Egni Trefin Energy

Community Energy Feasibility Report

Authors:
Daniel Blackburn, Renewable Energy Project Co-ordinator
Alex Ferraro, Renewable Energy Project Officer

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Table of Contents

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- Permission to reproduce images from Community Energy Wale's "State of the Sector 2022 report" in this study.
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Glossary

Only the following forms of these acronyms and abbreviations will be used in this document. For instance, CEO is only used as defined below and never for Chief Executive Officer.

AAHDC - Assistance for Areas with High Distribution Costs
AD - Anaerobic Digestion
AGL - Above Ground Level
ASHP - Air Source Heat Pump
Capex - Capital Expenditure
CARE - Cwm Arian Renewable Energy
CCGT - Combined Cycle Gas Turbine
CCS - Carbon Capture & Storage
CEE - Community Energy England
CEO - Community Energy Organisation
CES - Community Energy Scotland
CEW - Community Energy Wales
CHP - Combined Heat and Power
CIC - Community Interest Company
CPI - Consumer Price Index
CSE - Centre for Sustainable Energy
DECC - Department of Energy and Climate Change
ECO - Energy Company Obligation
EPC - Energy Performance Certificate
EST - Energy Savings Trust
EV - Electric Vehicle
FTE - Full Time Equivalent
GDUoS - Generator Distribution Use of System
GIS - Geographic Information System
GN - General Notes
GSHP - Ground Source Heat Pump
GW - Giga Watt
GWA - Global Wind Atlas
FiT - Feed in Tariff
FOAK - First of a Kind
Ha - Hectare
IRR - Internal Rate of Return
KV - Kilo Volt
KW - Kilo Watt
LAEP - Local Area Energy Plan Local
LCA - Landscape Characteristic Areas
LDP - Local Development Plan
LES - Local Energy Scotland
LV - Low Voltage
MEEP - Marine Energy Engagement Plan
MEW - Marine Energy Wales
MHPA - Milford Haven Port Authority
MW - Mega Watt
NEA - National Energy Action
NEF - New Economics Foundation
NICE - Northern Ireland Community Energy
NOAK - Nth of a Kind
NRW - Natural Resources Wales
O&M - Operation & Maintenance
PCC - Pembrokeshire County Council
PCF - Pembrokeshire Coastal Forum
PCNPA - Pembrokeshire Coast National Park Authority
PEDW - Planning & Environment Decisions Wales
PPA - Power Purchase Agreement
PV - Photo Voltaic
REScoop - Renewable Energy Sources Cooperatives
RHI - Renewable Heat Incentive
SDF - Sustainable Development Fund
SEG - Smart Energy Guarantee
SP - Strategic Policy
TBG - Transition Bro Gwaun
WG - Welsh Government
WGES - Welsh Government Energy Service

Executive Summary

The 3 month, Cwmpas funded,"Trefin Energy" feasibility study, jointly run by Llanrhian Community Council and Trefin Improvement culminates in the production of this feasibility report and it's findings.

Through the online survey and community meeting it was found that the local community, across the Parish and not only within Trefin, have a strong desire and resource to enact change and create wealth, resilience and community enhancement, parish wide through a potential community owned renewable energy project. There were few outright objections, but plentiful curiousity and informed concern of what, where, who, and how.

It was found that the parish is blessed with multiple identified energy resources at different scales including micro-hydro, solar, wind, and marine thanks to it's diverse landscape. The identification and quantifying of these resources gives legitimacy to the idea of community energy projects of different scales in the area. Of these resources solar PV and wind represent the greatest and most accessible resources for a community energy project to be based on.

Taking into account all techno-economic implications, medium scale wind power, coupled with novel income model and domestic consumer supply scheme "Energy Local", outperformed all other project scenarios whilst delivering the key goals and opportunities of the community energy organisation. It is a clear signal that medium scale wind would be a favourable project to pursue at this stage in the community projects infancy. If successful it would then provide a sustainable platform by which other community energy endeavours could be explored and progressed.

Introduction

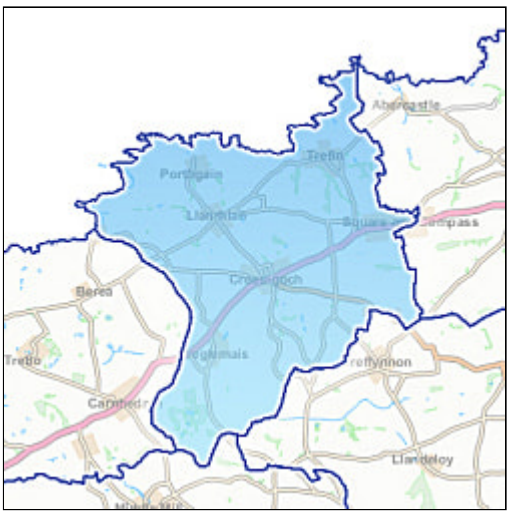
Trefin Energy is a three month project, funded by Cwmpas (Cwmpas, 2022) through a grant of £10,600 and is managed by Llanrhian Community Council in partnership with Gwelliant Trefin Improvement. Its focus is to commission a feasibility study into launching a community-led renewable energy project which will benefit the villagers of Trefin or the wider Llanrhian Community Parish as a whole. Its objective is to explore ways of harnessing local energy sources aiming in the longer term, to reduce energy bills, create a community benefit fund, contribute to energy security and to reduce carbon emissions, preferably through a locally-led enterprise.

A tender exercise was undertaken inviting other community energy groups or consultancies with relevant experience to bid for parts, or all aspects, of the feasibility study work. Cwm Arian Renewable Energy Ltd, as an established community renewable energy organisation with in house development expertise, were well-placed to bid for the full feasibility work. They were awarded the tender on April 14th 2023.

This feasibility report document represents the synthesis of the work CARE have been able to undertake in the short time frame and budget available. It aims to outline the renewable energy project possibilities given the areas resources and which of these the community may be most supportive of, ultimately providing Trefin Improvement and Llanrhian Community Council with information and conclusions for which projects may be best to move forward with and recommendations for how to do so.

Area Characteristics

Llanrhian Parish is a small ward within the county of Pembrokeshire covering an area of 2,327 hectares from the North Pembrokeshire coast between Abereiddy and West of Abercastle southwards to the the River Solva.



It has a low population of 870 (ONS, 2021), which is primarily concentrated in the villages of Trefin, Porthgain, Square & Compass, Croesgoch, Llanrhian and Tregemlais. A single primary school in Croesgoch serves these areas. The villages contain a small number of local businesses such as pubs, cafes, corner shops and petrol stations which are supported by the small rural permanent population and boosted greatly by tourism in the summer months. An agricultural merchants, also in Croesgoch, is indicative of the areas primary characteristic as farmland with no large businesses or energy consumers present aside from farms.

Topographically the parish is divided into two by a ridge running WNW from 106m ASL to 132m ASL atop which the main A487 broadly follows and the villages of Croesgoch and Square and Compass sit. This has created a narrow coastal region generally sloping northwards, creating the minor catchment and watercourses feeding into Abereiddy, Porthgain and Aber-draw while to south of the ridgeline the land generally slopes at a lower gradient

southwards creating the catchment for the River Solva.
With very little extensive woodland, the rolling slopes and gentle valleys to the coastal north provide panoramic views which suggest a timeless rugged beauty, a signature of the Pembrokeshire Coast National Park. The A487 itself suggests more modernity with large agricultural buildings prevalent in some views along with existing operating small to medium scale wind turbines to the south of the road.

