinary collaboration. Working under real-life constraints, they learn to co-create feasible and context-sensitive energy solutions together with local actors.

For more information about the ICEP module and previous projects, please visit:

<https://www.uni-flensburg.de/sedev/academics/icep-module>

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1. Background and Motivation

1.1. The context of Erris SEC

Erris is a rural region covering approximately 850 km² along the north-western seaboard of County Mayo, with a population of around 10,000, making it one of the lowest population density areas in Western Europe. Known for its strong Atlantic winds and outstanding natural beauty, Erris also faces significant structural energy challenges. The region is not connected to the national gas network, and most households rely heavily on solid fossil fuels such as peat, coal, oil, and timber for heating and cooking. This dependence results in high and volatile household energy costs, increased fuel poverty risks, and negative impacts on local air quality and the environment. Despite hosting abundant renewable energy resources, approximately €29.4 million leaves the local economy each year to pay for imported fossil fuels.

In response, the Sustainable Energy Authority of Ireland (SEAI) established the Sustainable Energy Community (SEC) program to ensure that the community directly benefits from its natural wind and solar resources through local ownership, improved living standards, and economic retention. Historically, renewable development in the region primarily benefited external developers. The SEC seeks to reverse this dynamic by promoting community participation, shared ownership models, and reinvestment of revenues locally. At the same time, SEAI and the SEC act as facilitators, helping residents navigate grants, connect with trusted contractors, and access funding for home energy upgrades, so that the clean energy transition leads to warmer, healthier, and more affordable homes (SEAI, 2026).

Besides the SEC program, SEAI has also worked on the Erris Energy Master Plan, which provides a foundation for this transition. It identifies the residential sector as the dominant energy consumer, accounting for approximately 66% of total energy use, largely due to poor building performance and a high Heat Loss Index (HLI) across much of the housing stock. The Master Plan sets an ambitious target of reducing CO₂ emissions by 30% by 2027, aligned with Ireland’s national climate objectives. However, financial, technical, social, and institutional barriers remain significant, making structured and inclusive implementation essential (SEAI, Erris Sustainable Energy Community, Plan Energy, 2022).

For too long, the wind has been a source for external developers. The SEC’s mission is to empower the communities.

1.2. Project Purpose

To move from strategy to action, this project adopted a participatory co-creation approach involving community workshops, door-to-door surveys collecting real energy bill data, stakeholder meetings with local representatives, contractors, public institutions, transport providers, and developers, as well as site visits and expert consultations. This engagement revealed that affordability is the primary concern for residents, alongside strong support for rooftop solar and conditional acceptance of wind energy, particularly where community ownership ensures tangible local benefits. Residents also emphasized the importance of storm resilience, grid reliability, and trusted guidance throughout the transition.

Based on this process, two broad implementation pathways were identified: individual household measures and community-scale projects, covering 17 opportunities across residential retrofitting, renewable generation, transport, and grid infrastructure. Recognizing capacity and funding constraints, the scope was strategically refined in consultation with the SEC. The ICEP 2026 SEDev team focused on three priority areas: (1) developing a solar-powered community swimming pool as a visible landmark project, (2) assessing the feasibility of community-owned wind and solar under existing grid constraints, and (3) strengthening the network and

practical delivery mechanisms of community energy. Together, these actions translate the Energy Master Plan from a technical document into a phased, community-driven roadmap, providing Erris a realistic implementation pathway for the energy transition.

1.3. Stakeholders Perspective

Table below shows the list of the most relevant stakeholders, and brief information of the consultations held throughout the project period.

Table 1 Stakeholders perspective

Stakeholders Meetings	
Erris SEC (Dr Orla Nic Suibhne)	SEAI Community Mentor for Co Mayo. Representing sustainability leadership, defining the core vision and stability of the project goals.
Erris Action Group	A meeting was held to understand the root causes of opposition to wind farms and learn from previous negative experiences between the community and developers.
BnM - Oweninny Wind Farm	Site visit to the developer's center to understand the project from an operational and industrial perspective.
Churchfield Home Service - One Stop Shop	Meeting to understand available retrofit solutions, specific SEAI grants, and strategies for raising community awareness about home upgrades.
Informatics Research Unit for Sustainable Engineering (IRUSE)	Consultation with the Energy Research Center to gain technical insights on heating systems and sustainable technologies with relevant case studies on Small Islands.
Kitepower	Gaining insights into emerging high-altitude wind technologies (Airborne Wind Energy). Note: Acknowledged as pre-commercial/under development.
Claremorris and Western District Energy Co-Op.	A study of a planned community-owned solar farm to understand the stages of development, "test bed" data, and the reform process required for community energy.
Solar West	Meeting with a specialist contractor focused on domestic and non-domestic solar projects. This provided insights into cost estimations for non-residential builds.
Local Link	Discussing the current transportation solutions in the area and their roadmap for "going green" to reduce private car usage.

1.4. Methodology: Co-creation approach From Wishes to Implementation Roadmap

To include the community's views and validate the methodology, door-to-door surveys were conducted, meetings with stakeholders were held, and three workshops were organized. The workshop's description is presented below.

Table 2 Workshop description and activities

Workshops			
	Workshop 1	Workshop 2	Workshop 3
Date	31 st January, 2026	7 th February, 2026	14 th February, 2026
Objectives	This workshop is to understand the Erris context, including energy concerns, household comfort, and community support or concerns regarding renewable energy.	The process collected community preferences for projects and validated the decision-making criteria and social indicators.	The roadmap for the opportunity themes is presented, detailing all the projects and gathering feedback from the community.
List of Activities	Put your home on the map Story circles ("Last winter + problems") Bill thermometer (Comfort survey printed) Energy on our Land	Wish Wall (17 Opportunity themes) The Token Vote The Golden Ticket Red Flag / Green Flag	Wish wall ideas + RoadMap Community Swimming Pool Heating Community-Owned Solar Farm Community-Owned Wind Farm St. Brendan College Solar PV project
Number of participants	6	6	21

We began by utilizing Workshop 1 to gather broad inputs from residents regarding their daily struggles. The goal was to understand the "real-world" context, cold homes, high bills, and infrastructure anxiety, rather than starting with technical solutions. This allowed us to scope down the vast field of renewable energy into specific Areas of Interest that mattered to the locals.

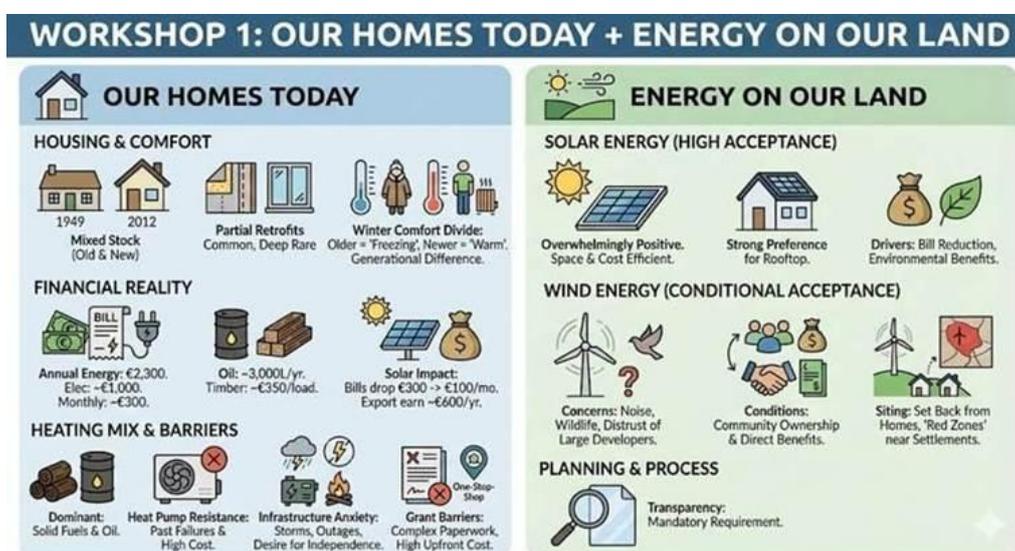


Figure 1 Workshop 1: Our homes today + Energy on Our Land

In Workshop 2, participants moved from identifying problems to generating solutions. They shared their ideas on flipcharts, producing 44 initial suggestions, which were then grouped into five categories and analyzed for feasibility, resulting in 17 refined ideas. Theme 3: Community Power Landmarks focused on technical and financial aspects (Section 3), while Themes 1, 2, 4, and 5 focused on implementation (Section 4). All projects were evaluated, sequenced, and ranked using the same criteria. The themes and their corresponding ideas are listed below.



Figure 2 Opportunity themes

1.5. Survey Results

To supplement information gathered during the workshops, to ensure inclusive participation for those unable to attend in person, and to reach a larger share of the population, we conducted a targeted survey that received 23

detailed responses. This data was essential for verifying our base data and providing additional input for the Decision Lens indicators. The survey showed that Home Heating Oil and Solid Fuel (Coal/Peat) are the most common fuel sources for the vast majority of households. Financial barriers emerged as a significant hurdle, with over **45%** of respondents highlighting high upfront capital expenditure (CAPEX) as the main reason for delaying deep retrofits. Additionally, the data indicates the community's vulnerability to regional infrastructure issues, as a majority reported experiencing power cuts, particularly during the winter months and during storms. Despite these challenges, there is a strong social license for the transition; nearly all respondents expressed a high willingness to participate in community energy projects, provided that funding remains accessible through government grants and that the long-term benefits are retained locally.

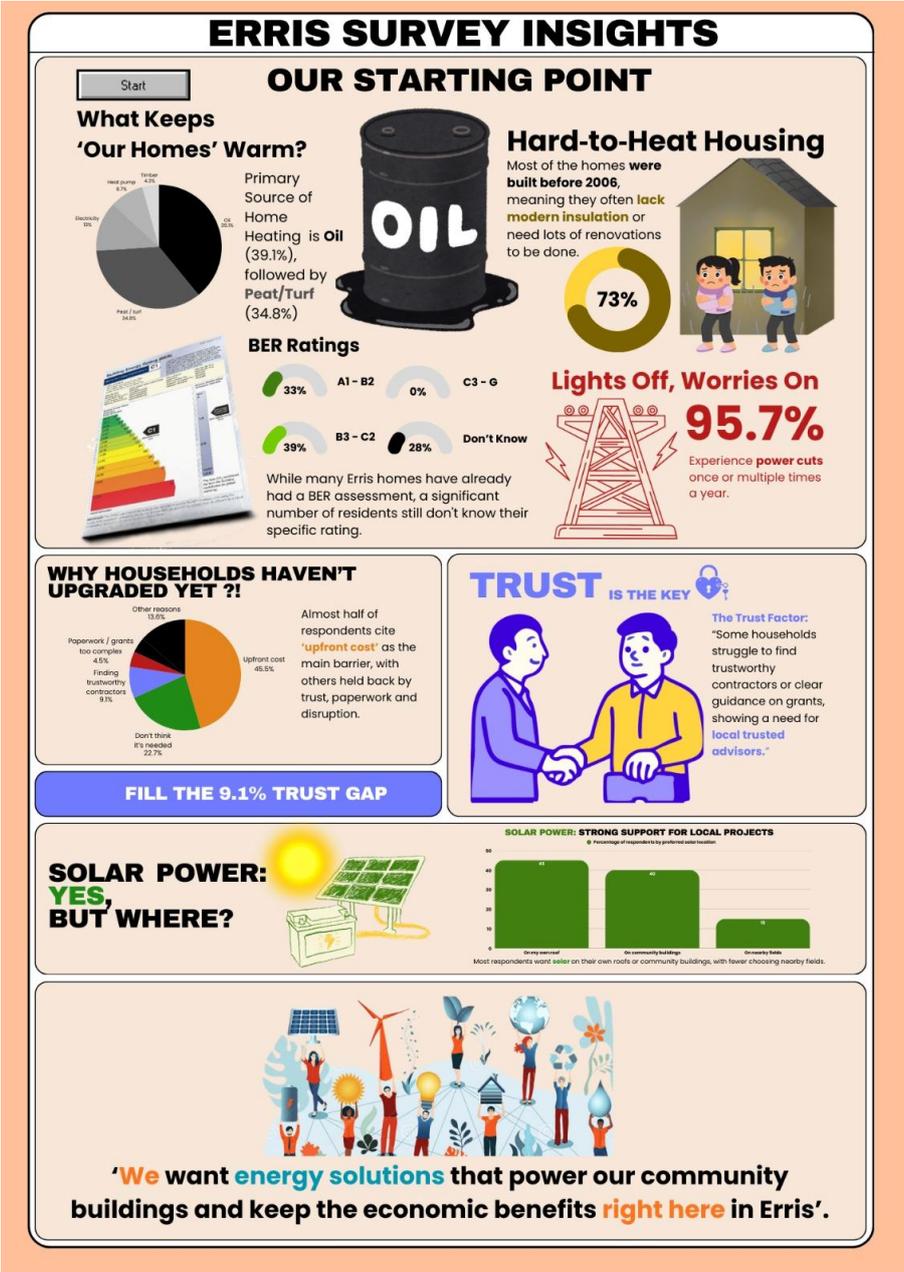


Figure 3 Erris survey insights

2. Indoor Swimming Pool reopening with energy optimization - Broadhaven Bay Hotel

2.1. Project Objective

The objective of this study is to evaluate the feasibility of reopening the indoor swimming pool for the community under economically sustainable operating conditions by analyzing its energy demand and identifying a suitable low-cost and low-carbon heating solution. The indoor swimming pool was closed after 2019 due to high operational costs, primarily driven by energy expenditure required to maintain water temperature and space heating. Rising electricity and fuel prices made the existing heating arrangement financially unsustainable. Based on a detailed energy demand model, different energy supply options are assessed, including solar photovoltaic generation to run heat pumps, and alternative fuel-based heating solutions. Each option is compared in terms of required system capacity, annual energy consumption, operating cost, and overall lifetime cost.

The purpose of the study is to determine the combination of technologies that can reduce energy-related operating costs and cost volatility while remaining practical to operate in a community-used facility, thereby supporting a stable and sustainable reopening of the swimming pool.

2.2. Heating System

This study estimated how much heat the indoor swimming pool complex needs and compared it with the recorded fuel consumption. The goal was to understand where the energy is really going and whether the current heating system size and operating costs make sense.

Unlike normal buildings, a swimming pool is heated to a constant, high temperature 24 hours every day. The water surface constantly releases moisture into the air, and that moisture must be removed, and the air reheated to keep the building comfortable and safe. Because of this, a pool behaves more like a humid climate system than a typical heated building.

The analysis shows that the largest heat loss occurs through the evaporation from the pool water. Even if the walls were perfectly insulated, the building would still consume a large amount of heat because water continuously evaporates. This happens day and night, and even when nobody is swimming. Losses through the building envelope are comparatively small. Improving insulation helps during cold days but does not significantly reduce yearly heating use. Hot water for showers is also important, but less so than evaporation.

2.2.1. Demand Estimation Methodology

2.2.1.1 Total heat demand

A model has been developed that estimates how much heat is needed each hour of the year to run the facility, focusing on three main uses.

- Heat lost through the pool water
- Heat lost through the building envelope
- Hot water for showers and sink

The model then identifies:

- Annual heat demand (sum of all hours)
- Peak demand (highest single hour)

This model estimates hall heat loss hour-by-hour based on outdoor temperature, building heat-loss factors, and ventilation. Annual hall-related heat demand is estimated to be 92,234 kWh. Table 3 shows what drives the hall demand, expressed as percentages of the annual hall total:

Table 3 Heat loss estimation

Driver	Annual energy (kwh)	%
Hall fabric loss	77,893	84.4%
Ventilation and Infiltration	21,587	10.8%
Distribution loss	4,392	4.8%

The pool model calculates the heat needed to keep the pool at the set temperature. The biggest driver is evaporation (water leaving the surface as vapour), which increases when the pool is in use. It applies to opening hours and activity. The Activity factor is classified into 3 constants based on working hours and peak times. Annual pool heat demand in the model is 485 MWh. Peak pool heat demand in the integrated Main model is 80.3 kW.

The shower model estimates hot-water energy based on mains water temperature, energy per shower, and the number of showers per hour. Annual shower/washbasin hot-water demand in the integrated main model is 62,060 kWh. Peak shower hot-water demand is 21.1 kW (kWh in that hour).

Table 4 Heat demand calculations

Types	Annual heat MWh	%
Pool heating	485.26	75%
Hall heating	92.23	14.2%
Showers	63.06	10.8%

The heating demand calculation is based on a number of fixed design constants. These are necessary because the purpose of the model is to predict future controlled operation of the building rather than reproduce past behaviour. The model assumes a stable temperature control, constant indoor controlled humidity, and defined opening hours. The updated calculation includes the installation and use of a pool cover outside operating hours. The cover substantially reduces evaporation during closed periods, which has a meaningful impact on annual energy demand. The hourly pool heat demand was first calculated without a cover using the evaporation-based heat-loss model. A reduction factor was then applied during non-operating hours to represent the insulating and vapour-barrier effect of the pool cover.

An evaporation reduction of **85%** was assumed when the cover is in place. Therefore, the covered-period heat demand was calculated as:

$$\text{Covered pool heat demand} = \text{Uncovered pool heat demand} \times (1 - 0.85)$$

This reduction was applied only during the defined closed hours of operation. During opening hours, the pool is uncovered, and the full evaporation heat loss is used.

Estimated heat demand:

- About 640 MWh per year total heat use
- With pool cover: about 527 MWh per year

The pool cover, therefore, reduces total demand by about 20% and reduces evaporation losses by about 70% during non-opening hours.

This confirms that covering the pool when unused is one of the most effective energy-saving measures available. While the pool cover reduces annual energy use, it does not significantly reduce the peak heating load that determines equipment sizing. The heating system must still be capable of meeting the highest hourly demand when the pool is open and in full use. Pipes in technical rooms and underground circulation continuously emit heat. Because the plant operates 24/7, these losses accumulate significantly over a year and are accounted separately as 5%.

2.2.1.2 Implications for future heating systems

Most energy savings come from controlling evaporation, not from insulating the building further. Operational improvements may reduce consumption significantly without changing the building. Heat pumps or alternative systems should be evaluated using useful heat demand, otherwise they may be incorrectly sized.

The peak hourly demand defines the nominal capacity of the heat pump, ensuring it can cover the maximum load during winter. The heat pump operates with a coefficient of performance (COP) of 3.68 to reduce the required electricity for heating.

Values below are derived from the Hall loss, swimming pool, and shower calculations (SCOP, annual electricity use, and thermal/electrical size outputs).