Planning Policy & Guidance

Planning is a critical issue for the projects of Community Energy Organisations (CEOs) right across the UK. CARE has tried to make light of the difficult planning journey for its community wind turbine as covered by this film reference (CARE, 2017). Hopefully since the time referred to in the film, with a climate emergency declared by Pembrokeshire County Council (PCC) and by both Welsh and UK Governments, local planners are more welcoming of renewable energy projects and especially those by CEOs. This guide points to the main general considerations for renewable energy projects requiring planning permissions in the Llanrhian parish. It also points out where projects of CEOs are encouraged via planning policy and guidance.

National

Planning Policy Wales (PPW) Edition 11 (2021)

This main planning document for Wales mentions community energy in its section on "Local Involvement and Community Benefit" - paragraphs 5.9.24 - 5.9.28 (Gov.Wales, 2021). It outlines the following specific support for CEOs in the planning system:

- *the social, environmental and economic benefits with any* [CEO] *development should be fully factored in and given weight in the decision making process.*
- *some benefits* [of a CEO development] *can be justified as mitigation of development impacts through the planning process.*
- *planning authorities should be as accommodating as possible* [in regard to the particular assistance CEOs may require navigating through the planning system]

Despite this support, the policy also states "*planning decisions must be based on an assessment of the impacts of the proposed development, irrespective of who the applicant is"*. As a result, in relation to the CEO aspect of PPW it can feel that the policy lacks much bite and requires local planners to enter into the spirit of the words of these paragraphs to favour the developments of CEOs.

CARE case study - part 1

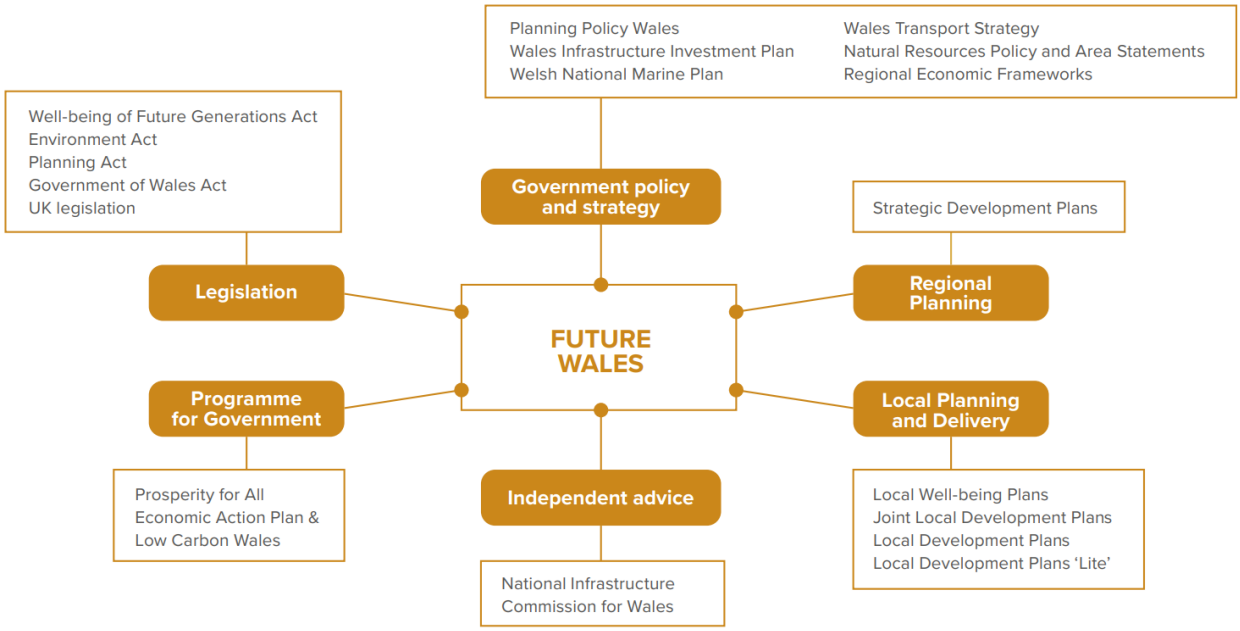
CARE's experience has been that, on occasion, the above spirit has not been entered into by the local planning process. In one community energy planning application, that was refused by PCC, it was indicated that no weight could be given to the CARE development because it could "be sold on to Richard Branson after approval". The Welsh Government's Planning & Environment Decisions Wales (PEDW) inspector went on to approve the subsequent application. Given this experience, even if local planning does not absorb the spirit of the PPW section on Local Involvement and Community Benefit, then there is hope that a PEDW inspector will.

There are numerous references in PPW to favour renewable energy developments in general which can be capitalised on in CEO planning applications:

- Paragraph 5.7.7: "*The benefits of renewable and low carbon energy, as part of the overall commitment to tackle the climate emergency and increase energy security, is of paramount importance."*
- Paragraph 5.7.14: "*The Welsh Government has set targets for the generation of renewable energy: • for Wales to generate 70% of its electricity consumption from renewable energy by 2030; • for one Gigawatt of renewable energy capacity in Wales to be locally owned by 2030; and • for new energy projects to have at least an element of local ownership. The planning system has an active role to help ensure the delivery of these targets."*
- Section 5.9 Renewable and Low Carbon Energy, paragraphs 5.9.1 – 5.9.30: This major section repeatedly highlights the importance of renewable energy developments in relation to planning. It details how local authorities should take the lead promoting renewable energy to maximise their area's potential through having strategic plans and consequently a supportive planning system. It also points to the toolkit for planners when planning for renewable and low carbon energy (Gov.Wales, 2015).

Future Wales - The National Plan 2040

This is another major document that has relevance to renewable energy and the national planning system framework. Future Wales in its opening statement: "*is a development plan with a strategy for addressing key national priorities through the planning system, including … achieving decarbonisation and climate-resilience ….. and improving the health and well-being of our communities"* (Gov.Wales, 2021). It relates to how local government develop their local planning in the following way.



The plan sets out its strategic aims via policies to prioritise the planning system. The climate emergency, decarbonisation and promoting renewable energy are front and centre of this document which can be readily referenced. The strategic policies that support renewable energy developments include:

- Policy 12 – Regional Connectivity. Where increase in the generation of renewable energy is supported in the transition to low emission vehicles.
- Policy 16 – Heat networks. These should have a renewable / low carbon or waste heat energy source.
- Policy 17 – Renewable and Low Carbon Energy and Associated Infrastructure.
    - *"In determining planning applications for renewable and low carbon energy development,*

decision-makers must give significant weight to the need to meet Wales' international commitments and our target to generate 70% of consumed electricity by renewable means by 2030 in order to combat the climate emergency."

- *"Proposals should describe the net benefits the scheme will bring in terms of social, economic, environmental and cultural improvements to local communities*."

- Policy 18 - Renewable and Low Carbon Energy Developments of National Significance.
  - *"Proposals for renewable and low carbon energy projects (including repowering) qualifying as Developments of National Significance will be permitted subject to…criteria"*

For planning applications the national policies and guidance outlined in the "Definitions & Policy Guidance" below can also be used for their material implications in relation to gaining consent for the renewable energy projects of CEOs.

Pembrokeshire County Council

The main local basis for planning decisions in Pembrokeshire is PCC's Local Development Plan (LDP) adopted on 28th February 2013 (PCC, 2013). This is a document that has a Vision and Objectives for Pembrokeshire, which it aims to achieve via Strategic Policies (SPs). The renewable energy developments and work of CEOs align with all three of these elements of the LDP which provides material weight in planning terms for their developments.

From the "Benefits" section below it can be seen that the work of CEOs aligns with the LDP Vision which states:

"To ensure that Pembrokeshire is prosperous and that it remains vibrant and special by creating: a network of strong ….. rural communities in ….. Service Centres, Service and Local Villages supported by a robust, sustainable, diverse high value-adding economy underpinned by the Area's unique environment, maritime access to the Milford Haven Waterway and Fishguard Harbour and internationally important energy ….. opportunities."

Given the content of this feasibility report it can also be seen that CEO developments in the county have the ability to contribute to 7 out of 10 of the LDPs strategic objectives:

A) Mitigating and responding to the challenge of climate change
B) Delivering design excellence and environmental quality
C) Sustaining and enhancing the rural and urban economy
D) Developing vibrant communities providing a range and mix of homes and local services
E) Building on the County's strategic location for energy and port related development
I) Improving access to goods and service
J) Protecting and enhancing the natural and built environment

They also contribute to the following Strategic Policies:

SP1 Sustainable Development
Sustainable development is highlighted in the LDP as the policy that overarches all the other SPs. The LDP also states that "*The planning system provides for a presumption in favour of sustainable development*". To

avoid vagueness the LDP uses the following specific definition from Planning Policy Wales, the national planning policy, to define sustainable development:

"*In Wales, this means enhancing the economic, social and environmental well-being of people and communities, achieving a better quality of life for our own generations in ways which:*

- *Promote social justice and equality of opportunity; and*
- *Enhance the natural and cultural environment and respect its limits – using only our fair share of the earth's resources and sustaining our cultural legacy.*

Sustainable development is the process by which we reach the goal of sustainability."

This is a fair summary of the work of CEOs and what they usually seek to achieve through renewable energy developments.

SP8 Affordable Housing Target

In relation to this policy the LDP states that *"Everyone in the County should have access to a good quality home that meets their housing requirements"*. Despite this in Pembrokeshire people suffer some of the worst levels of fuel poverty in the UK. The need to combat the poor condition of the housing stock is highlighted in the LDP in section 3.10 where it states that: *"The condition of Pembrokeshire's housing stock across all tenures needs improving, in particular to meet the Welsh Housing Quality Standard and to tackle fuel poverty"*. The contribution to this SP is clear through the robust record of Welsh CEOs in tackling fuel poverty.

SP9 Welsh Language

This policy sets out to "*protect the cultural and linguistic profile*" of Welsh speaking communities, such as those that surround the proposed development, "*so far as this is possible through the planning system*". Again the contribution to this SP is clear through the solid record of Welsh CEOs in supporting the Welsh Language.

SP15 Rural Settlements

This policy is aimed at meeting the challenge of "*keeping services viable in rural areas*". As discussed, and demonstrated the work of CEOs clearly keeps rural local services viable.

SP16 The Countryside

The overview of this policy states that:

"*The essential requirements of people who live and work in the countryside will be met whilst protecting the landscape and natural and built environment of Pembrokeshire and adjoining areas. Development ..... will be promoted [for] Enterprises for which a countryside location is essential*".

CEO developments help meet the essential requirements of people who live and work in the countryside. For many CEO renewable energy developments a countryside location is essential due to the need to be located away from residential properties.

In addition to the Strategic Policies, the Pembrokeshire LDP has an even longer list of General Policies or General Notes (GN). There are too many GNs to discuss in relation to CEO developments however "*GN.5*

Resource Efficiency and Renewable and Low-carbon Energy Proposals" is cited in renewable energy developments as it clearly states: "*Developments which enable the supply of renewable energy through environmentally acceptable solutions will be supported*."

The current adopted PCC LDP should have expired in 2021 and so is under review and a preferred strategy has been published regarding the proposals arising from the initial consultations; this is likely to be the foundation for the new LDP, LDP2, once finalised (PCC, 2018)

CARE case study - part 2

Like many Local Authorities the planning department of PCC is overwhelmed, leading to lengthy delays in determining renewable energy applications. All of CARE's renewable energy applications have gone beyond the statutory 12-week period within which PCC has to determine an application. The long delays are detrimental to projects and the morale of community groups who have developed them. Initially CARE would patiently wait until the application was determined by local planners even if this was well after the 12-week period. Latterly CARE's experience has been that it is more time efficient if after the statutory period an appeal is lodged with the WG Planning Inspectorate PEDW. It seems an appeal can prioritise a planning application for determination locally. Alternatively if the appeal does go to WG PEDW inspectors their planning decision is more likely to be favourable as they will reflect the up to planning guidance of Wales. Both these outcomes are easier for community groups to manage rather than indeterminate waiting.

In addition to the Local Development Plan, Pembrokeshire have been one of the first local authorities in Wales to develop a Local Area Energy Plan (LAEP) (PCC, 2022). These LAEPs are being developed by counties right across Wales to enable them to decarbonise. In May 2019, Pembrokeshire County Council declared a Climate Emergency, and committed to support Pembrokeshire's journey to net zero carbon by 2050. Based on this commitment and the completion of the LAEP it is anticipated that these will strongly influence the new LDP2 and make it easier, than it traditionally has been, to get planning consent for CEO developments in the county. The vision of the Pembrokeshire LAEP can be best summarised by this info graphic:

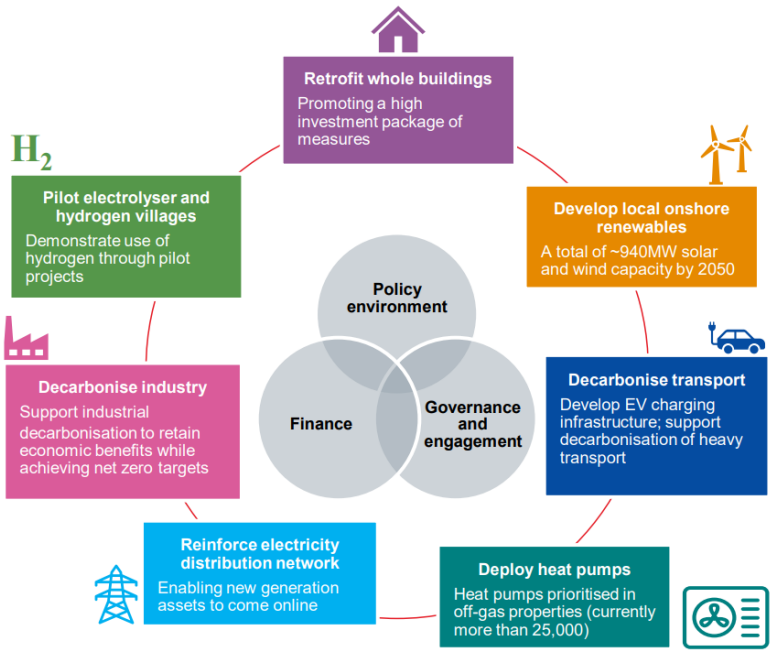


Figure 21: Priority intervention areas in Pembrokeshire

Action 2 of the LAEP is to "*Develop local onshore renewables*". This is broken down into "*Action 2.1. Update local development plan*" and "*Action 2.2 Develop a programme of renewable energy development*". Encouragingly Action 2.2 states:

"*We will develop a programme of renewable energy development with appropriate commercial models. We will learn from previous renewable energy planning applications and consider the merits of different ownership strategies and commercial models: from self developing land ….. to community-led renewables projects.*"

The LAEP prescribes a massive increase in the amount of roof and ground mounted solar PV in Pembrokeshire, which is encouraging for applications for these projects in relation to CEOs. However, given the cost effectiveness of onshore wind to generate electricity it seems rather misguided that the LAEP does not recommend an increase in this energy source in the county.

Pembrokeshire Coast National Park Authority

The yellow line indicates the boundary of the Pembrokeshire Coast National Park.

The northern 1-3km of coast of Llanrhian Community Parish lies within the boundary of the Pembrokeshire Coast National Park as illustrated above. The National Park status is designated in order "to conserve the natural beauty, wildlife, and cultural heritage of the area". The Pembrokeshire National Park Authority (PCNPA) has produced Supplementary Planning Guidance for Renewable Energy (PCNPA, 2021) which was

adopted 5th May 2021. It provides an explanation of potential technologies at various scales giving key sensitivities and guidance for the Park in general. For scales of ground mount solar and wind projects it assesses the sensitivity of specified Landscape Character Areas (LCAs) within the Park to these technologies, along with guidance for developers as to what may be permissible that "should not adversely affect the special qualities of the National Parks".

Overall the PCNPA is aligned with Welsh Government net-zero targets, stating:

"*Designated landscapes must contribute to a sustainable low carbon economy for Wales, for example, through enabling the generation of renewable energy at an appropriate scale, water management and carbon sequestration*"

Of particular relevance to this feasibility study is the following statement supporting community energy schemes:

"*Communities should be supported to bring forward appropriate renewable energy schemes which have the potential to reduce dependence on carbon based energy and be a source of revenue for the community*"

Table 1 below summarises the general PCNPA guidance for a given technology:

Table 1: Summary of PCNPA General Guidance

Technology	Suitability	Sensitivities within the PCNP	Guidance
Small Scale Solar PV & Thermal	All areas of the National Park have good potential for solar energy generation; and small-scale solar installations can make a key contribution to meeting renewable energy targets in the National Park	Can be used throughout the Park due to low landscape impact so long as care is taken to minimise to an acceptable level the visibility of the units. Both technologies can be retrofitted on the roof of existing buildings using roof-mounted panels or integrated into the design of new buildings, such as through the use of PV roof shingles. Designated buildings and Conservation Areas are likely to be particularly sensitive to small scale solar installations. Retrofitted roof-mounted solar units on buildings can sometimes have a 'modernising' effect on their character and appearance, particularly when they are located on the principal elevation of a property. It is therefore beneficial for solar panels to: match other roof materials; lie be flush with the roof and be mounted at the same angle to minimise contrast; be mounted on a side or rear roof elevation where they are likely to be less visible in the case of retrofitted panels, or incorporated as a garden feature, especially in the case of older buildings; be located and at a suitable angle to maximize the capture of the sun's	In this way solar technologies can help: maintain and enhance the rich heritage of historic buildings and settlements of the National Park reflecting their local character. ensure that new development, restoration and conversions reinforce and enhance the character of settlements and their setting. ensure that high quality modern design fits neatly and complements building traditions of the past.

		energy	
Anaerobic Digestion	Dependant on scale and availability of feedstocks locally	Areas of the National Park where AD development of any scale should be avoided are: Tranquil, rural areas where human influence is limited. The coastal edge. All areas of semi-natural habitat. Areas with a strong historic character.	Large commercial AD plants are unlikely to be acceptable
Biomass & CHP	Large electricity production - Unsuitable Domestic/small scale dependent on scale of landscape & settlement	□ Historic buildings, listed buildings and those located in Conservation Areas will require care in the siting of new structures and flue. □ Avoid visible installations in prominent locations and key views, particularly along the coastline □ Installation must not affect designated features or character and appearance of conservation areas	Larger scale commercial plants unsuitable. Small scale community plants possible if sensitively built/sited.
Micro-hydro	Well-developed in Wales, most sites with a potential greater than 1 MW exploited. 'Run of river' with an installed capacity of less than 100kW and the restoration of traditional mills (both river mills and tidal mill) realistic in PCNP. Appropriate locations for 'storage' schemes, where a large body of water is dammed and flow released through turbines when power is required, are unlikely to exist.	Hydro schemes sited in rivers lined with trees may be concealed more easily than those in open landscapes. □ In areas of more open landscape, high standards of design will help to minimise visual impacts, including the use of local materials for weirs and built structures along with vegetation screening. □ Burying pipelines and minimising hard surfacing and 'formal' planting can help to integrate more visible schemes into the rural landscape. □ Mills that are Listed Buildings and/or located within a Conservation Area require sensitive restoration that respects the structure of the original building. □ Measures should be taken to minimise any visual or noise impacts on the amenity of neighbouring land uses.	Appropriate siting and design, utilising landform and existing vegetation to help screen the new small turbine housing. Sensitive restoration of old water mill sites or other structures (i.e. weirs, mill ponds, millraces or leats, sluice gates and tailrace outlets) will bring considerable conservation benefits over and above the generation of electricity
Ground Source and Air Source Heat Pumps (GSHP & ASHP)	There are opportunities to use ground and air source heat pumps throughout the National Park.so	Underground pipework can easily be covered with soft or hard surfaces and so the system will not be visible from outside the building. □ During construction, the laying of pipes linked should avoid disturbing ground which would be difficult to restore, such as unimproved grasslands, semi-natural habitats, tree roots and archaeological remains. □ Pembrokeshire Coast National Park Authority may require an archaeological survey before construction □ Air source heat pumps should be mounted on the least visible elevations, such as the rear or side elevation of the building if using an externally	Because of their minimal landscape impacts, all areas of the National Park could be considered for the installation of ground and air source heat pumps.

		mounted unit. Internal units are appropriate anywhere within the National Park. Measures should be taken to minimise any visual and noise impacts on the amenity of neighbouring land uses.	
District Heating	Scope for small-scale district heating systems associated with community facilities within the such as swimming pools, leisure centres, sports halls, day and community centres, hotels and businesses, potentially combined with an adjacent new development.	-	The most appropriate opportunities will be small-scale district heating schemes associated with new development within the main settlements of the National Park, and small-scale schemes linked to an existing facility that has a large heat demand.