Table 5 Annual electricity use

Heat pump	Thermal size (kWth)	Electrical size (kWel)	Annual HP electricity (kWh)	SCOP (kWth/kWel)
Hall space heating	18.26	5.23	26,485	3.68
Pool heating heat pump	80.3	21	131,865	3.68
Shower DHW heat pump	45.36	15.64	21,743	2.9
Total	141.88	41.87	180,093	-

- Hall heat pump: sized around hall peak 18.26 kW
- Pool heat pump: sized around pool peak 80.3 kW
- Shower/DHW heat pump: sized around shower peak 45.36 kW

Once the heating demand is known, different heating systems are compared by converting the heat demand into energy input:

- Boilers: $\text{fuel required} = \text{heat demand} \div \text{boiler efficiency}$
- Heat pumps: $\text{electricity required} = \text{heat demand} \div \text{COP}$

Assumption

Table 6 Key assumptions to build the model and estimate energy demand

Parameters	Value	unit	Sources
U values	Wall -0.651 window- 1.4, roof- 0.2	w/m2k	Designing buildings, 2023
Pool activity factors	Base-1.25 Off – 0.75 Peakttime 2		(ASHRAE, n.d.)

Peak hours	10	Hours/peak	assumption
Number of people (Shower)	Shower-120 Peak – 25 per hour Washbasin- 200 Peak- 50	numbers	assumption
Air Handling Unit	Working hours- 0.4 Closing- 0.2		Innovant, 2022
Pool cover	85	%	(DOE, n.d.; ASHRAE, 2019)
Air velocity over the pool	0.23	m/s	(E3S Conferences, 2022)
Weather data	Hourly annual Ambient temperature	Degree celsius	(Government of Ireland, n.d.)
Air and water Saturation Vapour Pressure	Tetens eq.	kPa	(Monteith & Unsworth, 2013)
Heat Pump SCOP	Medium – 3.68 High - 2.9	KWth/kWel	(SEAI, n.d.-b)
ASHRAE Equation	$\dot{m}_{evap} = A_{pool} \cdot (p_w - p_a) \cdot (0.089 + 0.0782 \cdot v) \cdot AF$		(IBPSA, 2018)

2.2.2. Model limitations

This is a physics-based model based on weather data. As evaporation is mainly activity-based, assumptions have been made based on the literature. The evaporation rate is estimated using typical activity patterns based on the literature of indoor swimming pools, not measured humidity control data or actual usage by consumers. Pool geometry, indoor temperature setpoints, operating schedules, shower usage rates, system efficiencies, and cost parameters are on-site survey values. All non-public inputs are replaced using measured data obtained during site visits and stakeholder interviews. Hourly outdoor air temperature data are taken from a publicly available weather dataset for Belmullet, Ireland. The building physics are simplified and do not simulate real-time humidity control behaviour. These data are used consistently for the calculation of building heat losses, heat pump performance, and mains water temperature estimation. Heat recovery systems and control strategy details are not fully represented. Future changes in usage, visitor numbers, or equipment aging are not included. Physical constants such as water density, specific heat capacity, and latent heat of vaporisation are taken from standard thermodynamic references. The literature-based assumptions are expected to vary highly from actual usage in Belmullet.

Key takeaway

Indoor pools mainly consume heat because water evaporates, not just because the building leaks heat. Using a pool cover and improving operation can reduce energy use significantly. Alternative heating technologies should be sized after thoroughly comparing the available technologies.

2.3. Energy demand modeling

To understand how much energy the swimming pool building requires each year in Ireland, a digital heat loss model of the pool hall was developed using professional building simulation software (DesignBuilder 2025.1). The purpose of this modelling exercise was to estimate the annual energy demand of the facility and to identify which elements of the building are responsible for most of the energy consumption.

The digital model represents the actual pool hall in three dimensions. It includes the size of the building, the materials used in the walls and roof, the windows, the internal air temperature, the pool water temperature, and the ventilation system. Local weather data from IWECC / IWECC2 for Belmullet were applied in order to reflect the real climate of the west of Ireland, including wind exposure and outdoor humidity levels.

One of the most critical aspects of modelling an indoor swimming pool is the accurate representation of evaporation from the pool surface. Warm pool water continuously evaporates into the surrounding air, generating a significant latent moisture load. This moisture must be removed by the ventilation and dehumidification system in order to maintain acceptable indoor humidity levels and prevent condensation-related damage. The removal of latent moisture requires substantial energy input, and this process is widely recognised as the principal driver of energy consumption in natatorium facilities compared to conventional buildings. Accordingly, the model incorporated the pool surface as a continuous moisture source to reflect realistic operational conditions. This modelling approach is consistent with established guidance provided in the ASHRAE Handbook—HVAC Applications (Natatorium Design Chapter) and CIBSE Guide B: Heating, Ventilating, Air Conditioning and Refrigeration, both of which identify evaporation control as the dominant energy consideration in indoor swimming pool environments (ASHRAE, 2019; CIBSE, 2016).

The simulation results indicated an annual heat and electricity demand of approximately 700 megawatt hours (MWh) under standard operating assumptions. Historical energy bills for the facility indicated consumption of approximately 808 MWh per year. The difference between these values can reasonably be explained by variations in operating hours, system control performance, and real-life inefficiencies that are difficult to fully capture in simulation. Further work is required to reduce this discrepancy.

Most importantly, modelling confirmed a key conclusion: the majority of the energy demand does not come from heat loss through the building envelope, such as walls or the roof. Instead, it comes from moisture removal, ventilation, heating, and pool water heating.

In practical terms, the swimming pool hall is a building where energy consumption is determined primarily by the operation of its technical systems rather than by the thickness of its walls. The majority of the energy demand arises from managing air humidity, maintaining water temperature, and continuously ventilating the space to ensure comfort and prevent condensation.

This is consistent with established industry guidance. According to the ASHRAE Handbook—HVAC Applications, latent heat associated with evaporation typically represents the largest single component of total heating demand in indoor pools, often accounting for approximately 50–70% of the total thermal load under normal operating conditions. Ventilation, air heating, and pool water heating together generally constitute a further significant portion of demand. By contrast, transmission losses through walls, roof, and glazing commonly represent a comparatively smaller share of total energy consumption in properly heated natatorium buildings.

In other words, while insulation quality remains important, the dominant energy drivers in indoor swimming pool facilities are moisture control, air treatment, and water heating. For this reason, system optimisation delivers substantially greater impact than envelope upgrades alone.

This understanding guided the retrofit strategy. Rather than focusing on expensive structural alterations, the emphasis was placed on upgrading mechanical systems and improving heat recovery performance.

The DesignBuilder model incorporated the principal architectural, thermal, and operational parameters governing building performance. These included geometrically scaled drawings; detailed construction assemblies for walls, roof, and glazing; representation of the existing air and water heating systems; mechanical ventilation and dehumidification configurations; internal activity profiles; occupancy density; operational schedules; and building orientation relative to solar exposure. Together, these inputs ensured a thermodynamically coherent simulation framework reflecting both physical fabric characteristics and real operational behaviour.

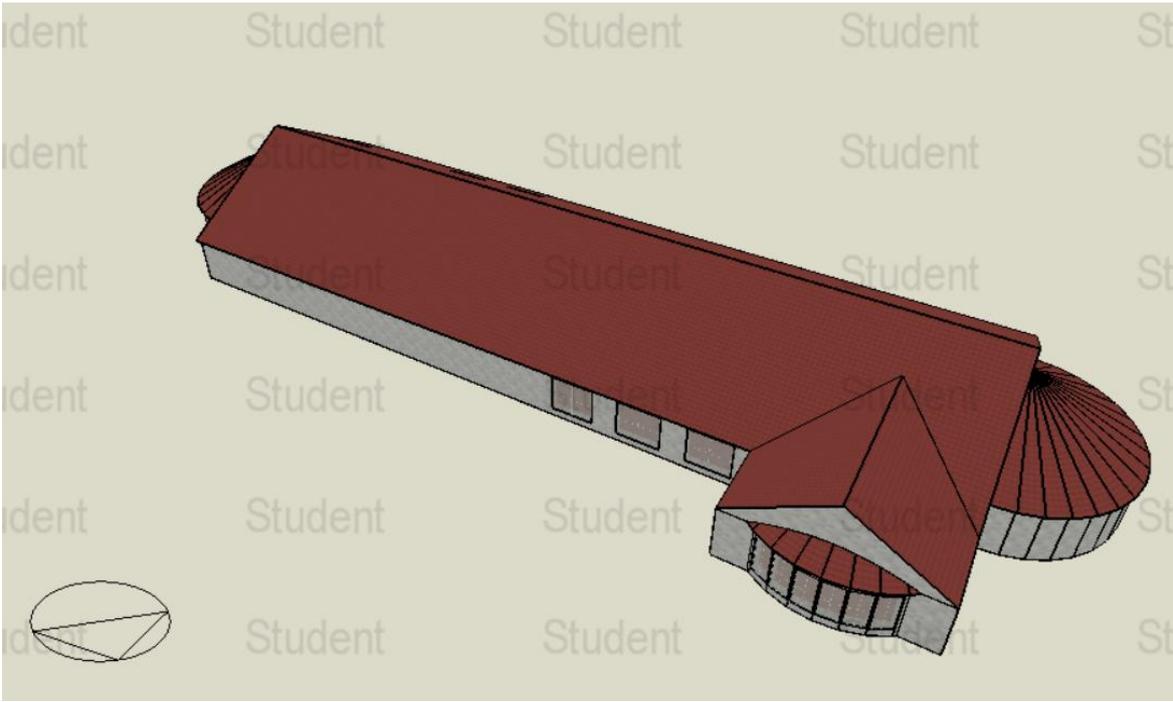


Figure 4 3D view of the DesignBuilder model

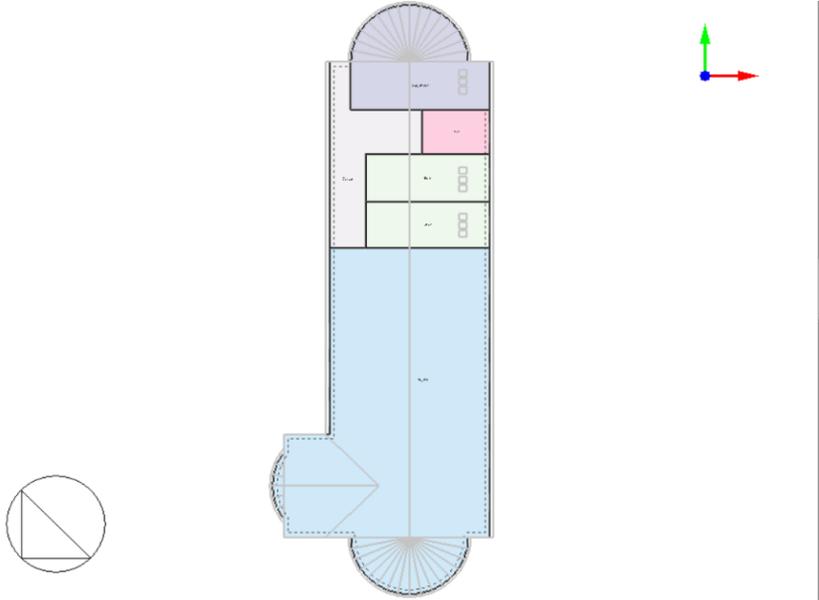


Figure 5 Zoning view showing pool hall as the primary conditioned zone

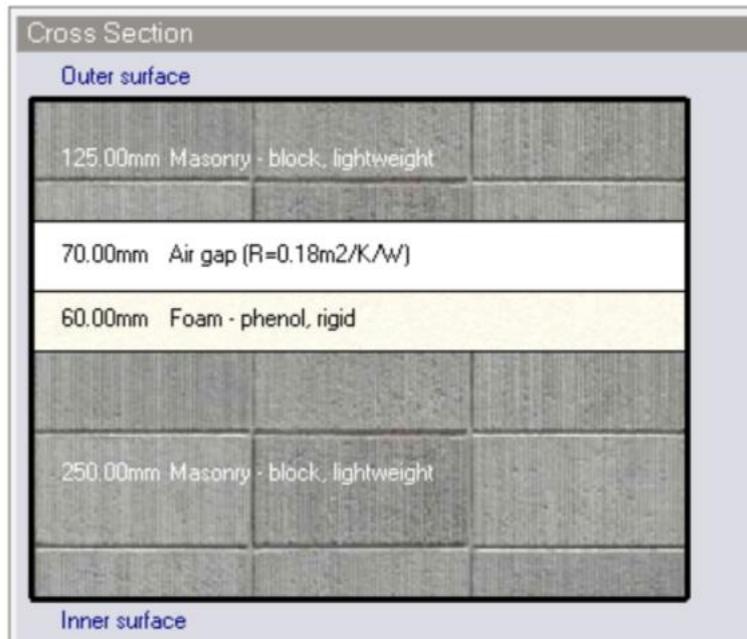


Figure 6 Wall construction view

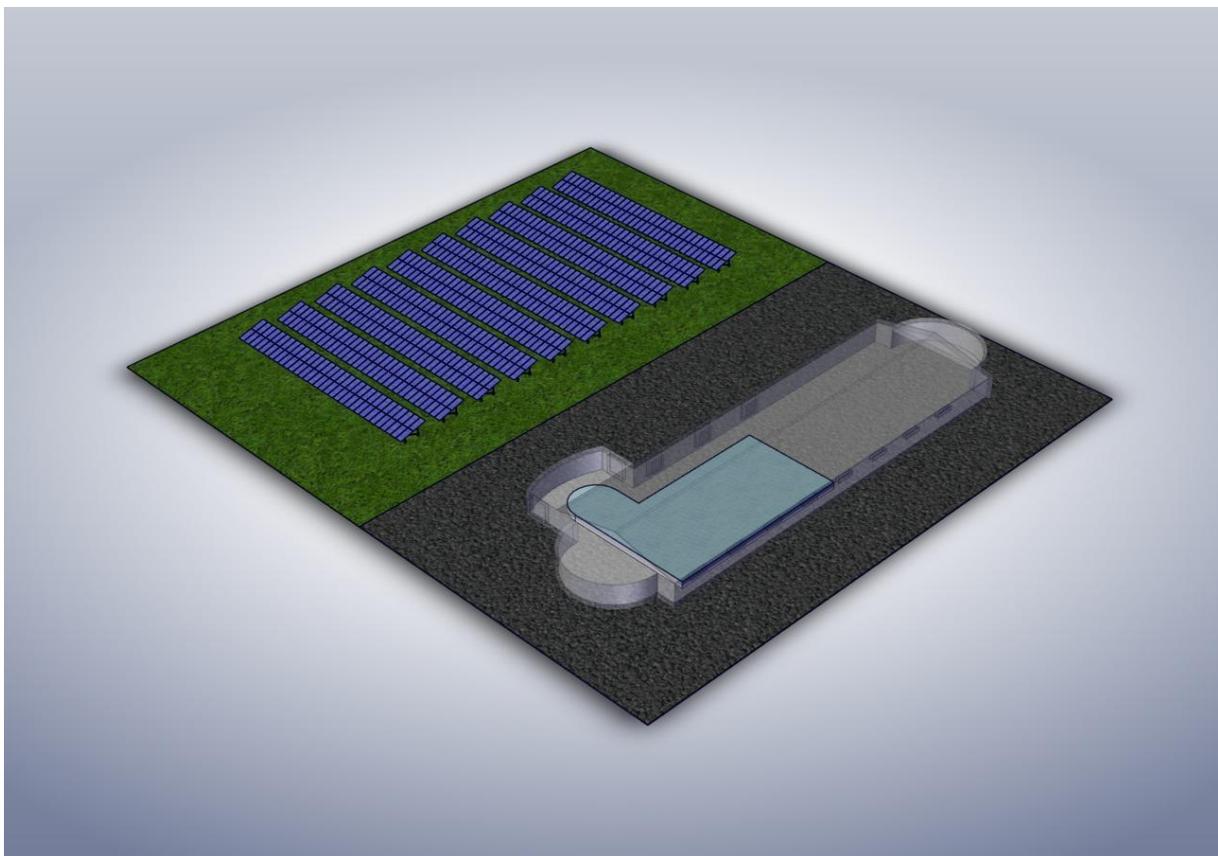


Figure 7 3D Illustration for the building and proposed solar system

2.4. Retrofitting options and system sizing

Based on the modelling results and engineering assessment, the most effective path to reducing energy consumption is through system optimization rather than major structural refurbishment.

The first area addressed is pool water heating. The existing system of LPG boilers is replaced with modern air-to-water heat pump technology. The proposed system utilises an electrically driven vapour-compression cycle to upgrade low-grade ambient thermal energy to a useful temperature level suitable for space and water heating applications. In Ireland's maritime climate, this technology performs efficiently because outdoor air temperatures are relatively moderate throughout the year. The system is sized to match the steady heat losses from the pool, including evaporation, transmission through the pool structure, and pool make-up water. This approach significantly reduces primary energy demand compared to traditional fossil-fuel systems.

A separate heat pump system is proposed for domestic hot water production. This serves showers, washrooms, and other ancillary facilities. By separating domestic hot water production from the main pool heating loop, the system achieves both operational flexibility and thermodynamic efficiency. A primary technical reason for this separation lies in the differing temperature requirements of the two systems. Pool water is typically maintained at approximately 28–29°C, whereas domestic hot water must be delivered at significantly higher temperatures, approximately 58–60°C, to meet hygiene and safety standards. In the existing configuration, conventional boilers operate at elevated temperatures and subsequently blend hot water with cooler pool water, resulting in inherent efficiency losses. In contrast, dedicated heat pumps can be designed to supply each circuit at its required temperature level. By delivering heat precisely at the target temperature rather than generating excess high-temperature heat and diluting it, the system operates at higher seasonal performance factors and improved overall efficiency.

The central element of the upgrade is the installation of a modern natatorium air handling unit. This unit is specifically designed for indoor swimming pools. It removes moisture from the air using a cooling coil, then captures the rejected heat from that process and uses it to reheat the supply air. In simple terms, the system recovers heat that would otherwise be wasted. This internal heat recycling significantly reduces the overall heating requirement.

Because much of the pool hall heat is already being reused through the dehumidification process, there is no strong technical justification for deep structural retrofits such as extensive wall insulation upgrades. The building's main energy challenge lies in managing humidity and ventilation efficiently. By modernizing the HVAC systems, the building achieves substantial performance improvement without disruptive structural intervention.

One targeted building improvement is the replacement of a large, glazed section on one façade. The existing glazing is assumed to have relatively high heat loss compared to modern standards. Upgrading to higher-performance glazing improves local comfort conditions near the windows. This ensures that occupants standing close to the façade do not experience cold draughts or discomfort, even though the overall building temperature remains controlled. This measure enhances comfort and indoor environmental quality rather than serving as the primary energy-saving intervention.

With the proposed system upgrades in place, the projected annual final energy consumption is reduced to approximately 300 MWh per year, which is 62% lower compared to the 2019 data. This represents a major improvement compared to historical operations. The reduction is achieved through:

- High-efficiency heat pump technology,
- Heat recovery within the dehumidification process,
- Improved control of humidity and ventilation,
- Targeted glazing upgrade for comfort enhancement.

The retrofit strategy, therefore, focuses on intelligent system design rather than heavy construction work. It delivers substantial energy reduction while maintaining indoor comfort and operational reliability. The approach

is technically sound, economically rational, and aligned with modern best practice for indoor swimming pool facilities operating in coastal Irish climates.

2.5. Solar PV System Assessment

2.5.1. Modelling Approach

The solar photovoltaic (PV) systems were simulated using PVsyst software. Two technical configurations were assessed for the leisure centre:

- A rooftop PV system installed on the south-west facing leisure centre roof (azimuth 225°).
- A ground-mounted PV system with optimal south-facing orientation (azimuth 180°).

Table 7 Comparison of ground-mounted and rooftop PV systems

Parameter	Only Pool Roof	Ground Mount
PV modules (pcs)	240	576
Panel rating	450 W	450 W
Installed AC capacity	108 kWp	259 kWp
Inverters	40kW×2	4
Tilt angle	30°	30°
Azimuth	SW (225°)	South (180°)
Tracking	Fixed	Fixed
Annual AC generation	87,487 kWh	253,480 kWh
DC/AC ratio	1.35	1.29
Specific yield	810 kWh/kWp	978 kWh/kWp

The ground-mounted system significantly outperforms the rooftop option. This is primarily due to its optimal south orientation, lower shading risk, and higher specific yield (978 kWh/kWp compared to 810 kWh/kWp).

The rooftop system is constrained by suboptimal orientation and limited available surface area, which restricts installed capacity and reduces annual output. In both systems, the 450 W module was selected due to its widespread availability, ensuring ease of procurement, maintenance, and potential future expansion.

Given the projected annual electricity demand after electrification (approximately 287 MWh/year), the 259 kWp ground-mounted PV system has an estimated annual production of 253 MWh. However, due to seasonal variations between solar generation and heating-driven demand, grid imports will still be required during winter months, while surplus generation may occur during summer.

2.6. Modelled Electricity Demand and Self-Consumption

The leisure centre includes an indoor heated pool, children's pool, Jacuzzi, sauna, steam room, and spa facilities. To estimate baseline consumption, historical billing data were analysed:

- 2019: Full operation (hotel + leisure centre)
- 2023: Hotel-only operation (pool closed)

By subtracting the 2023 hotel-only demand from the 2019 total demand, the swimming pool and leisure centre electricity consumption was estimated at approximately 190 MWh/year.

Given as historical bills, after the closure of the swimming pool:

- Energy consumption of the Broadhaven Bay complex decreased by 37.3%
- However, total annual energy cost increased from approximately €170,000 (ex-VAT) in 2019 to €205,000 (ex-VAT) in 2023

Despite lower consumption, costs did not decrease proportionally because:

- Electricity prices more than doubled
- LPG prices increased significantly

Historically, the swimming pool accounted for €106,614 per year in electricity and LPG costs, based on pre-2023 energy prices. If the pool reopens with the same energy demand profile and continues to use LPG for heating, the annual energy cost is estimated to increase to approximately €160,000, reflecting current energy price assumptions. This estimate is based on an electricity grid import price of €0.30/kWh and an LPG price of €0.14/kWh.

The objective was to estimate annual electricity demand for the reopened swimming pool and associated leisure facilities using a structured bottom-up approach. The historical benchmark of 190 MWh/year was used to validate the model.

2.6.1. Modelling Approach

Rather than relying solely on historical billing data, a detailed equipment-level demand model was constructed. The 24-hour day was divided into three operational time blocks:

1. Base Hours - Night-time background load
2. Opening Hours - Standard operating period
3. Peak Hours - High occupancy / high usage periods

Each electrical device was:

- Assigned to specific time blocks
- Adjusted using a loading factor (0-1)
- Calculated based on connected capacity × operating hours × load factor

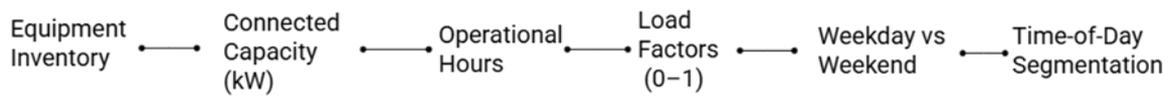


Figure 8 Part-load operation

This prevents overestimation from assuming full rated capacity at all times and reflects realistic part-load operation (e.g., cycling pumps, intermittent gym equipment use).

Following the heating system, the additional electricity demand from the pool water heat pumps and domestic hot water heat pumps was incorporated into the overall load profile.

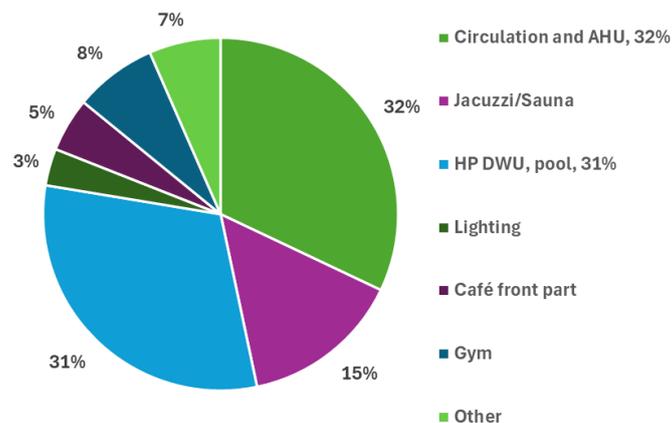


Figure 9 Modelled Energy Consumption Distribution by Category

Seasonal adjustment factors were applied to reflect higher winter heating loads and reduced summer demand. The estimated annual electricity demand resulting from electrification, including the heating formerly covered by gas boilers, is 287.3 MWh/year. Heat pumps account for approximately 31% of total projected electricity demand. This validated demand model forms the basis for solar sizing and financial evaluation.

2.7. Investment and operation cost analysis

This section evaluates the investment cost of the 259.2 kWp ground-mounted solar PV system combined with full heat pump electrification of the pool. Two cases were compared:

1. Electricity cost without solar system
2. Electricity cost with solar system

The financial analysis is based on the expected average annual solar generation of 253.48 MWh, as simulated in PVsyst. PVsyst is a widely used solar photovoltaic system modelling software that estimates energy production based on site-specific weather data, system configuration, shading conditions, and technical performance parameters.

- **Investment Overview**

The project comprises a 259.2 kWp ground-mounted solar PV system combined with full heating electrification through high-efficiency heat pumps. The total capital expenditure (CAPEX), including a 10% contingency allowance, is estimated at €386,452. For financial modelling purposes, a 40% capital grant support scenario is assumed, resulting in a net investment requirement of €231,871 over a project lifetime of 25 years. Grant

assumptions are informed by the SEAI Non-Domestic Microgeneration Grant framework, while CAPEX estimates are based on supplier quotations and industry cost benchmarks for commercial-scale PV systems.

Table 8 Solar PV CAPEX Summary

Item	Cost (€)
PV modules	€40,320
Inverters x4	€40,000
Installation	€150,000
AHU 18-20kW	€30,000
HP domestic hot water	€35,000
HP Ecodan 40kW x2	€56,000
Contingency (% of subtotal)	10.00%
Subtotal (excl. contingency)	€351,320
Total CAPEX (incl. contingency)	€386,452

- Year 1 Operating Cost Comparison**

Operating expenses are estimated by if the swimming pool operates fully on the following electrification of the heating system. Two cases were assessed; first, without a solar system, all electricity is imported from the grid. Second, with a solar system, on-site PV generation offsets grid imports, with night-consumption and surplus exported during the high-generation months.

Operating costs consist of: Variable cost (Electricity purchases from the grid), Fixed cost (Estimated at 2% of total CAPEX, routine operation and maintenance). The analysis is based on aggregated monthly energy balances, rather than hourly or time-of-use modelling. A flat electricity import price of €0.30/kWh and export tariff of €0.19/kWh were assumed. It is important to note that this is a simplified financial screening assessment; the model is based on monthly net energy values rather than hourly load profiles.

Table 9 Operating Cost Comparison Year 1

Metric	Without Solar	Solar
Var OPEX - Electricity cost (€)	€103,593	€25,759
Fixed OPEX (€)	-	€7,729
Total OPEX (€)	€103,593	€33,488
Year 1 savings (€)	€70,105	

Considering 15% of export potential improves the overall economics of the project, but this should be modelled conservatively depending on export tariff conditions. Based on annual energy savings and benefits (i.e. avoided electricity costs), the simple payback period is approximately 4.5 years.

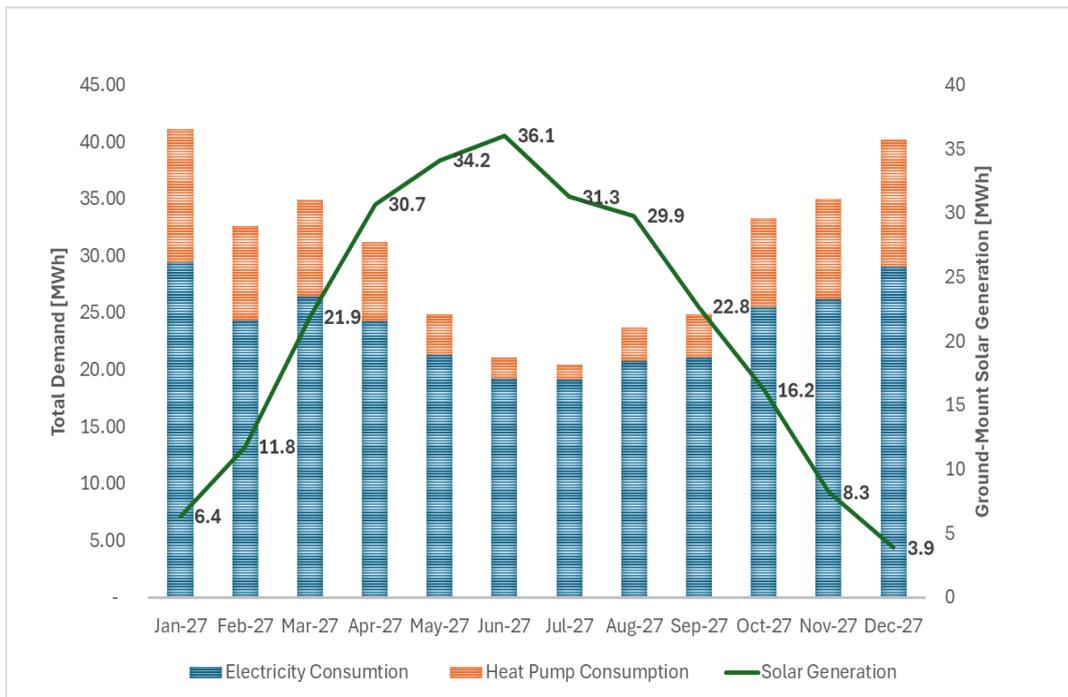


Figure 10 Monthly Modelled Electricity Demand with Heat Pump Load and Solar Generation Profile (MWh)

The figure shows the seasonal relationship between total electricity demand (including heat pump consumption) and solar PV generation. Demand peaks in winter due to increased heating loads, while solar production is lowest during this period. Conversely, solar generation reaches its maximum in summer when heating demand declines. This creates a seasonal mismatch, with higher grid imports required in winter and potential surplus generation in summer on a total monthly basis.

3. Opportunities for community scale Renewable energy projects

3.1. Resource Assessment and suitability for community-scale projects

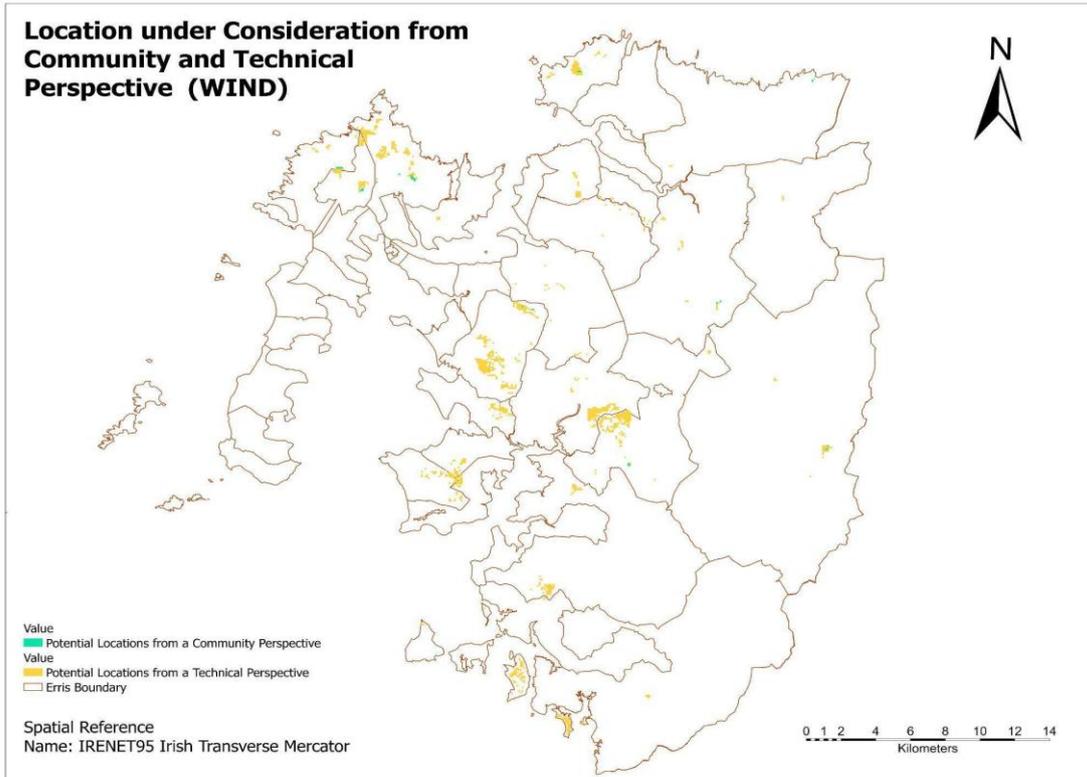
3.1.1. Solar and Wind

The Erris region possesses substantial potential for renewable energy development, characterized by solar PV yields of approximately 953.98 kWh/kWp (Global Solar Atlas, n.d.) and wind power densities reaching 3500 W/m² in specific locales (Global Wind Atlas, n.d.). However, the area's natural beauty and significance to the tourism sector necessitates that any technological advancement remains aligned with the priorities of local residents. To achieve a balance between technical feasibility and community values, an Analytical Hierarchy Process (AHP) model was utilized to facilitate a Multi-Criteria Decision Analysis (MCDA) within ArcGIS Pro, a Geographic Information System software. This methodological approach allowed for the identification of viable development sites by integrating primary data collected through Focus community workshops and mixed-mode surveys conducted both online and in-person with the Erris community and technical experts. The insights were obtained from six technical experts, evenly split between wind (n=3) and solar (n=3). The community input had 23 residents participating in surveys and community workshops, while the final analytical model utilizes 10 complete response sets (n=10) to ensure data integrity and weighting consistency across both renewable energy criteria. By synthesizing these diverse inputs, the model reconciled the perspectives of wind and solar specialists with local viewpoints to generate comprehensive suitability maps for both resources. The resulting weightings and site-specific outcomes derived from this analysis are presented in the table below.

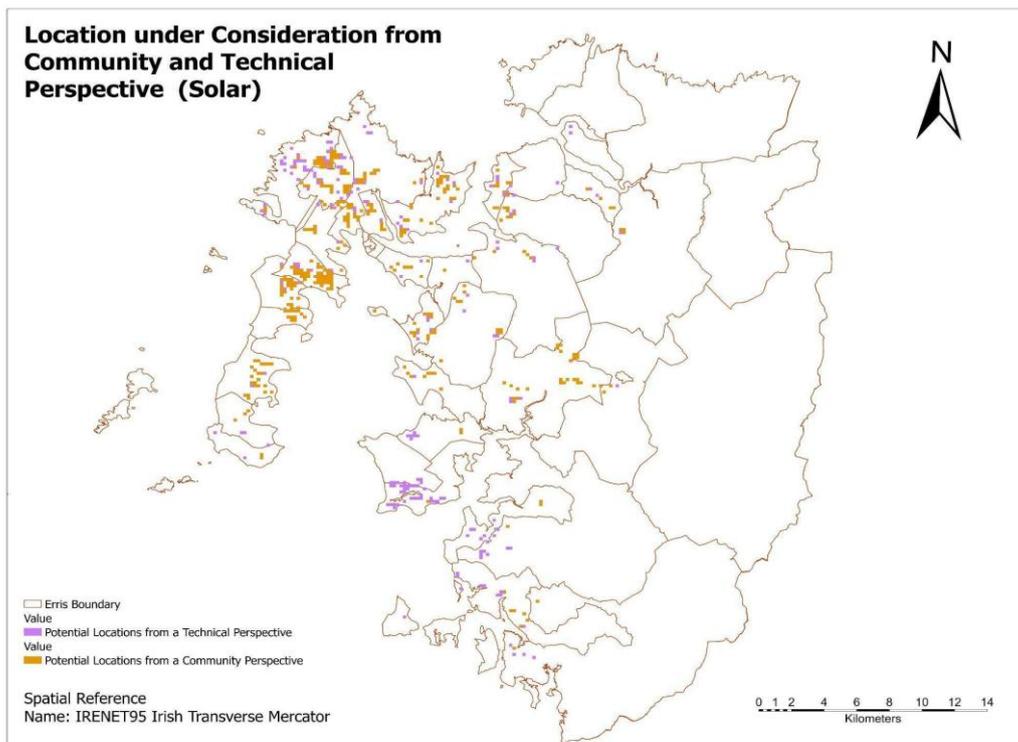
Table 10 Importance levels by weight for wind and solar site factors according to experts and the Erris community

RE Type	Criteria	Priority Weights (Expert) (%)	Priority Weights (Community) (%)
Wind	Wind Power Density	17.5	13.2
	Land Cover	2.4	16.2
	Distance to Houses	18.1	36.8
	Distance to grid	23.9	9.6
	Slope	23.9	12.2
	Distance to Road	14.2	12.1
Solar	PV out	32.2	11.0
	Land Cover	26.6	14.3
	Distance to Houses	4.0	18.2
	Distance to grid	7.7	26.4
	Slope	25.8	13.2
	Distance to Road	3.7	16.9

In wind deployment, technical experts prioritize technical and logistical feasibility, specifically Distance to Grid and Slope (both at 23.9%) as they are focused on the efficiency of power transmission, cost and the physical ease of construction. In contrast, the community prioritizes 'setback' distance to houses (36.8%), emphasizing concerns over noise, flickering, and visual impact over technical factors. For solar energy development, the Community believes that Distance to Grid (26.4%) is the most important factor, followed by Distance to Houses (18.2%). The experts place their primary focus on the actual potential energy output (PVout, 32.2%) of the site, and Land Cover (26.6%). These stakeholder inputs resulted in two distinct suitability models reflecting the divergent priorities of the local community and wind and solar experts. To identify potential "zones of agreement," a spatial overlay analysis was performed, isolating the geographic intersections where both parties estimated development viable. The resulting maps, illustrated in the following figures, highlight these areas of mutual interest for solar and wind potential in the Erris region. As illustrated in Figure 2-b, which depicts the areas under consideration for wind energy, there is a notable divergence between the two perspectives. Only a marginal area aligns with community expectations, whereas the technical criteria identify area significantly more expansive. Conversely, the results for solar energy (Figure 2-a) demonstrate a higher degree of spatial correlation. In this instance, both community and technical insights converge on a larger number of suitable sites, showing substantial overlap in their respective priorities.