Trefin is assessed as "LCA20" or Landscape Characteristic Area 20 within the document. PCNPA's guidance for Trefin can act as a proxy for the other areas of Llanrhian Parish within the Park. Table 2 & 3 below summarises the PCNPA's assessment of Trefin regarding scales of solar and wind developments:

Table 2: Trefin LCA Guidance for Field Scale Solar PV		
Overview	Although the undulating nature and scale of the landscape could indicate reduced sensitivity to solar PV development, the strong pattern of medium scale irregular fields, high percentage of pasture land, limited enclosure, presence of highly valued natural habitats, important historic features and sense of remoteness along the coast all increase levels of sensitivity to solar PV development.	
	LCA Sensitivity Rating	**LCA Key Sensitivities**
Large Scale Field Solar PV (5MW, >5ha)	High	Its open and exposed character with few woodlands particularly along the coast. The extensive views along the coast and the essential relationship of this landscape with its coastline. The area's strong relative sense of remoteness, particularly along the coastal edge. Its highly valued habitats of international importance, particularly along the coastal cliffs and the areas of lowland heathland. The strong, irregular field pattern defined by hedgebanks and walls. The nationally important archaeological sites, including prehistoric and early Christian monuments and remains relating to its industrial past, such as lime kilns. The character and appearance of the Conservation Areas at Porthgain and Trefin
Medium Scale Field Solar PV (1-5MW, 3-4.9ha)	High	
Small Scale Field Solar PV (0.5MW-1MW, 1-2.9ha)	Moderate	
Very Small Scale Field Solar PV (100-500kW, <1ha)	Moderate	
PCNPA Guidance		

- The presence of a strong pattern of irregular medium scale fields, limited enclosure and valued semi-natural habitats means that the landscape is particularly sensitive to 'medium' and 'large' scale PV developments. Small fields would also be sensitive to all but the smallest 'small' scale PV developments.
- The natural and highly visible coastal edge and wooded inlets would be sensitive to all scales of solar PV development requiring that any PV developments are sited well back from the coastal edge so that they do not detract from its remote and strong cultural sense of place.
- Avoid all scales of PV development in areas of very small fields.
- More generally do not allow PV development to mask the field pattern with development across multiple fields
- Use folds in the landform and small woodland clumps and scrub to screen PV development from public vantage points including rights of way, favouring flat landforms and lower slopes, while avoiding prominent landforms, highly visible slopes, or coastal headlands.
- Avoid development in the more remote and tranquil parts of this LCA. No development should occur on the open swathes of lowland heathlands and coastal cliffs of international importance.
- Ensure that PV development does not affect the wealth of historical and archaeological features present, dating from prehistoric times to the recent industrial past, with the northernmost area of this LCA Pen Caer: Garn Fawr and Strumble Head Registered Landscape of Special Historic Interest in Wales.
- Ensure that PV development does not affect the character and setting of the Trefin and Porthgain Conservation Areas, the latter recognising the large-scale industrial heritage of the area.
- Protect views along the coastline from the Pembrokeshire Coast Path, other rights of way and public vantage points.
- Avoid locations where PV developments would be directly overlooked at close quarters by important/sensitive viewpoints

Table 3: Trefin LCA Guidance for Wind Power

Overview	This landscape's large scale, open aspect, settled character, and past industrial activity may indicate that features such as wind turbines may be accommodated within the LCA if sensitively sited. However, its open undeveloped skylines, extensive coastal views, relative sense of remoteness on the coastal edge, highly valued coastal and heathland habitats, and presence of nationally important archaeological and historic sites all increase sensitivity to wind turbines.	
	LCA Sensitivity Rating	**LCA Key Sensitivities**
Large Turbines (65-125m tip height, 330kW-5MW)	High	Landscape attributes that are particularly sensitive to wind turbines are: □ Its large scale, open aspect and undeveloped skylines. □ The extensive views along the coast. □ The area's strong relative sense of remoteness, particularly on the coastal edge. □ The wealth of nationally important archaeological sites, particularly related to the area's industrial heritage such as lime kilns and the famous Blue Lagoon quarry. □ The character of the Conservation Areas at Trefin and Porthgain. □ Its highly valued habitats, particularly along the coastal cliffs and the areas of lowland heathland.
Medium Turbines (25-65m tip height, 50-330kW	High	
Small Turbines (<25m tip, 10-50kW)	Moderate-High	

PCNPA Guidance

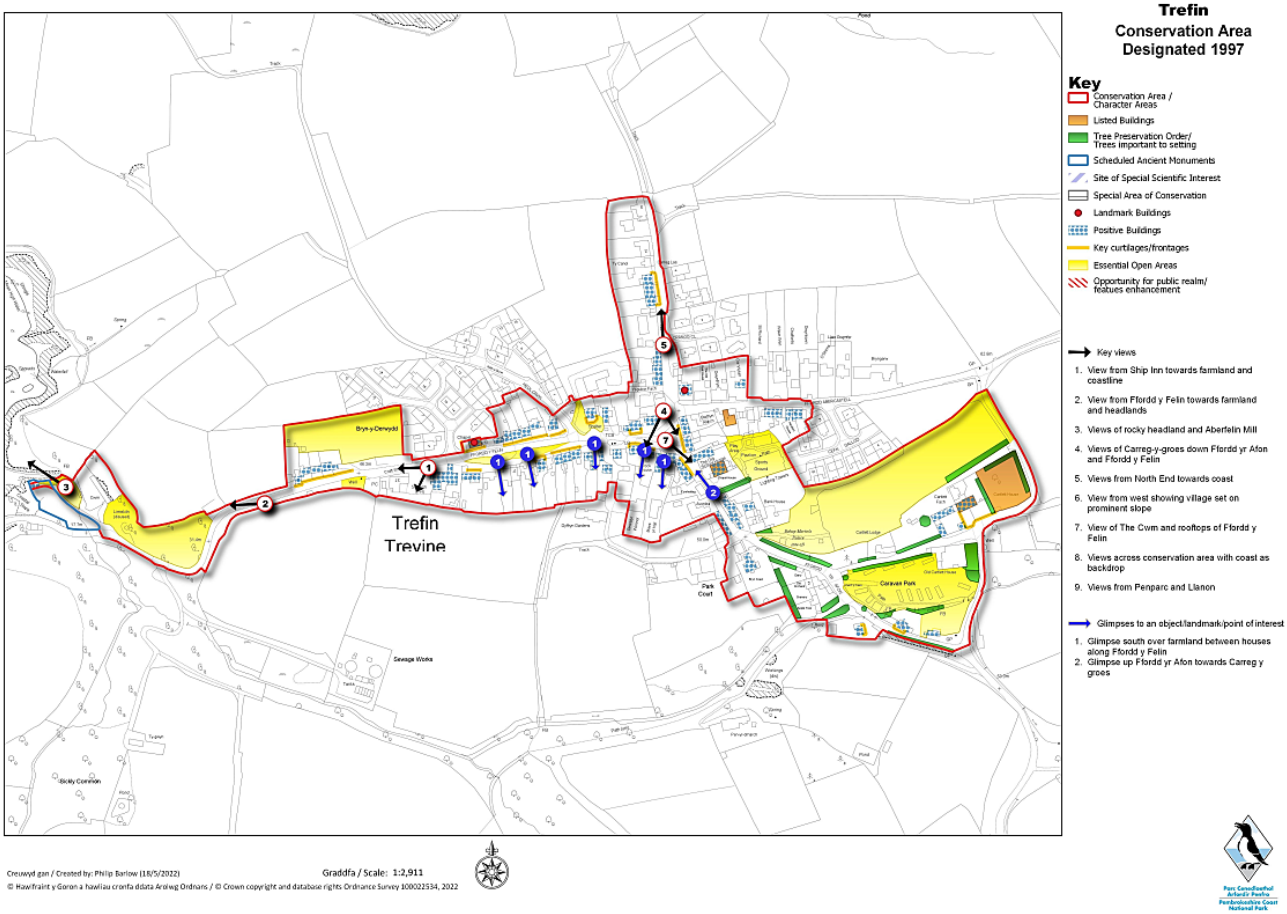
- Large and medium scale turbines would not be appropriate in this landscape.
- There may be limited opportunity for single or small clusters of small scale turbines as long as they are sensitively sited and take account the guidance below.
- Only site small scale turbines in areas where they can visually relate to existing buildings or built structures in the landscape.
- Avoid the proliferation of separate small turbine schemes along the same ridgelines.
- Avoid the close juxtaposition of different turbine designs and heights, aiming instead for a consistent height and design in any given area. Further supplementary guidance for developers on cumulative impact of wind turbines is available here.
- Maintain open views along the coastline by siting turbines and related infrastructure away from the coastal edge. Protect views to this coastline from the inland LCAs (15 and 16) by sensitively siting turbines.
- Ensure turbines and related infrastructure do not affect the area's valued heathland and cliff-top habitats.

- ☐ Ensure turbines do not adversely affect the character or setting of the Conservation Areas at Trefin and Porthgain.
- ☐ Ensure turbines do not adversely affect the area's valued historic and archaeological features, including lime kilns and other features linked to its industrial heritage.
- ☐ The National Park Authority should ensure that any wind turbine development located within this LCA does not sacrifice the essential integrity, coherence and character of the landscape or the special qualities of the National Park.

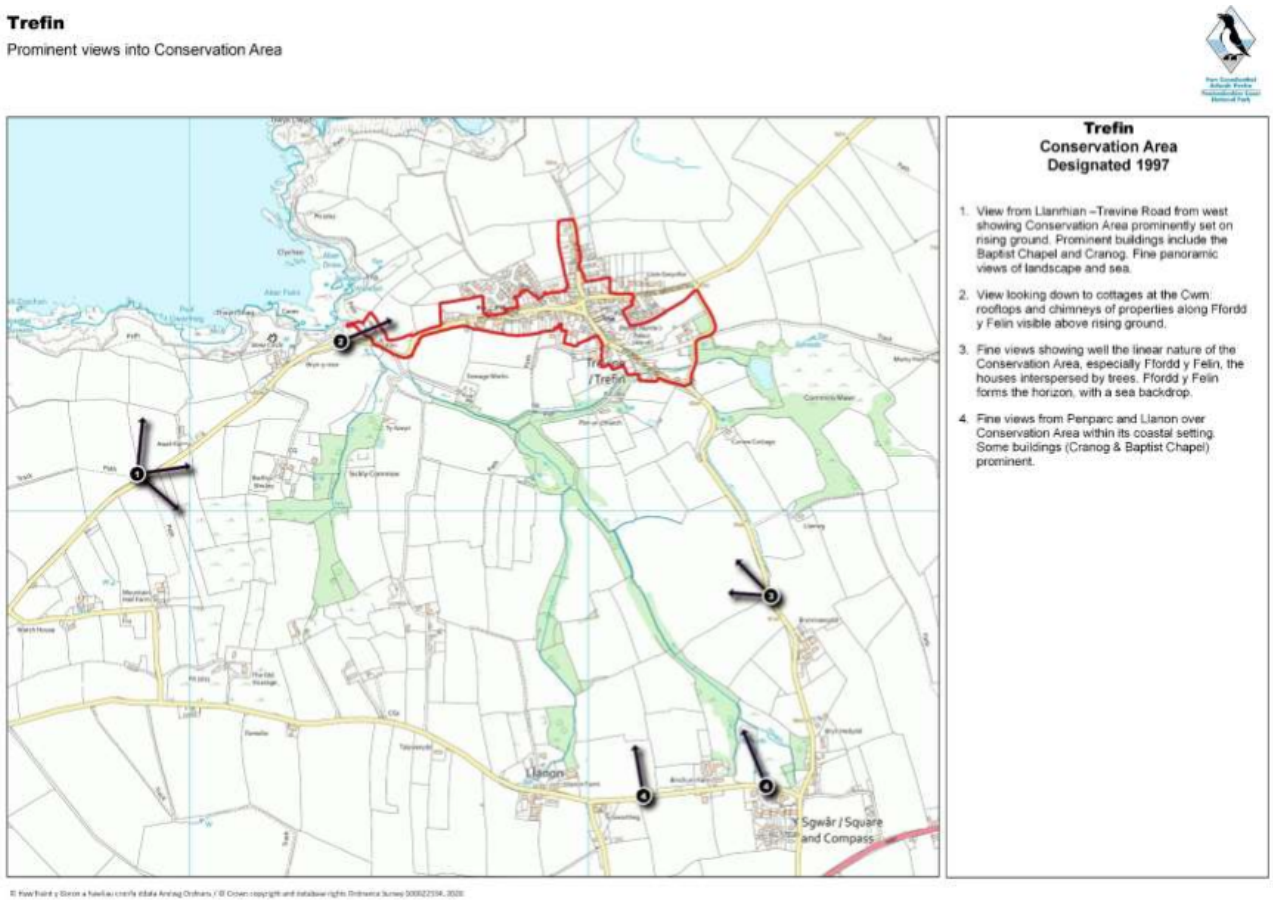
Conservation Areas

Trefin Conservation Area Supplementary Planning Guidance

PCNPA adopted the Supplementary Planning Guidance for the Trefin Conservation Area on October 26th 2022 (PCNPA, 2022)