(a)



(b)

Figure 11 Maps of the Erris region show where technical experts and the local community agree on potential locations for (a) solar and (b) wind farms

Following the identification of zones of agreement and site visits, a strategic location was selected for detailed technical modelling of solar and wind projects in PVsyst and WindPRO. This site was chosen for its alignment with the priorities of solar and wind experts, as well as the preferences of the local community. Situated at 54.1639063°N, 9.8107243°W, the location offers ideal logistical conditions, characterized by flat terrain, within 700 meters to road and the transmission network and approximately 4.8 km from the Bangor Erris 38kV Substation, which provides a suitable injection capacity of 4.8 MW.



Figure 12 The maps highlight three development areas: Areas 1 and 2 are proposed sites for three 1MW wind turbines, and Area 3 is Provisionally selected for a 5MW community solar farm.

3.2. Proposed community energy systems

3.2.1. Open field solar plant [AEP, costs and CO₂ saved]

- **Project Site**

Utility-scale solar projects of a size of 5MW requires a balance of cost and performance optimized for specific locations. After a GIS site feasibility study sites were chosen including the project site which was proposed by the landowner. The project is situated at latitude 54.16 N, and longitude -9.81 W, at an altitude of 12 meters. A meteorological data sourced from PVGIS API TMY was used, with Global Horizontal Irradiation of 925.9 kWh/m², average temperature of 10.12 degrees, which benefits module efficiency compared to warmer climates.

- **PV System Design**

The PV panels were oriented with a fixed tilt angle of 30 degrees, which is the optimal angle between the summer and winter tilt angle. In the Northern Hemisphere, panels ideally face true south, which is ideal for the weather nature of Ireland to maximize production.

Table 11 Ground-mounted design specifications

Parameter	Ground Mounted
No. PV Modules	10,620
Panel Rating	625 W
Installed DC Capacity	6500 kW
Inverter Rating	300 kW (String Inverter)
No. of Inverters	17
Tilt Angle	30°
Azimuth	South (0°)
Tracking	Fixed
Annual AC Generation	5949.5 MWh
DC/AC ratio	1.30
Specific Yield	896 kWh/kWp/year

The number of Jinko solar, JKM-78HL4-(V)-625 PV modules per string and the other subsequent string is based on the inverter DC electrical input characteristics. A large-scale solar ground mounted project typically utilizes high efficiency modules to maximize power density. A PV module of 625W bifacial is selected to increase the yield by capturing light reflected from the ground. The selected PV inverter, which is Sun2000-330ktl-h1-h2, manufactured by Huawei.

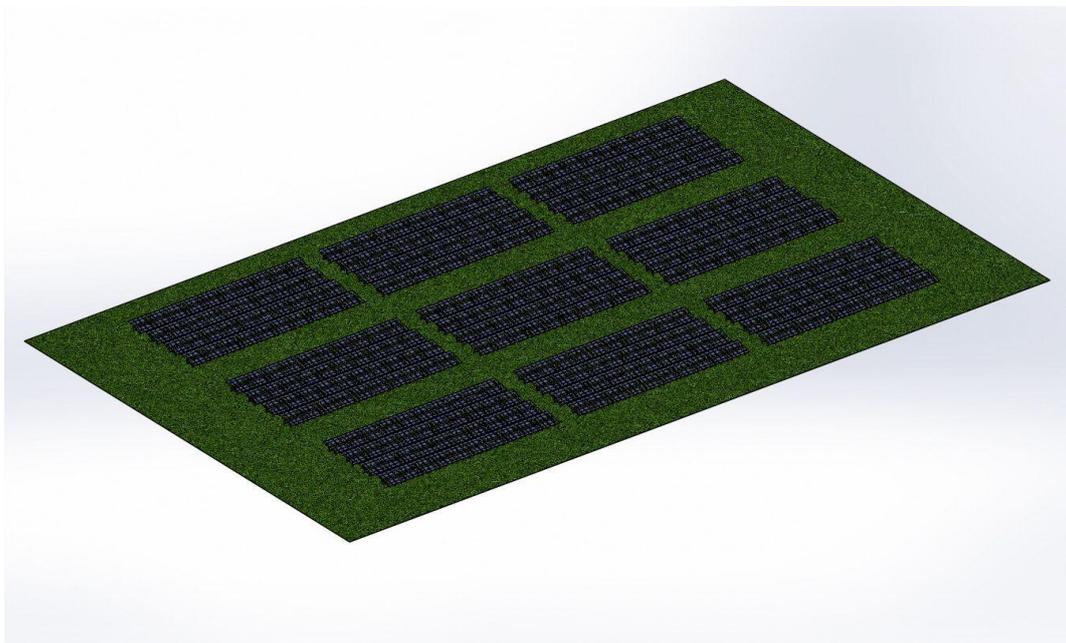


Figure 13 Ground-mounted solar layout

- **Energy Yield Analysis**

The system specific production is 896 kWh/kWp/year, estimated at an annual production of 5,949.5 MWh.

In June the peak production of 912.1 MWh can be expected, while December will have the lowest production of 93.8 MWh. The capacity factor is approximately 10.2% (5,949.5/ (6638×8760 h)).

The performance is determined by environmental and system losses; total effective losses of the site is approximately 16.89%.

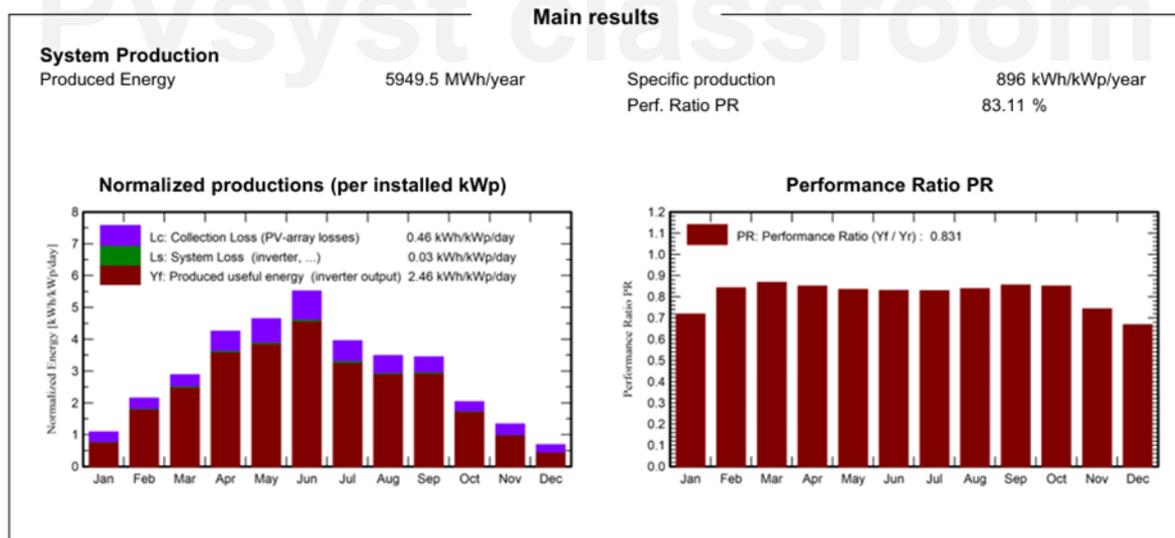


Figure 14 System normalized production and PR

Balances and main results

	GlobHor kWh/m ²	DiffHor kWh/m ²	T_Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray MWh	E_Grid MWh	PR ratio
January	18.2	12.42	5.12	33.5	25.2	162.7	159.9	0.719
February	36.4	20.03	6.58	60.1	53.6	340.7	336.1	0.842
March	69.7	42.97	6.70	89.5	84.4	522.5	515.4	0.867
April	111.2	60.46	9.17	127.5	120.7	728.6	719.4	0.850
May	137.8	82.63	10.72	143.9	135.6	806.8	796.5	0.834
June	163.9	90.88	14.08	165.6	156.1	923.4	912.1	0.830
July	123.2	87.89	13.53	122.5	114.3	685.0	673.7	0.829
August	100.6	69.82	14.00	108.0	101.6	609.1	601.2	0.839
September	84.5	52.48	14.33	103.3	97.6	593.9	586.4	0.855
October	45.5	30.87	11.74	63.2	57.8	361.7	356.8	0.850
November	23.1	16.08	7.78	40.2	31.4	201.5	198.2	0.743
December	12.0	9.28	7.44	21.2	15.1	96.2	93.8	0.668
Year	925.9	575.81	10.12	1078.5	993.4	6032.1	5949.5	0.831

Figure 15 Balances and main results

- Sustainability and lifecycle impact**

A carbon offset of 226.3 g/kWh is used for the CO₂ savings calculation

Annual CO₂ savings = (Annual production (MWh) × Carbon offset (g/kWh)) / 1000000 =
 (5949.5 × 1000 × 226.3) / 1000000 = 134.64 metric tons

3.2.2. Small Wind farm [AEP, Shadow and Noise]

The small wind farm case study is aimed at assisting the local community with their decision making in case the community energy project is proposed. The community energy project is not only for economic efficiency but should effectively address local community's concern over impacts on surrounding residents and neighbourhood. Therefore, a case study on the proposed location #1, which is introduced in the previous section is conducted. The objective of this case study is to compare annual energy production, shadow and flickers, noise, and visual impact of small-scale wind farms with different sizes of wind turbines. This case study enables residents to see the trade-offs, advantages and disadvantages of different wind farm layouts.

Table 12 Types of wind turbines used in the case study

	Three small wind turbines	Single wind turbine
Model	EWT-DW 54-X	SG-4.3-120
Capacity	1000kW	4300kW
Rotor diameter	54m	120m
Hub height	50m	85m

The calculations and assessments are conducted using Windpro, a wind power plant design software program that is widely utilised within the industry. For a comprehensive detailed explanation of the methodology and results, please refer to the background report.

The wind turbines are proposed in the following coordinates, with the three-turbine layout specifically aligned perpendicular to the predominant wind directions, WSW (West-Southwest) and SSW (South-Southwest) based on wind rose analysis on Windpro.

Table 13 Locations of proposed small wind farm layout

Turbine specification		Easting	Northing
EWT-DW 54-X	Wind Turbine 1	481,654 E	825,531 N
	Wind Turbine 2	481,789 E	825,444 N
	Wind Turbine 3	481,933 E	825,362 N
SG-4.3-120	Wind Turbine 1	481,755 E	825,396 N

- **Annual Energy Production (AEP)**

Comparison of AEP of different wind turbine layouts with and without prior computational fluid dynamics (CFD) analysis is outlined in the following table.

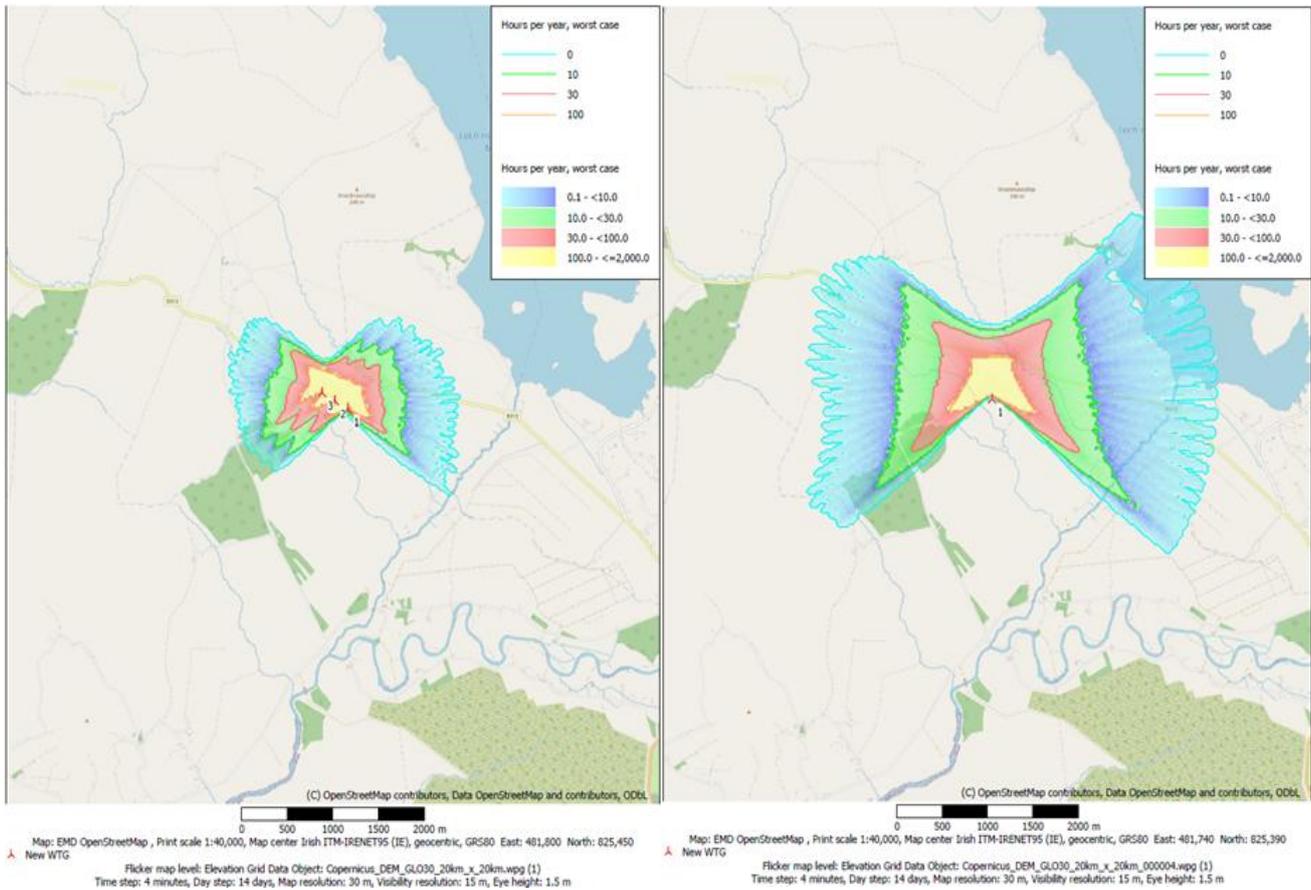
Table 14 Comparison of AEP of different wind turbine layouts

Turbine	Qty	Rated capacity, kW	AEP with prior Computational Fluid Dynamics analysis, MWh/year	Capacity factor with prior Computational Fluid Dynamics analysis
EWT-DW 54-X	3	3000	9,280.0	35.3%
SG-4.3-120	1	4300	20,402.6	54.1%

The wind farm is composed of three wind turbines of the EWT-DW 54-X model, with a total rated capacity of 3,000 kW, they may generate 9,280.0 MWh/year with a capacity factor of 35.3%. In contrast, a single wind turbine of the SG-4.3-120 model, with a rated capacity of 4,300 kW, may generate 20,402.6 MWh/year with a capacity factor of 54.1%.

• **Shadow and Flickers**

The shadow and flicker effects are important local impacts, and they are modelled for the proposed layouts. The analysis indicates that the wind farm layout with three small turbines has less impact on the surrounding area than the single wind turbine. In this case study area, the single turbine has possibility of flicker affecting the nearby houses within 1 km radius for 10 hours per year in the worst-case scenario. The worst-case scenario sets an assumption that the sun is shining brightly every day, the wind is blowing continuously, and the turbine blades are always locked in one direction. Therefore, in a real-life scenario, the probability of having 10 hours of shadow or flicker exposure per year in nearby houses within 1km radius is low.



(a)

(b)

Figure 16 Annual Shadow and flicker hours around (a) 3 small wind turbines and (b) a single wind turbine in the worst-case scenario (Source: Authors)

- **Noise**

Maps below show noise propagation of wind turbines at a wind speed of 12 meters per second. According to the assessment, the wind farm layout of three small turbines has a relatively higher noise footprint than the single turbine. Although the three wind turbines have a higher noise footprint, in both cases, the nearest buildings in the case study area are not affected.

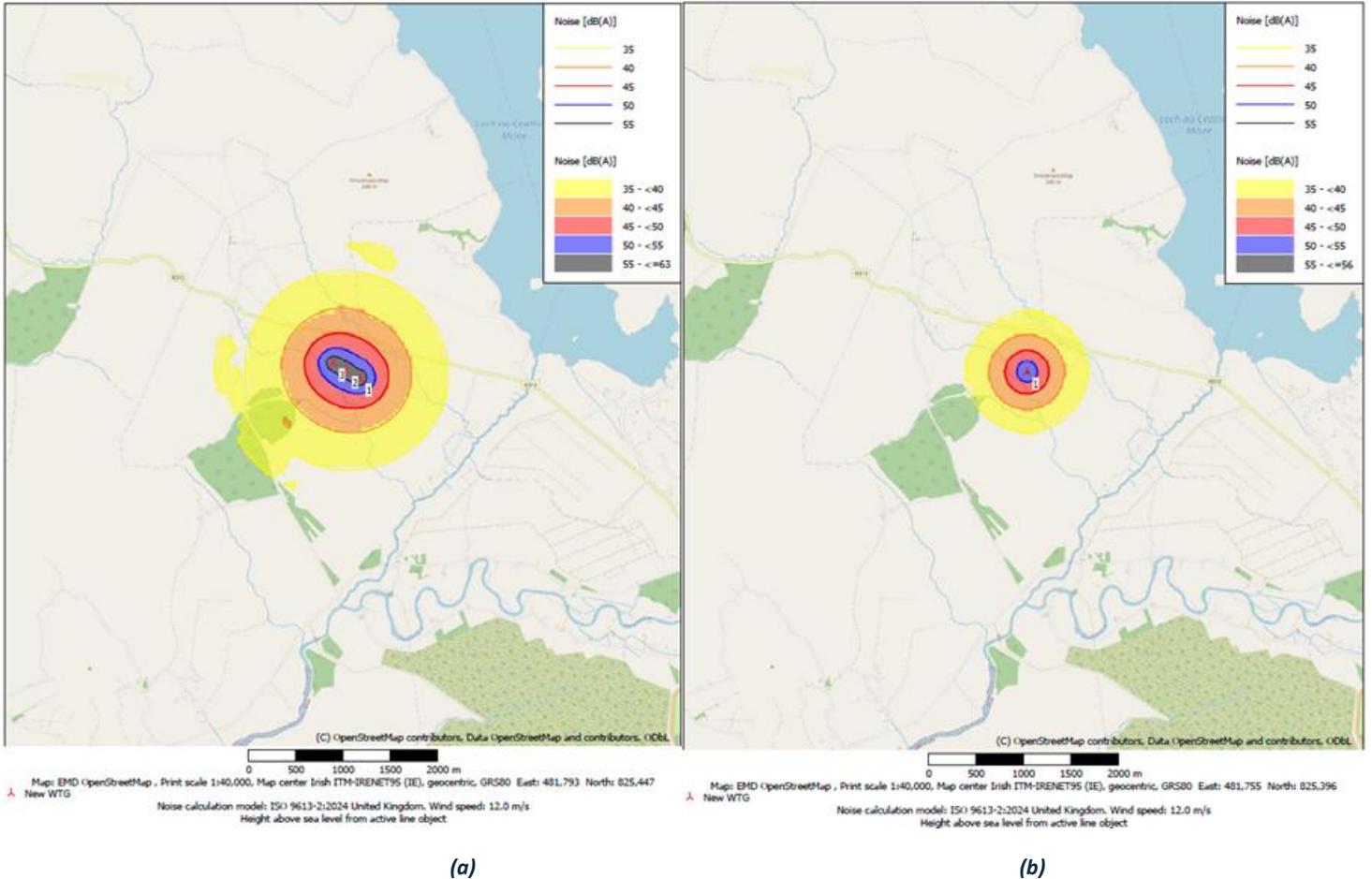


Figure 17 Noise propagation around (a) 3 small wind turbines and (b) a single wind turbine at a wind speed of 12m/s (Source: Authors)

- **Visual impact:**

The following maps calculate the exposure areas, which highlights where in the surrounding region the turbines might be visible. In the areas zero "0", no turbines are visible, and 1 denotes areas with 1-3 (a) and 1(b) turbines visible. Both maps account for screening from observer height of 1.5m. As illustrated by the maps, due to its greater height the single turbine exhibits a greater overall exposure area in comparison to the wind farm layout that is composed of three smaller turbines.

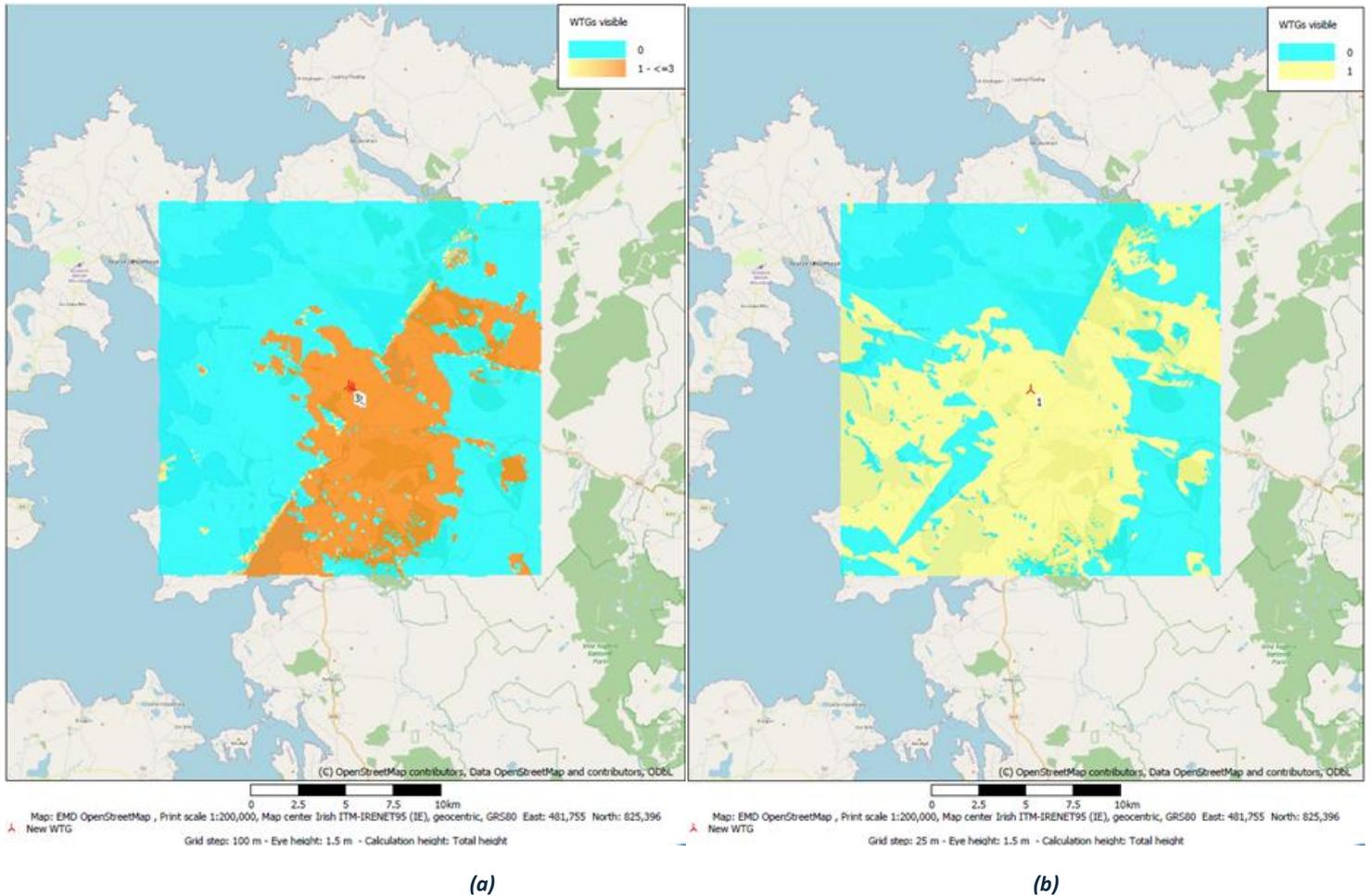


Figure 18 Visible areas (a) 3 small wind turbines and (b) a single wind turbine from height of 1.5m (Source: Authors)

In conclusion, the case study highlights the trade-offs between two different wind farm layouts: three small 1MW wind turbines versus a single 4.3MW wind turbine. The single 4.3MW turbine is significantly more efficient, operating at a 54.1% capacity factor compared to the 35.3% achieved by the three smaller 1MW turbines. However, this efficiency comes with a risk of visual impact and shadow flicker for nearby residents. In terms of shadow flicker and visual impact, the single large turbine with higher hub height poses a relatively higher risk compared to the three small turbines. Conversely, according to the noise analysis, the three small turbines produce a wider noise footprint than the single turbine, though it is important to note that neither layout will affect the nearest buildings.

3.2.3. Ground Mounted Solar PV + BESS for St Brendans College

This section lists briefly the problems, assumptions, and results specific to a techno-economic analysis for a 130 kWp DC/ 100 kWp AC ground mounted PV system coupled with a 120-kWh battery for St Brendans College, Belmullet. The annual electricity bill for the college sat at around 36,000 Euros for 2025, constituting over 50% of the institute's annual running budget (Source: Interaction with the Principal of the School). Based on the detailed monthly energy bills from June to December (except for November), an hourly load profile was generated for the entire year using interpolation and stochastic forecasting methods. The assumptions made for the hourly disaggregation were:

- Night load is distributed uniformly from 11 PM to 8 AM.
- After the school closes at 4 PM, the load profile follows the night load profile.
- Between 8 AM and 4 PM, the hourly loads are different (Details in background report).

- The November load profile resembles the first half of December more than it does with October. October is relatively warmer, and the second half of December is not a realistic winter profile due to the Christmas and New Year periods.

The detailed methodology followed to disaggregate daily loads to hourly profiles can be retrieved from the background report. Figure below shows the proposed site layout (conceptual design) for PV+BESS design, made in Helioscope (HelioScope | Commercial Solar Software, n.d.).



Figure 19 Proposed site layout for the 130 kWp DC PV plant for St Brendans College (Top Right Corner: St. Brendans College)

The annual energy production and the total demand of the school is shown in figure below.

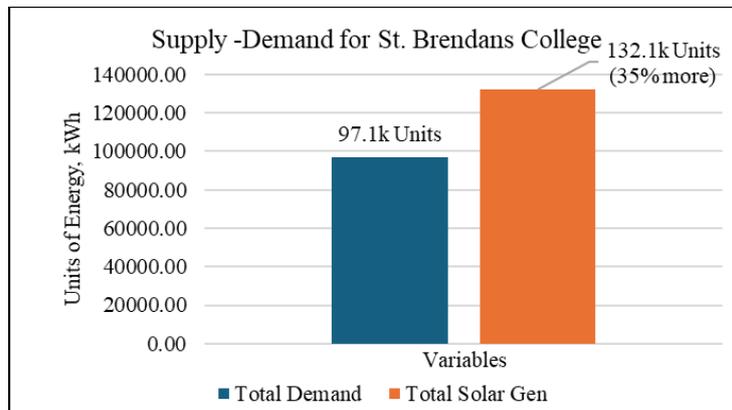


Figure 20 Comparison of Annual Energy Production and Demand for the College

The total AEP (132.1 MWh) exceeds the demand (97.1 MWh) by 35%, but the intermittency of solar production only during the sunshine hours reduces self-consumption and possibility of residual night load arises. Thus, the load duration curve was plotted (figure below) for two cases: Only solar PV v/s PV + BESS. This was done after the observation of a night load throughout the year.

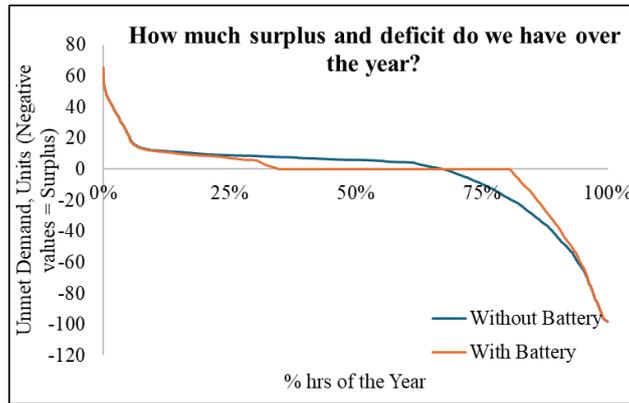


Figure 21 Load duration curve for the college in different system configurations

Without addition of a battery, there is a residual load for approximately 67% of the annual hours. But for most of these residual load hours, the hourly demand value sits below 20 kW (attributed to the relatively constant night load). Thus, a proposal of adding a 120-kWh battery is made. Adding the battery to the system increases the investment cost but reduces the number of residual load hours (to 35% of the annual hours) and is expected to pay back within the project lifetime. Thus, addition of a battery is technically feasible.

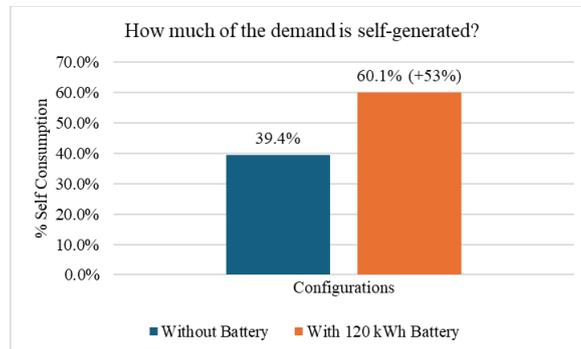


Figure 22 Self-Sufficiency Indices (SSIs) for varied configurations

Having only a PV system of 130 kWp helps the college generate 39.4% of its total energy demand. Upon adding the battery, the SSI value jumps to 60.1% of the total load. This is highly beneficial, as it reduces the amount of expensive nighttime electricity to be imported from the grid. With only a PV system, the college is expected to make a monetary benefit of above 26 thousand Euros annually, which is 72% of the electricity bills for 2025. Upon supplementing the system with the proposed battery system, the benefits rise by 12% (to approx. 29.5 thousand Euros).

Figure below shows the result of an economic model for calculating the discounted cumulative cash flow throughout the project duration. The detailed list of parameters used in this model can be found in the background reports.

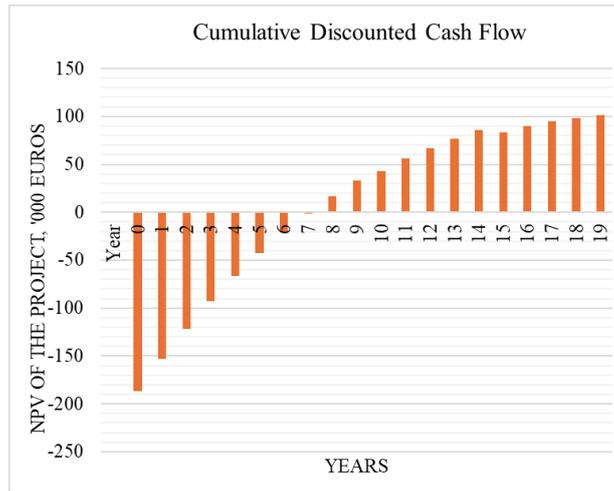


Figure 23 Cash flow model for St Brendans College PV+BESS

The basis of decision-making based on these metrics follows the logic:

If the project has a positive Net Present Value (NPV), IRR is greater than the discount rate, and payback time is less than the project lifetime, then the project is considered economically viable. In the current case, all three conditions are satisfied (NPV of 103 thousand Euros, IRR of 7.8% which exceeds the assumed 5% discount rate, and payback of 8 years which is well below the project lifetime). Thus, the project is economically feasible. Furthermore, the school is eligible for the “non-domestic microgen grant”, the grant amount of which calculates to 22.6 thousand Euros. The detailed application process to be followed by the school is available on the website of Non-Domestic Microgen Scheme (Non-Domestic Microgen Scheme, 2019). The CO₂ offset, calculated using the grid emission factor for Ireland (Byrne, 2025) is 30 MT annually (132.1 MWh per year × 0.226 g/ MWh).

3.2.4. Integration of community solar under grid constraints

3.2.5. Battery energy storage for grid integration

This section of the report evaluates the results of an ideal BESS size (MW/MWh) that maximizes project value as determined by internal rate of return (IRR), payback period and net present value (NPV) for the co-located hybrid solar PV + onshore wind with a 4.8 MW grid export limit.

The model incorporates: Hourly solar and wind generation profiles (two selectable datasets); A scientific-based BESS dispatch logic engine (shown in **Appendix A1**); A complete economic model shown in **Appendix A2** (CAPEX, OPEX, LCOE, LCOS, CRF, revenue); A ‘CLICK OF A BUTTON’ optimizer capable of evaluating 50+ battery sizes shown in **Appendix A3**; and whose output shows NPV vs Battery Sizes and IRR vs Battery Sizes curves as shown in Figures 1 and 2 below.

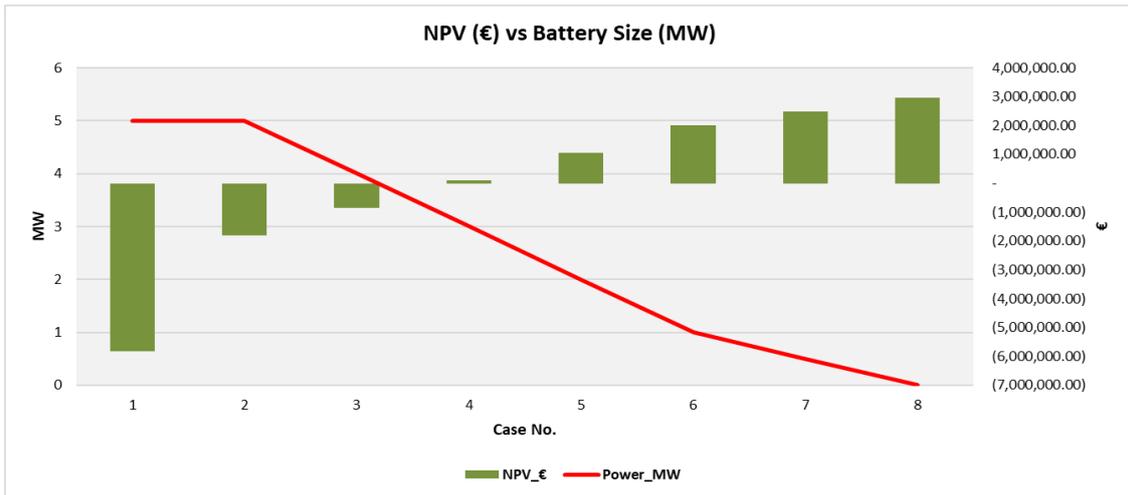


Figure 24 NPV versus BESS Power in MW (source: Author)

In general, and depending on the renewable profile set, the findings show that BESS size of lower capacities for such a community scale hybrid project constrained by 4.8MW grid limit has a higher affinity to higher returns on investment but for optimal economic applications of similar objective, there is NO need for BESS addition as earlier reported in the Erris Master Plan report. This result is consistent with IRENA 2024 report on Renewable Power Generation Costs (pages 57 & 186) which confirmed that *solar + wind systems* tend to have lower LCOE amongst the four (4) different Hybrid Renewable Energy Systems (HRES) namely: *solar + BESS*; *wind + BESS*; *solar + wind*; and *solar + wind + BESS* respectively.