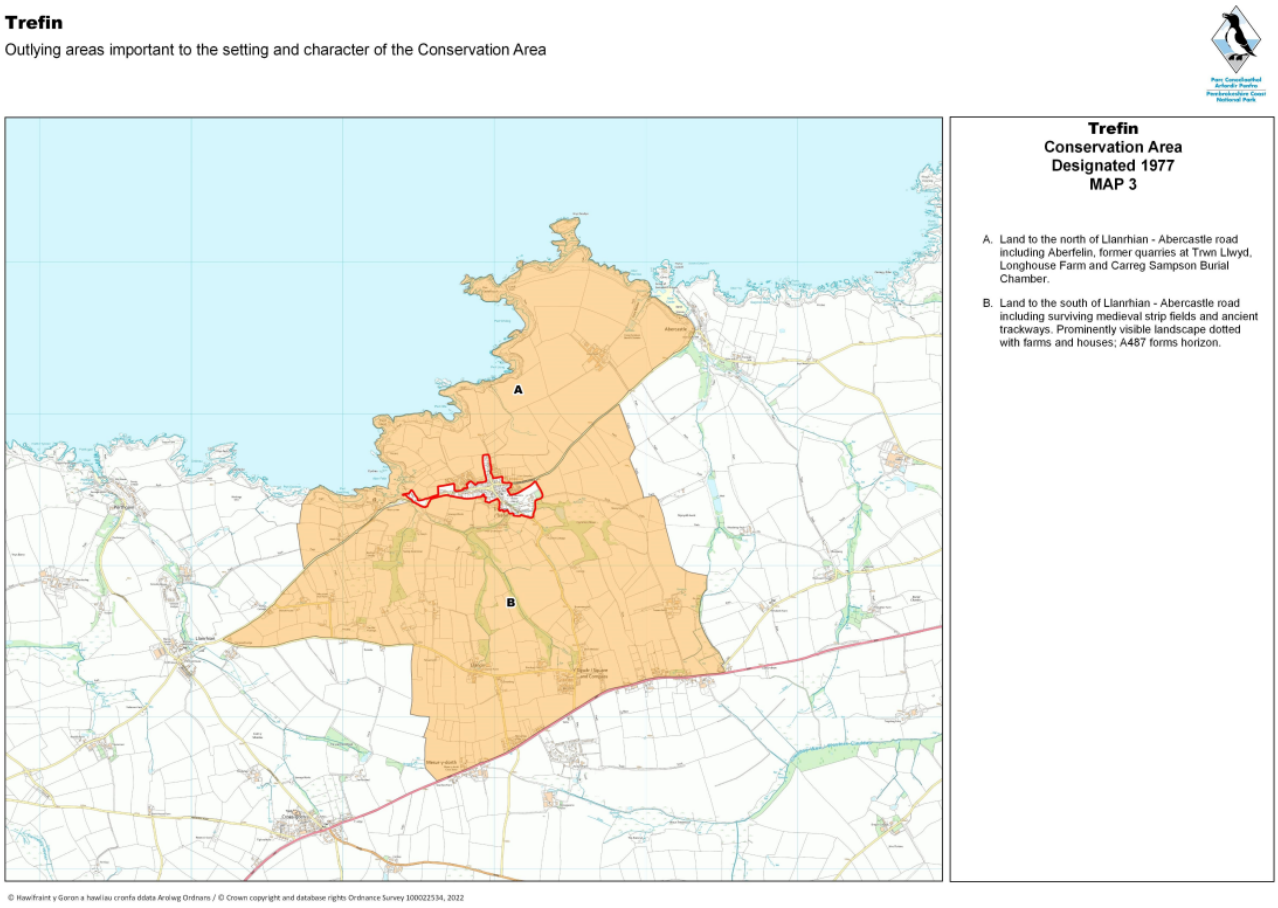
It is a key document regarding any Trefin focused development as it provides guidance on the suitability of rooftop solar PV within the conservation area as well as the key views within and towards the conservation area that are to be protected to maintain its landscape setting, thereby informing potential locations for field scale solar PV. The key prominent views and glimpses from within the area are to the south over the stream valley and farmland, west towards the bay and Ffordd y Felin, with a single view Northwards to the coast along North End Rd. The key views towards the conservation area are from the higher grounds to the south along the minor road as indicated in the map below.



Any community development of solar PV would need to take these views into consideration. At rooftop scale, although permitted development, buildings within the conservation area with roof pitches visible to these viewpoints would potentially need to consider solar PV that retains the character of the visible roofscape of Trefin, such as solar slate tiles or roof integrated panels of dark colour. The SPG provides the following guidance:

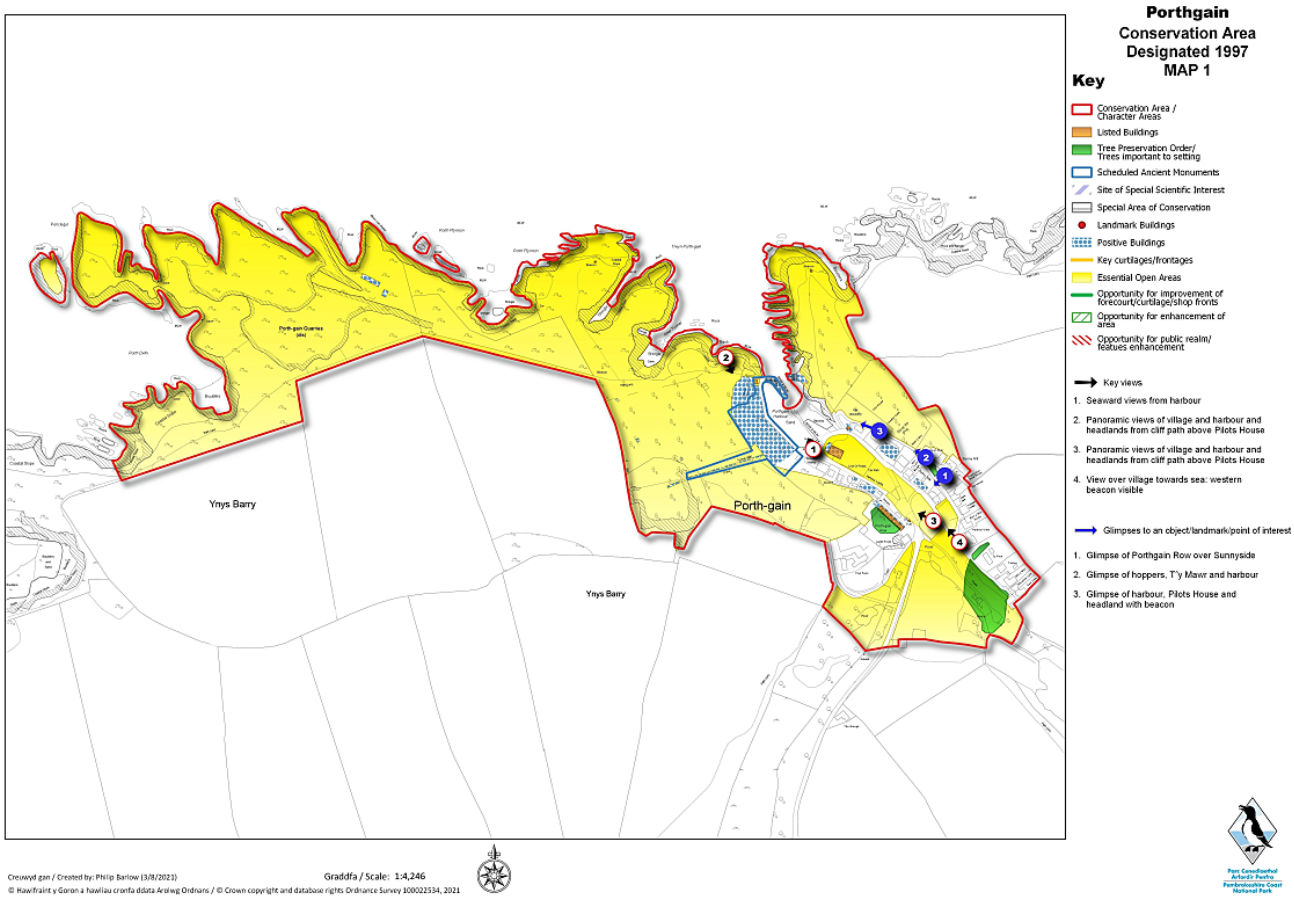
- *"The need to promote energy efficiency will be balanced against the need to protect the character and appearance of the area when dealing with proposals for solar panels in Conservation Areas. Due to sensitivity of the Conservation Area to modern alternations, careful consideration will need to be given to the siting and design of the panels."*
- *"Notwithstanding prevailing householder permitted development rights, the installation of microgeneration equipment on the principal elevations of buildings or in prominent locations within Conservation Areas will require careful consideration. Alternative locations at the rear of buildings, on subsidiary outbuildings or ground.-mounted, where the panels would not be visible from the highway, should be considered. They should not project more than 200mm from the roof or wall surface. Solar slates along with an increasing number of 'heritage range' products are available*."
- *"The panels themselves should be of a dark colour and the framing should be in matt black or grey. Standard light-coloured blue panels with reflective light grey framing should be avoided."*