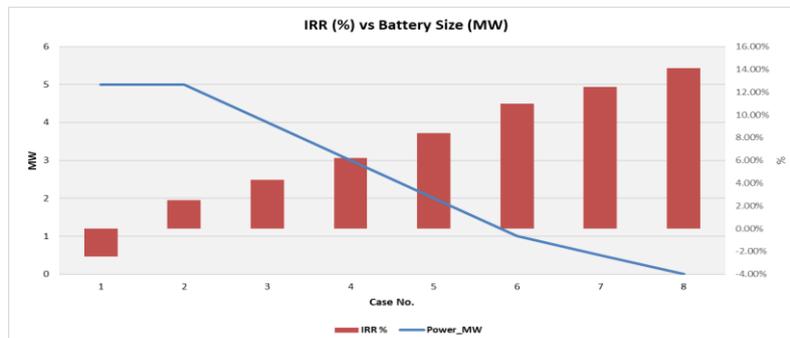


Figure 25 IRR versus BESS Power in MW (source: Author)

It can clearly be observed from Figures 1 & 2 that the lower the capacity of the BESS, the higher the returns on investment for the HRES. In this case, 0MW / 0MWh BESS size proved to be the optimal BESS size.

This modeling framework is appropriate for grant applications, stakeholder engagement, and community energy planning. **It is also transparent, can be audited and readily available for common use.**

3.3. Financial Analysis

Financial analysis is fundamental to the long-term viability of renewable energy projects, as it balances capital investment with the consistent revenue needed for sustainability. In community-led projects, this framework is essential to determine local benefits for the community. To assess the viability of both community owned solar farm and wind farm in Erris specific underlying assumptions were applied to determine key financial performance indicators (KPIs).

3.3.1. Input Parameters

The model utilizes distinct financial and technical inputs for each energy source:

Solar: Requires an initial investment of €4,987,384 for a solar farm of 5MW capacity with annual operation and maintenance (O&M) costs of €34,750. It is modeled with a feed-in tariff of €0.14/kWh under the Small-Scale Renewable Electricity Support Scheme (SRESS) support for community owned project till solar project (1 MW- 6 MW) and an annual production target of 5,949,500 kWh for a lifetime of 30 years. The model also considered a community loan of 250000€ with an interest rate of 6.0 from the credit union in County Mayo for both sources.

Wind: Requires a higher investment of €6,230,432 for a capacity of 3MW capacity and annual O&M costs of €72,400. The wind component operates on a lower feed-in tariff of €0.09/kWh under SRESS support for community owned wind projects with an annual production of 9,325,700 kWh. Both resources are evaluated using a consistent 6% discount rate.

3.3.2. Results

Table below shows the financial Key Performance Indicators (KPIs) for the proposed solar and wind projects.

Table 15 Financial KPIs for Solar and Wind

	Parameter	Value	Unit
Solar	Levelized Cost of Energy	0.0722	EUR/kWh
	Payback	9.5	Years
	Internal Rate of Return	15.20	%
	Net Present Value	688,873	EUR
Wind	Levelized Cost of Energy	0.0617	EUR/kWh
	Payback	11.5	Years
	Internal Rate of Return	10.91	%
	Net Present Value	996,574	EUR

The results indicate that both technologies are financially viable, though they offer different return profiles. The solar projects demonstrate highly cost-effective with a Levelized Cost of Energy (LCOE) of €0.0722/kWh. It features a strong Internal Rate of Return (IRR) of 15.20%, leading to a relatively short payback period of 9.5 years. While the wind component has a lower LCOE of €0.0647/kWh, its lower tariff and higher upfront costs result in a longer payback period of 11.5 years. Subsequently, the analysis indicates that the project is positioned to provide a good financial return. While the solar project offers faster capital recovery and a higher rate of return, the wind project contributes a larger overall net value to the community over the project's lifecycle.

4. Implementation prospects

4.1. Translating the indicators and decision lens in the Erris context

This section introduces a standardized scoring framework designed to evaluate, prioritize, and sequence energy projects proposed by the Erris community during the “Wish Wall” activity. Each project is assessed across five key dimensions: environmental, social, financial, practical, and technical.

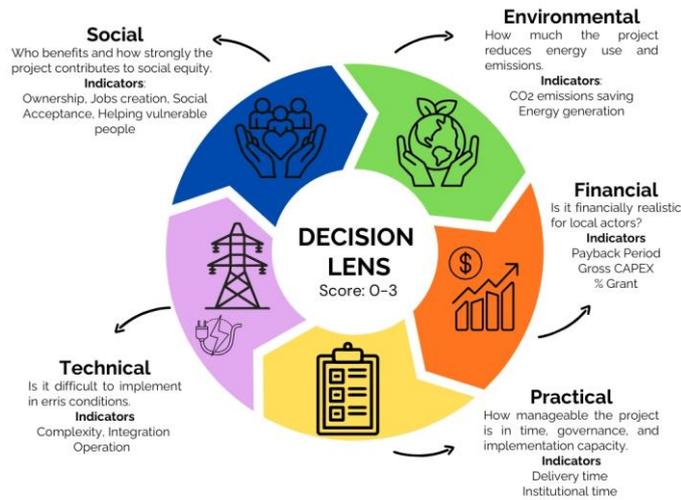


Figure 26 Five-Dimension Decision Lens (Scoring Framework 0-3). Source: Created by authors

For each dimension, a set of clearly defined indicators is applied. By assigning numerical values to these indicators, the framework systematically evaluates both the feasibility and potential impact of each initiative. The combined scores enable transparent comparison across projects and support evidence-based decision-making.

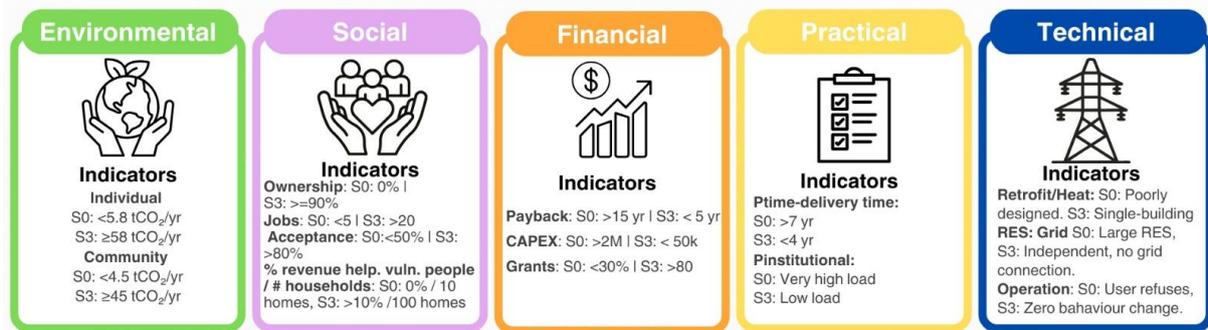


Figure 27 Environmental, Social, Financial, Practical and Technical Indicators - Scoring Overview

Source: Created by authors | S0= Score 0, S3= Score 3. Only the highest (Score 3) and lowest (Score 0) values are shown here. See the SENSE report for full scoring details.

Based on overall performance, projects are categorized into three implementation pathways:

- Quick win: High-impact, low-complexity initiatives that can be delivered in the short term.
- Medium Term projects: requiring moderate planning, coordination, or investment.
- Long Term Projects: Complex or capital-intensive ventures requiring extended development.

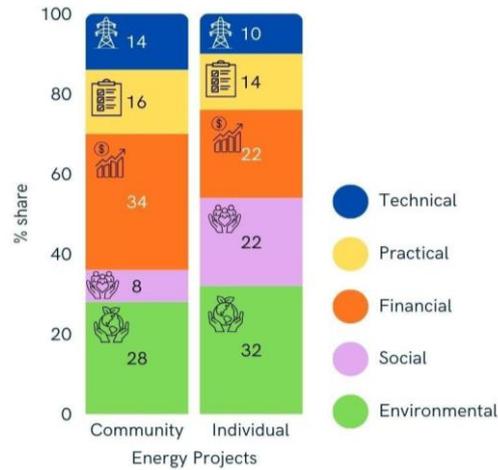


Figure 28 Community vs. Individual Project Weighting by Decision Lens (%)

The lens was defined before fieldwork, but the indicators and their prioritization were shaped by the community and other stakeholders during the second workshop. Six participants ranked the five dimensions (social, environmental, financial, practical, and technical) through a “Token Vote” activity, allocating five tokens per project category, community, and individual, based on their priorities and the ideas generated in the Wish Wall. For individual and community projects, the voting results were as follows:

Based on the results, the priority order and ranking for sequencing individual and community projects (short, medium, and long term) is shown below.

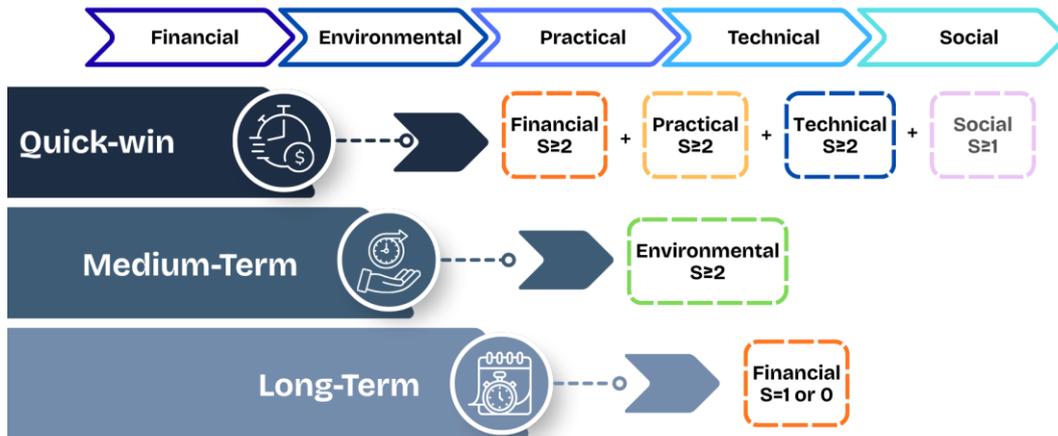


Figure 29 Strategic Prioritization Matrix for Quick-, Medium-, and Long-Term Actions for Individual Projects.

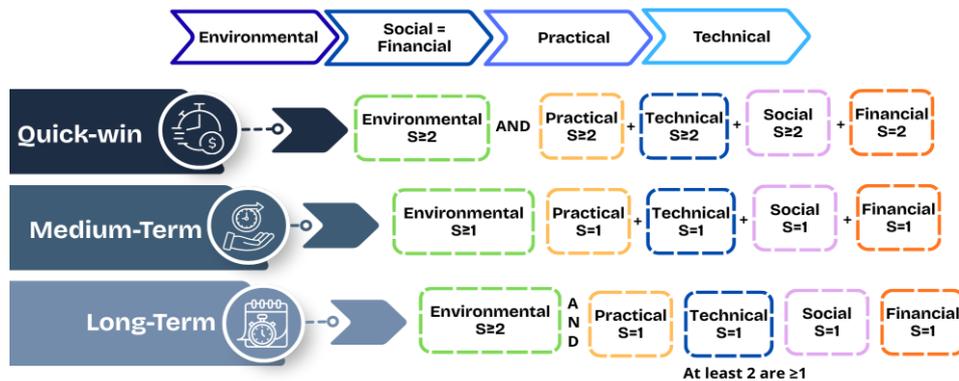


Figure 30 Strategic Prioritization Matrix for Quick-, Medium-, and Long-Term Actions for community projects.

Source: Created by authors

The social lens includes ownership, social acceptance, job creation, and support for vulnerable people, with a new criterion allocating 10% of community project revenue to vulnerable groups. Community priorities were ranked through “The Golden Ticket” activity, informing the weighting of social indicators.

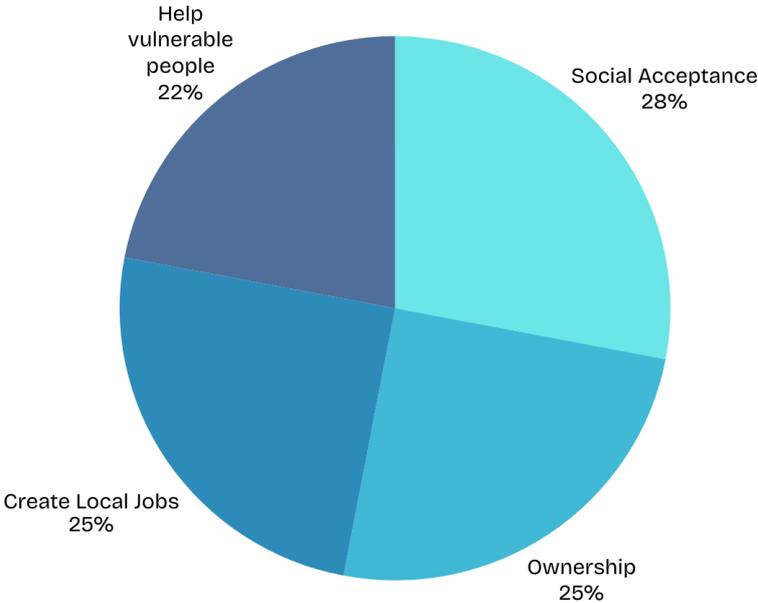


Figure 31 Weighting of Social Impact Dimensions. Source: Created by authors

In Erris, where social acceptance is crucial, a “Red Flag, Green Flag” activity encouraged dialogue by having participants signal agreement or concerns on proposals like wind turbines, solar farm, and rooftop solar, revealing how community perspectives can change through discussion.

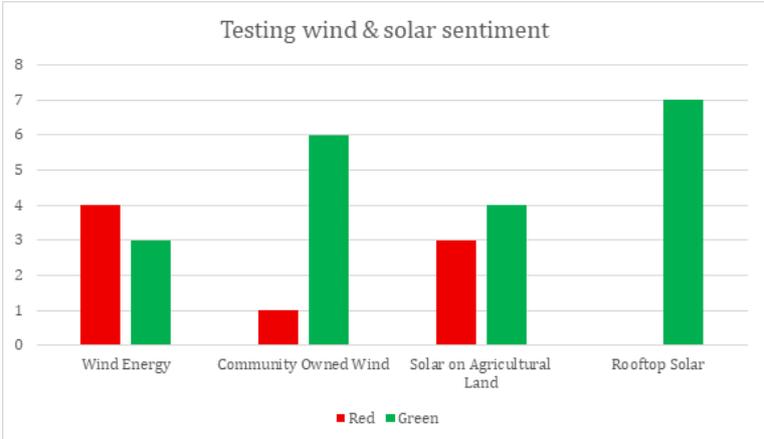


Figure 32 Testing wind & solar sentiment

Thanks to this input, the scoring framework integrates technical criteria with community feedback to prioritize individual and community energy projects in Erris. Through participatory co-creation workshops, projects are classified as Quick Wins, Medium, Long Term, or Unphased, ensuring they are feasible, impactful, and community-supported, providing a clear roadmap for sustainable local energy development.

4.2. Reading the decision lenses: our ‘now, next, later’ roadmap for Erris

Building on the lenses described above, the opportunity themes are now turned into ‘a practical to-do list’ for Erris. Instead of sitting in one long list, each action has been placed in a clear phase: Quick-wins, Medium-term, or Long-term according to how it performs on the five lenses. Table 16 below shows this profile for every theme: which concrete actions it contains, how they score, and which phase they land in within the Erris roadmap.

Table 16 Opportunities by theme, scores on five lenses, and Quick-, Medium- or Long-term phase in the Erris roadmap.

Theme / Package	Action name	Main action	Community/Individual	E	S	F	P	T	Phase rule-based
Theme1: Community Energy Literacy & Support									
T1-BR	Erris Energy Bridge	Community-run energy advice and grant help at one front door, with a special welcome for fuel-poor households.	Community	3	2	3	3	3	Quick-wins
T1-CO	Renewables Ownership Scheme (Co-op)	Local co-operative where neighbors buy small shares in nearby solar and wind projects and get part of the profits back on their bills.	Community	3	2	3	2	1	Medium-term
T1-TRACK	Energy Progress Tracker	Simple public dashboard and story bank that shows carbon cuts, bill savings, and how projects are helping struggling households.	Community	3	2	3	3	3	Quick-wins
Theme2: Home heating transition									
T2-UP	Home Energy Step-Up	Step-by-step home upgrade pathway for below-B3 homes, combining advice, grants, and extra finance so upgrades feel doable.	Individual	3	2	2	3	3	Quick-wins
T2-WH	Warmer Homes Outreach	Local mapping and clinics that actively seek out the coldest homes and walk people through the Warmer Homes Scheme.	Individual	3	2	3	3	2	Quick-wins
T2-HP	Clean Heat Erris: Heat Pumps	Practical ‘heat-pump and solar’ sessions for suitable homes, followed by training at an Energy Academy.	Individual	3	1	2	3	1	Medium-term
Theme3: Community Power Landmarks									
T3-POOL	Swimming Pool Heating	Conversion of the community pool to a heat-pump and 210 kW solar PV system; replaces LPG use and turns the pool into a flagship renewable energy hub.	Community	2	3	2	2	2	Quick-wins
T3-SB	Solar for Saint Brendan's College	Rooftop or ground-mount solar PV at St Brendan's; supplies school daytime loads and creates a live teaching lab for students and parents.	Community	3	1	1	3	2	Medium-term
T3-W2	Community Wind Farm #2: 4.3 MW Wind Turbines	4.3 MW community-stake onshore wind farm at one site; co-operative or REC holds a defined equity share alongside a commercial partner.	Community	3	3	1	1	1	Long-term
T3-W1	Community Wind Farm #1: 3 x 1MW Wind Turbines	3 x 1 MW community-stake onshore turbines; smaller pilot wind cluster to build experience with shared ownership and planning in Erris.	Community	3	3	1	1	1	Long-term
T3-SG	Community Solar Farm	5 MW ground-mounted community solar PV array	Community	3	3	1	1	1	Long-term
Theme4: Community Grid & Resilience Hubs									
T4-LN	Stronger Storm Lines	ESB upgrades on the two or three weakest rural lines, guided by an Erris resilience group, with priority for older and fuel-poor households.	Community	0	1	1	2	2	Long-term
T4-BACKUP	Backup-Power Rooms	20-40 kWh batteries in three key buildings to keep lights, Wi-Fi, sockets, and limited heat running during blackouts.	Community	0	1	2	2	2	Long-term
T4-GP	Grid Passport for Local Rooftop Solar	Feeder-level waiting list and support so 10-15 homes per upgraded line, especially long-term and fuel-poor residents, can connect PV fairly.	Individual	2	1	3	3	2	Quick-wins

Theme5: Plug-&-Go Community Mobility									
T5-SBEV	St Brendan's College EV Hub	Two chargers at the school: one 50 kW DC for the bus and urgent top-ups, and one 7 kW AC for staff with simple rules and shared usage data on EV kilometers and CO ₂ savings.	Individual	1	1	2	1	2	Long-term
T5-AE	'Almost There' EV Point	Single 11 kW AC chargers at the Irish Wheelchair Association Centre, the SuperValu Belmullet car park, and the Ballycroy Visitor Centre car park, with easy parking rules and modest tariffs that channel tourist EV spending into an Erris mobility fund.	Community	1	1	2	2	2	Medium-term
T5-LL	Local Link Pass	About €5,000 per year to fund discounted or free Local Link journeys for around 20 low-income households, using income from EV projects and grants.	Community	0	1	3	2	2	Long-term

4.2.1. What each theme tells us

- **Theme 1: Community Energy Literacy & Support**

T1-BR Erris Energy Bridge and T1-TRACK Energy Progress Tracker are quick wins, using small local teams and simple tools to give households advice, grant help, and feedback on savings. T1-CO Renewables Ownership Scheme (Co-op) is a medium-term scheme, as a fair community share in wind and solar needs more organization and technical work.

- **Theme 2: Home Heating Transition**

This theme starts with the coldest homes. T2-UP Home Energy Step-Up and T2-WH Warmer Homes Outreach are quick wins that help below-B3, especially F-E2, homes to use grants and upgrades without getting lost. T2-HP Clean Heat Erris is Medium-term, because moving to heat pumps is a bigger, costlier change and needs more support.

- **Theme 3: Community Power Landmarks**

T3-POOL Swimming Pool Heating is a Quick-win, turning a familiar pool into a visible clean-energy site. T3-SB Solar for Saint Brendan's College is Medium-term, needing agreement with the school and grid checks. T3-W1, T3-W2, and T3-SG are Long-term community wind and solar projects with big benefits but major investment, permitting, and organizational needs.

- **Theme 4: Community Grid & Resilience Hubs**

Here, the focus is on the 'backstage' of the system. T4-LN Stronger Storm Lines and T4-BACKUP Backup-Power Rooms are Long-term because they depend on ESB upgrades, multiple grants, and detailed design. T4-GP Grid Passport for Local Rooftop Solar is a Quick-win, creating a fair queue and support service so long-term and fuel-poor residents can connect to rooftop solar as lines improve.

- **Theme 5: Plug-&-Go Community Mobility**

Change in transport is slower. T5-AE 'Almost There' EV Point is a Medium-term step that adds chargers in key car parks and channels some tourist spending into an Erris mobility fund. T5-SBEV St Brendan's College EV Hub and T5-LL Local Link Pass are Long-term, as they depend on more EVs on the road, stable income, and close work with transport providers.

The figure below sums this up, showing how each action from the profile table falls into Quick-win, Medium-term, or Long-term before the 17 activities are sequenced by implementation strategy.

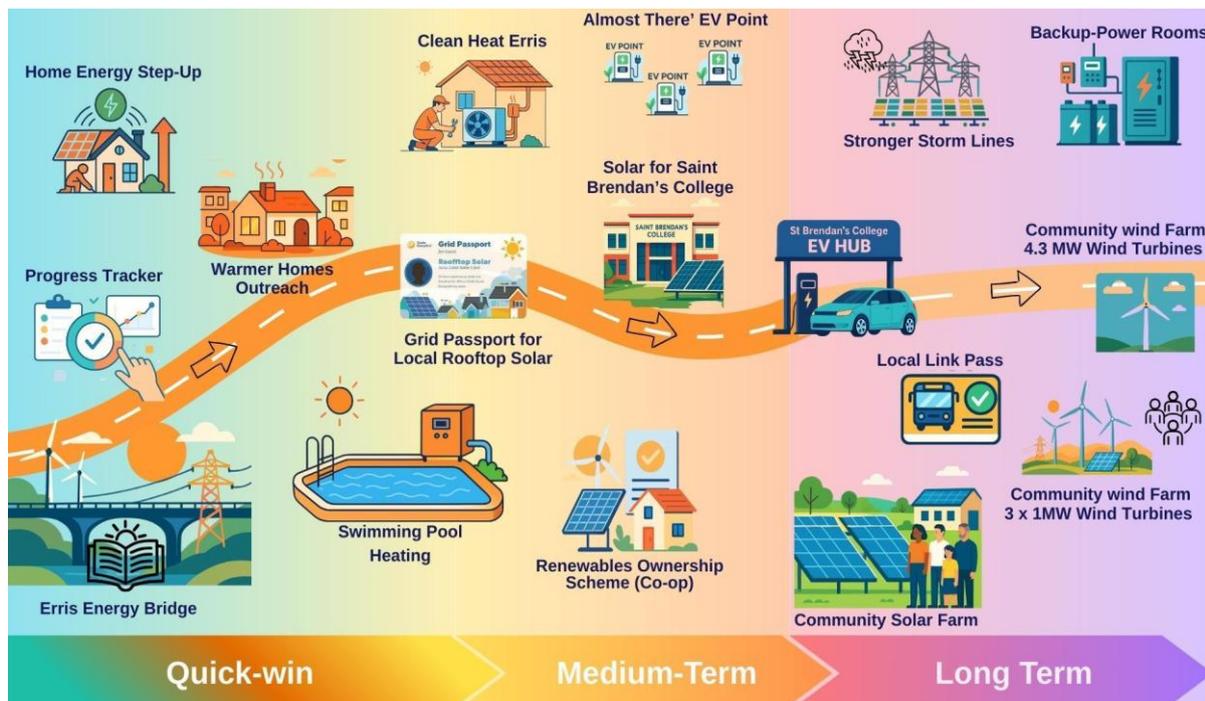


Figure 33 Erris Sustainable Energy Community Energy Master Plan Roadmap (Quick-Win, Medium-Term, and Long-Term Actions). Source: Created by authors.

4.2.2. Phased roadmap strategy

The phased-roadmap strategy views Erris energy projects as layers of growth, not a list that was picked at random. First, the scoring lens sorts actions into Quick-wins, Medium-term, and Long-term, clarifying risk, complexity, and resource needs. Quick-wins go first to test systems, build trust, and grow skills; Medium-term projects build on that base; Long-term projects come last and rely on the organization and experience created earlier, like a forest that starts with seedlings and only later becomes a full canopy.

- **Phase 1 (2025-2029) Seedling**

In the first phase, Erris focuses on low-risk, visible steps that make the plan feel real. Erris Energy Bridge and the Energy Progress Tracker give households a shared ‘front door’ to advice, grants, and progress stories. Home Energy Step-Up and Warmer Homes Outreach pulls sub-B3 and F-E2 homes into actual upgrades, the Grid Passport for Local Rooftop Solar queues 10-15 priority homes per line, and Swimming Pool Heating turns a major fossil-fuel user into a local renewable landmark.

- **Phase 2 (2029-2035) Growth**

Once these seedlings have taken root, Medium-term actions move them into a bigger pot. The Renewables Ownership Scheme (Co-op) turns residents into co-owners and seeds future fuel-poverty funds. Solar for Saint Brendan's College and ‘Almost There’ EV Point strengthen visible public infrastructure and generate income that can later support the Local Link Pass. Clean Heat Erris: Heat Pumps scales up to more than 50 oil-heated B2 homes through workshops and group ‘heat-pump/solar parties’. These actions use the same channels as Phase 1, so the step up in scale feels natural rather than a jump.

- **Phase 3 (Post-2035) Rooted**

In the rooted phase, stronger organizations, steadier income, and better technical skills make the largest projects possible. Community Wind Farms #1 and #2 and the 5 MW Community Solar Farm move ahead, while ESB-led Stronger Storm Lines and Backup-Power Rooms keep key services running during storms and blackouts. St Brendan's College EV Hub links back to Phase 2 solar, opening the way for an electric school bus, and the Local Link Pass redirects EV-hub income into affordable journeys for low-income households. Putting these actions last

shows they stand on earlier work: the forest is there because the seedlings were cared for, and each pot was right-sized before the next canopy grew.

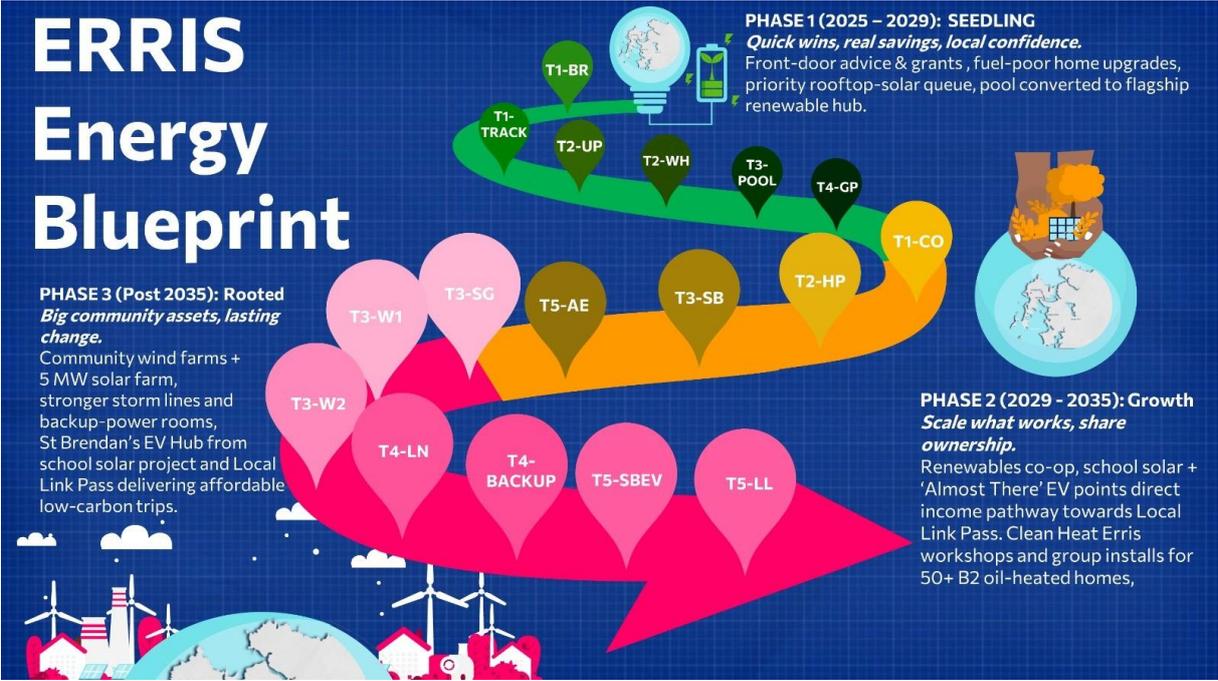


Figure 34 Erris Energy Blueprint: From seedling to fully rooted projects over three phases.

4.3. Checking the roadmap against the 'ERRIS Wish Wall'

Placing the 'ERRIS Wish Wall' workshop results alongside the roadmap makes it a live validation of whether the sequence still feels like 'our' plan. This means the roadmap matches 10 out of 15 ideas in their expected phase, or about 67% 'phase-match accuracy,' and captures all 15 ideas in the plan, plus two additional actions from wider stakeholders' input as shown in Table 17.

Table 17 Validation gaps between lenses and community phasing

Theme / Package	Action name	Lens' phase result	Wish wall	Gap
Case 1: Big public building projects that are closer than we thought				
T3-POOL	Swimming Pool Heating	Quick-wins	Medium-term	Gap driven by the pool feeling 'too big and political', not by its actual readiness.
T3-SB	Solar for Saint Brendan's College	Medium-term	Long-term	Gap driven by expectations that school projects are slow, not by the solar scores.
Case 2: Community solar & EV chargers are held back by the rules				
T3-SG	Community Solar Farm	Long-term	Medium-term	Gap driven by CAPEX, SPV/REC, and grid rules, even though local workshop and survey results show strong community support for the solar farm.
T5-SBEV	St Brendan's College EV Hub	Long-term	Quick-wins	Gap driven by stacked solar-plus-admin steps; the EV kit is simple and broadly acceptable, so delay comes from process, not technology.
T5-AE	'Almost There' EV Point	Medium-term	Quick-wins	Gap driven by assumed permit and coordination effort, not by charger scale.
Case 3: Actions match with the wish wall				
T1-BR	Erris Energy Bridge	Quick-wins	Quick-wins	

T2-UP	Home Energy Step-Up	Quick-wins	Quick-wins
T2-WH	Warmer Homes Outreach	Quick-wins	Quick-wins
T4-GP	Grid Passport for Local Rooftop Solar	Quick-wins	Quick-wins
T1-CO	Renewables Ownership Scheme (Co-op)	Medium-term	Medium-term
T2-HP	Clean Heat Erris: Heat Pumps	Medium-term	Medium-term
T3-W2	Community Wind Farm #2: 4.3 MW Wind Turbines	Long-term	Long-term
T3-W1	Community Wind Farm #1: 3 x 1MW Wind Turbines	Long-term	Long-term
T4-LN	Stronger Storm Lines	Long-term	Long-term
T4-BACKUP	Backup-Power Rooms	Long-term	Long-term

The remaining five ideas act as useful ‘mismatches’ which are divided into 2 cases that sharpen the validation loop, instead of weakening it, as follows:

- **Case 1: Big public buildings that move closer**

In Case 1, the ‘error’ sits mostly with community intuition: people downgrade the pool hub and St Brendan’s solar because they read size, CAPEX, and politics as automatic delay and conflict, even though they actually want those services back and place them in the medium-term on the Wish Wall. That caution is understandable; big institutions feel distant and hard to influence, but it ignores concrete evidence on standard technology, strong grants, committed owners, and short paybacks, which shows these anchors are among the most deliverable projects. The way to close this gap is to make that evidence visible (simple payback stories, ownership and decision maps, clear timelines) and to hard-wire community roles into governance so large public projects feel actionable, not like someone else’s risky experiment.

- **Case 2: Community solar and EV hubs held back by rules**

In Case 2, the ‘error’ lies more in the rule-set than in community judgement. Residents pull the 5 MW community solar farm and both EV hubs into early phases because they fit lived preferences for fair, visible, shared infrastructure, but the Financial, Practical, and Technical lenses push them back by punishing high CAPEX, new SPV/REC structures, long grid procedures, and stacked lead-times. Here, the framework treats today’s grant rules, legal forms, and grid bottlenecks as if they were fixed facts, instead of policy variables that could be changed. Closing this gap is not about fixing a ‘wrong’ lens, but about using its rules as policy levers for improvement: cutting lead-times or trying to simplify delivery models where Practical scores are low, strengthening grants or risk-sharing where Financial scores are weak, and redesigning who benefits where Social scores lag, so that when the phasing is re-run, community solar and EV hubs can move closer to the ‘soon’ horizon residents already have in mind.

Together, the two cases point to a clear policy job: work on a cautious community story and a cautious rule-set at the same time. Case 1 says: tell a sharper, evidence-based story so big public anchors are seen as near-term upgrades, not distant experiments. Case 2 says: use the scoring rules as levers – CAPEX and grants, SPV/REC templates and grid pathways so community solar and EV hubs can actually move into the ‘soon’ horizon people already expect.

4.4. Policy recommendations

The workshops, surveys, and 5-Dimension Decision Lens applied to the Erris Opportunity Themes reveal that home upgrades and community energy projects consistently stall because of systemic institutional, infrastructural, and financial bottlenecks. Currently, high-impact initiatives such as community renewable energy projects are trapped in our medium-term and long-term delivery phases.

The following policy recommendations are targeted interventions designed specifically to remove the weakest link constraints identified in our models to move these projects along the different phases. These recommendations provide mechanisms needed to unblock delayed projects, facilitate rollout of the opportunity themes, and accelerate implementation.



Figure 35 Policy recommendations

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6. Appendices

Appendix 1. Information on heat pumps

The decarbonization of Ireland's building sector is an essential component of the country's climate policy. Commercial buildings that have high thermal energy demands, such as leisure centers and indoor swimming pools, are significant opportunities for electrification using heat pump technology. Swimming pools require constant energy input to maintain the pool water temperature, provide domestic hot water for showering in the facility, and control humidity in the pool hall environment.

Traditionally, these energy requirements are supplied by natural gas boilers that have efficiencies between 85-92%. However, the cumulative effect of carbon taxes, unstable fossil fuel prices, and the increasing penetration of renewable energy into Ireland's electricity supply has altered the economic landscape in favor of electrically driven heating systems.

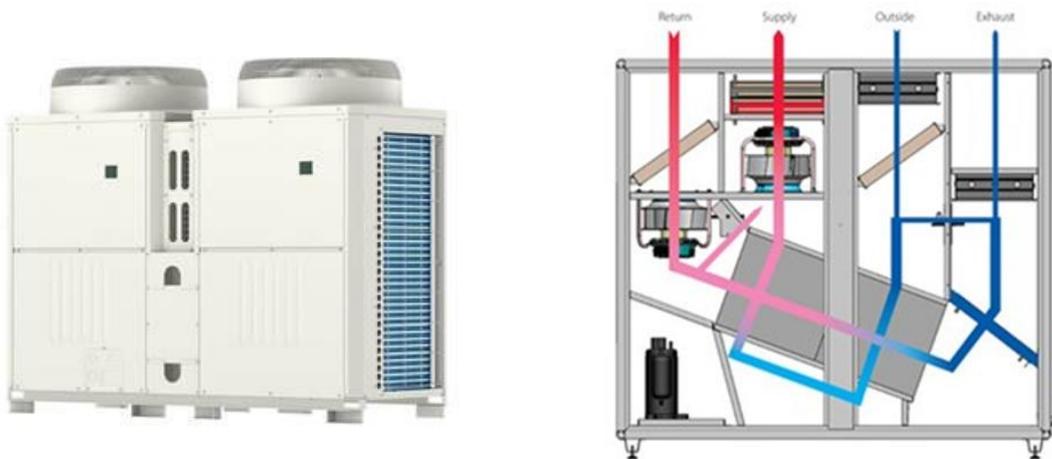


Figure 36 Mitsubishi Ecodan CAHV-P500YA-HPB

The Mitsubishi Ecodan CAHV-P500YA-HPB units are connected in cascade to achieve a system output rating of 80 kW. The primary function is to provide a constant low-temperature baseload to cover:

1. Pool water heating via a plate heat exchanger
2. Underfloor heating and ancillary space heating
3. Buffer tank charging to ensure hydraulic stability
4. Surface evaporation
5. Convective losses
6. Transmission loss through the enclosure

Due to its continuous nature and the fact that it operates at low to moderate temperatures (typically a 30-35°C flow), this type of load is considered to be thermodynamically favorable for an air-source heat pump (Mitsubishi Electric).

- **High-Temperature Heat Pump**



Figure 37 High-Temperature Heat Pump - Source: Mitsubishi Electric 2022

The EcodanPro QAHV unit is specifically designed for the generation of potable hot water. It also has the capacity to deliver high flow temperatures of 90°C, making it suitable for use in commercial and industrial applications. The use of natural CO₂ as a refrigerant in the QAHV unit results in one of the lowest impacts on the environment for the generation of hot water. It is specifically designed to withstand the harsh climate of New Zealand. The QAHV unit, being an inverter heat pump, operates with high efficiency. By using Mitsubishi Electric's distinctive technology, the QAHV unit provides reliable performance and maintains high capacity for heating at low outdoor temperatures (Mitsubishi, 2024).

The Mitsubishi QAHV-N560YA-HPB heat pump system uses the refrigerant carbon dioxide (R744) to effectively provide high-temperature domestic hot water (DHW) at 90°C for showers and sanitary use within the facility. Unlike conventional heat pumps, the CO₂-based system maintains high efficiency at high temperature ratings, is suitable for maintaining sanitary requirements, and prevents the growth of Legionella. The use of CO₂ also minimizes the overall footprint of the system, as the GWP of CO₂ is 1. The separation of the high-temperature DHW requirement from the pool water heater ensures that the system operates at an optimal level (Mitsubishi, 2024).

Key Features:

1. Uses Natural CO₂ Refrigerant

The QAHV system uses environmentally friendly and highly effective CO₂ as its refrigerant, which is characterized by zero Ozone Depletion Potential and Global Warming Potential of 1. The CO₂ refrigerant also results in a reduced carbon footprint for the QAHV system and is capable of handling flow temperatures up to 90°C.

2. High Efficiency

The QAHV system is designed to ensure high efficiency and low environmental impact due to the application of advanced technology and supercritical natural CO₂ refrigerant.

3. Stable Heating Even at Low Ambient Temperatures

Mitsubishi Electric's QAHV system uses Flash Injection Technology to ensure that its full heating capacity of 40 kW is maintained even at ambient temperatures as low as -3°C. The QAHV system is also capable of providing 90°C hot water even at ambient temperatures as low as -25°C.

- **Climate Control & Dehumidification**



Figure 38 Swimming Pool Application of Plate Heat Exchanger

Evaporation of water in swimming pool environments is unavoidable. However, with the implementation of a well-designed ventilation and dehumidification system, the relative humidity level may be kept at a comfortable level. The DanX may be designed to meet various needs by considering the pool size, water temperature, air temperature, humidity, and bathing. With the availability of a one-stage or two-stage heat recovery system, the DanX may be considered an optimal device for the regulation of swimming pool hall environments (Skive, 2022).

Key Features

1. **Integrated Dehumidification and Heating:** The system incorporates dehumidification along with heating functions, which results in an increase in the level of efficiency while managing humidity and temperature in the pool hall.
2. **Cross-Flow Heat Exchanger:** The cross-flow heat exchanger allows for the recovery of latent heat from exhaust air and subsequently transfers the recovered heat to fresh air. This reduces the energy consumption of the CAHV system used to heat the swimming pool.
4. **Optimised for Pool Environments:** The Dantherm DANX 9/18 XWPS is specifically designed to function in indoor swimming pool environments while efficiently managing high moisture levels, while maintaining optimal air quality.
5. **Automatic Control System:** The system is equipped with an automatic control system that adjusts the airflow and temperature in accordance with the indoor air conditions.
6. **Reduced Operational Costs:** The system reduces the overall cost of operations while maintaining optimal air quality and temperature in the swimming pool hall by integrating heat recovery with energy-efficient dehumidification.

- **Electricity Cost (2026, Ireland) & OPEX**

This cost element is one of the major Operational Expenditure (OPEX) components, reflecting the cost impact of the heat pump system’s operations. This section calculates the total electricity consumption and its corresponding cost by integrating the yearly demand requirement with the electricity cost in Ireland in the year 2026.

The total electricity consumption required by the heat pump system to operate is 99,745.28kWh. This value considers the electricity required by the heat pump system to meet the total demand requirement, including the pool water, domestic hot water, and dehumidification of the pool hall air.

In view of the fact that the price of electricity in Ireland for the year 2026 for commercial customers will be €0.37 per kWh, the total cost of electricity can be determined as follows:

$$OPEX = Electricity\ Consumption \times Electricity\ Price = 99,745.28kWh \times 0.37€/kWh = 36,905€$$

Thus, the total cost of electricity for the heat pump system will be €36,905, which forms a substantial part of the total annual operating costs of the facility. This figure encapsulates the cost of operating the heat pump system, including the cost of energy used for heating the pool water, the cost of energy used to produce domestic hot water, and the cost of energy used for the control of humidity levels in the pool hall. The cost of electricity forms a crucial parameter in the determination of the economic viability of the system.

- **Gas Boiler Baseline**

In order to assess the financial viability of the heat pump system, it is necessary to compare it with the baseline cost required to operate the conventional natural gas boiler. The natural gas boiler is expected to have an efficiency rate of about 90%, which means it requires additional energy to the required amount to cover the inefficiency factor.

Assuming the total demand required to satisfy the swimming pool facility is 63,056.39 kWh, the total amount of gas required to satisfy the demand can be determined by considering the boiler's efficiency rate.

$$Gas\ Input = Total\ Thermal\ Demand / Boiler\ Efficiency = 63,056.39\ kWh / 0.90 = 70,062\ kWh$$

Thus, the gas boiler system will require an annual gas consumption of about 70,062 kWh to meet the specified thermal demand.

- **Calculation of CAPEX for Individual Heat Pump Configurations**

- 1. Pool and Space Heating – Air-to-water Heat pump**

To calculate the CAPEX for the Mitsubishi CAHV heat pumps, the formula is obtained by multiplying the total units of the equipment installed in the system.

Unit Cost for CAHV: Typical price per unit is around €32,269 for each 40 kW rating (Orianair Sales, n.d.).

Total cost for 2 units:

$$CAPEX_{CAHV} = 2 \times 32,269 = 64,538$$

The above are the costs pertaining to the Mitsubishi CAHV units intended for the treatment of pool water and space heating.

- 2. High Temperature Domestic Hot Water – (Water to water heat pump)**

Mitsubishi QAHV is a type of CO₂-based heat pump designed to meet the needs for high-temperature domestic hot water (DHW). The indicative cost of a single QAHV unit, which is 40 kW, is usually around €42,413, although this may vary due to the conditions of the installation and configuration of the system itself (Orianair Sales., n.d.).

Total cost for 1 unit:

$$CAPEX_{QAHV} = 42,413€$$

The above is the cost for the one Mitsubishi QAHV unit which provides high-temperature DHW.

- 3. Pool Hall Climate Control and Dehumidification – Air Handling Unit**

The Dantherm DANX 9/18 XWPS is used for dehumidification and ventilation in the pool hall. The cost estimate for the Dantherm Air Handling Unit (AHU) is in the range of €85,000 to €100,000, with the point estimate at €90,000.

Total cost for 1 unit:

$$CAPEX_{DANTHERM} = 90,000$$

This is the cost estimate for one Dantherm Air Handling Unit.

6. Total CAPEX Calculation of Heat Pumps

Having determined the cost estimate for each system, the total cost estimate for the entire heat pump system can be determined by adding up all the cost estimates.

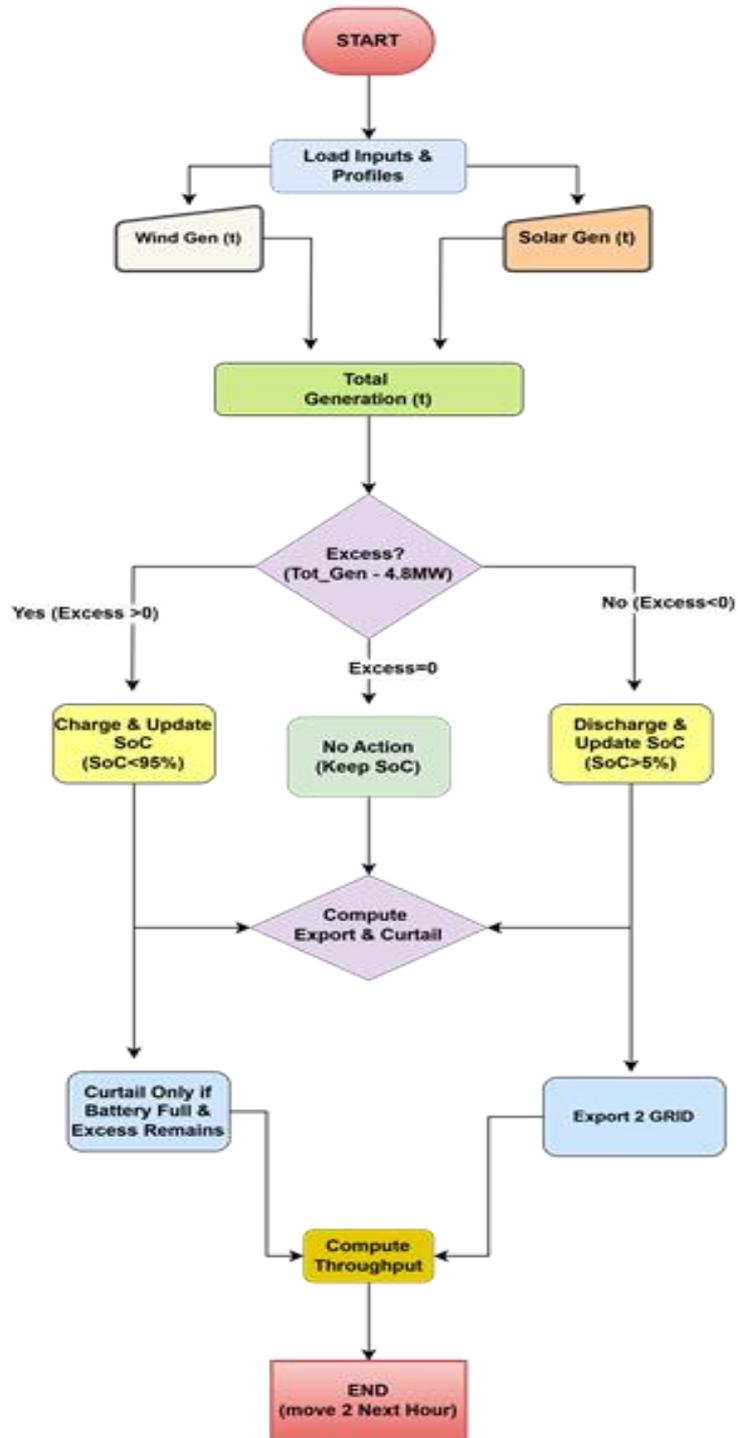
$$CAPEX_{total} = CAPEX_{CAHV} + CAPEX_{QAHV} + CAPEX_{DANTHERM}$$

Substituting the values:

$$CAPEX \text{ (total)} = 64,538\text{€} + 42,413\text{€} + 90,000\text{€} = 196,950\text{€}$$

Thus, the total capital expenditure for the three heat pump systems is approximately €196,950.

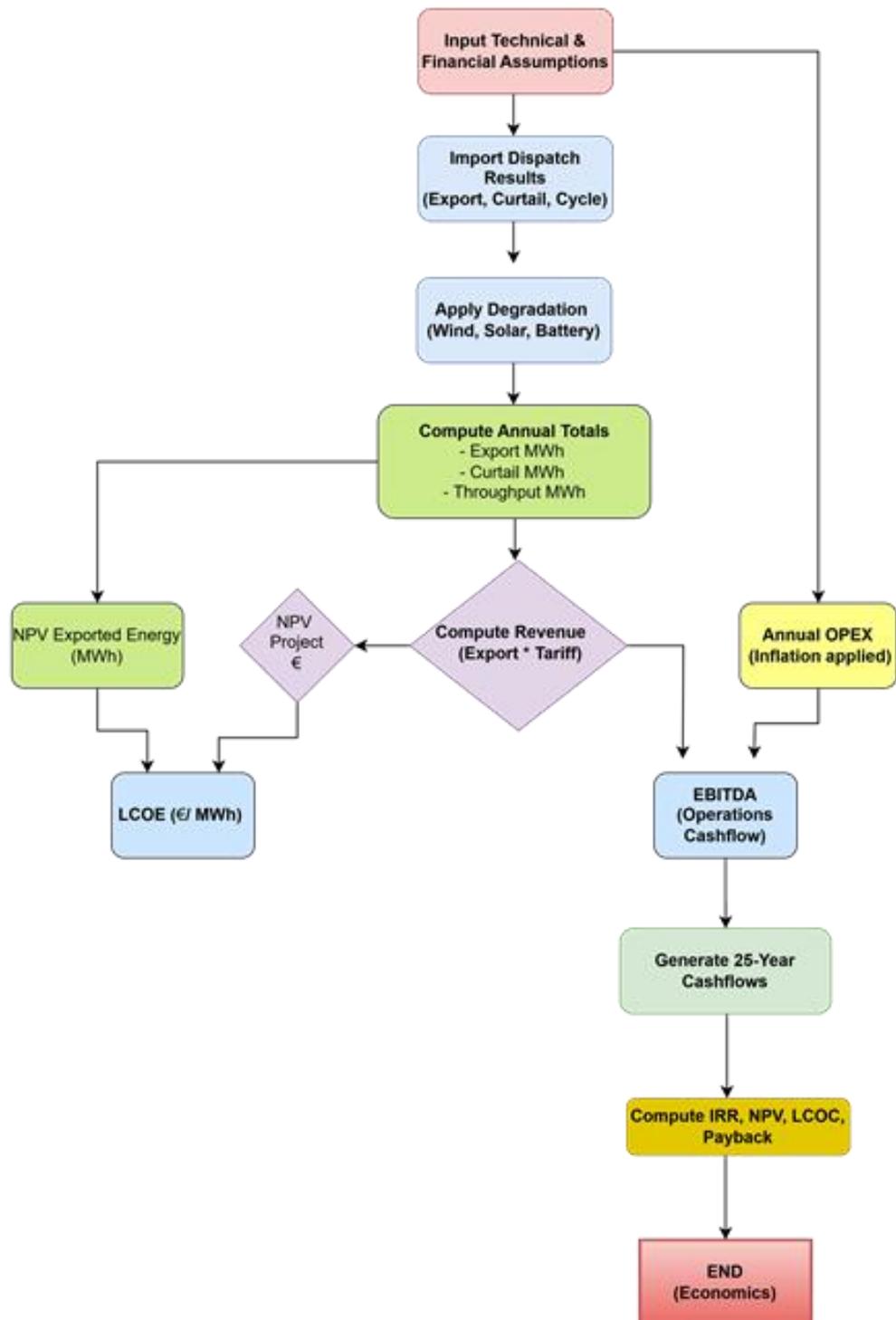
Appendix 2. Battery Dispatch Logic Diagram



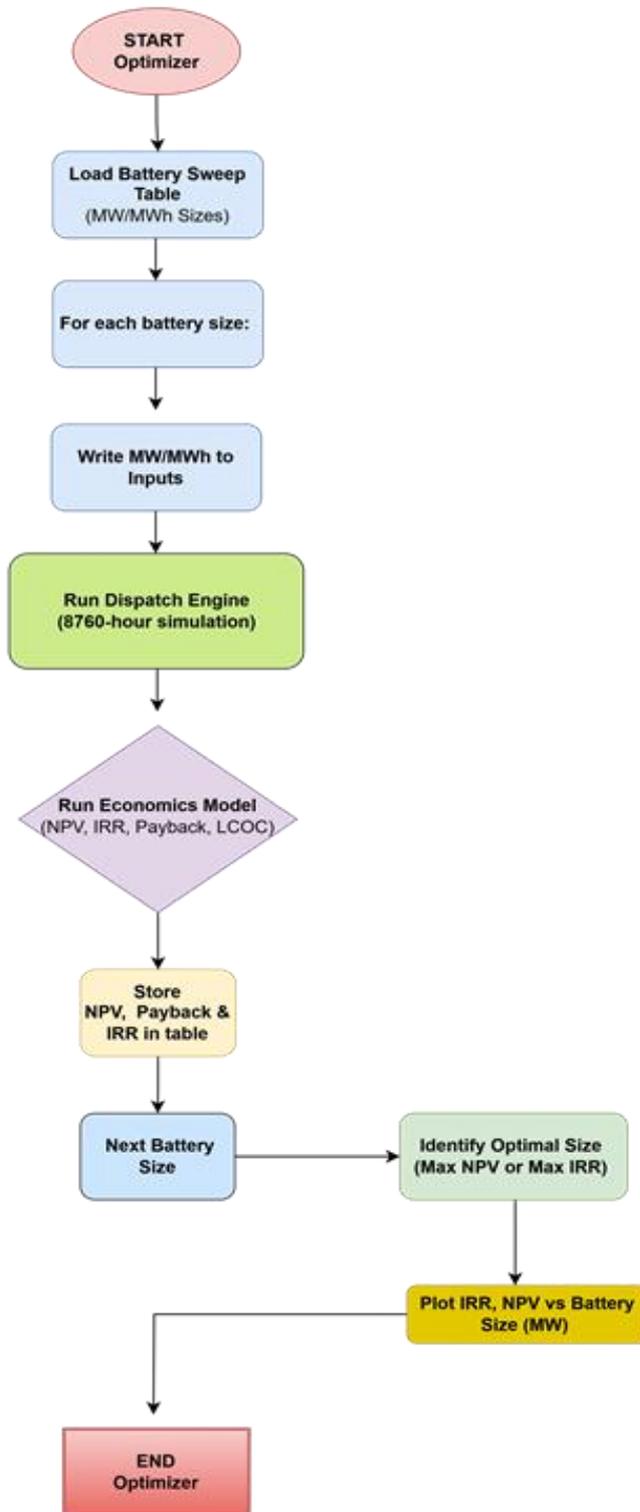
Erris Community Energy BESS Dispatch Logic

Appendix 3. Economic Calculation Flow Diagram

Erris Community Energy Economic Calculation Flow - 25-Year Model



Appendix 4. Optimizer Loop Flow Diagram



Erris Community Energy_BESS Optimization Loop Flow Model