At field scale topography, vegetation, and built environment would need to be assessed to determine appropriate locations, if any, for solar arrays with the least visible impact on these views and from the Pembrokeshire Coast Path itself. The classification by PCNPA of surrounding areas that are important to the setting and character of the conservation area, as shown in the map below, adds further restrictions on feasible locations.



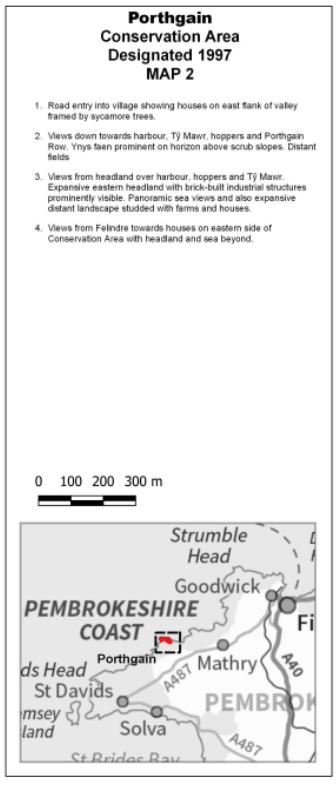
Porthgain Conservation Area Supplementary Planning Guidance

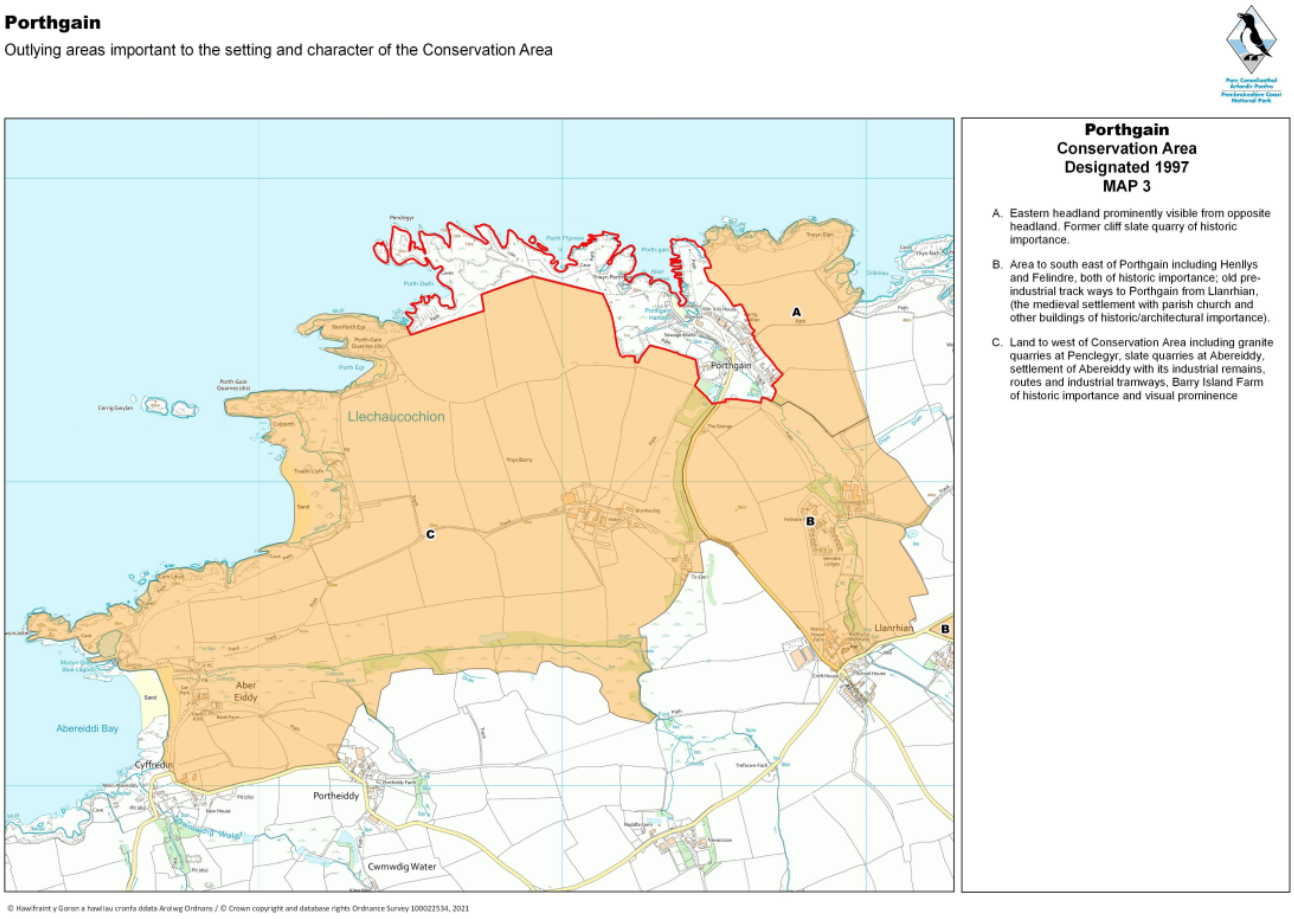
Llanrhian Parish also contains the second conservation area of Porthgain (PCNPA, 2022). Whilst less visible from the south and A487 due to the topography, it nonetheless has similar restrictions regarding developments within the conservation area, particularly as it has a higher proportion of Listed Buildings than Trefin, as well as restrictions on feasible locations for field scale solar PV.outside the conservation area due to landscape setting.



Porthgain

Prominent views into Conservation Area





Community Energy

This section reviews the policy framework that community energy exists within in Wales. It also outlines the many benefits of CEOs, their potential organisational legal structure and sources of funding and support for their work.

Definitions & Policy Guidance

The UK government outlines community energy as being the following:

- *Community energy covers aspects of collective action to reduce, purchase, manage and generate energy.*
- *Community energy projects have an emphasis on local engagement, local leadership and control and the local community benefiting collectively from the outcomes.*
- *Community-led action can often tackle challenging issues around energy, with community groups well placed to understand their local areas and to bring people together with common purpose.*(GOV.UK, 2015)

The UK government has produced a Community Energy Strategy (DECC, 2014).

Community Energy in Wales is a devolved matter. The Welsh Government define community energy ownership as:

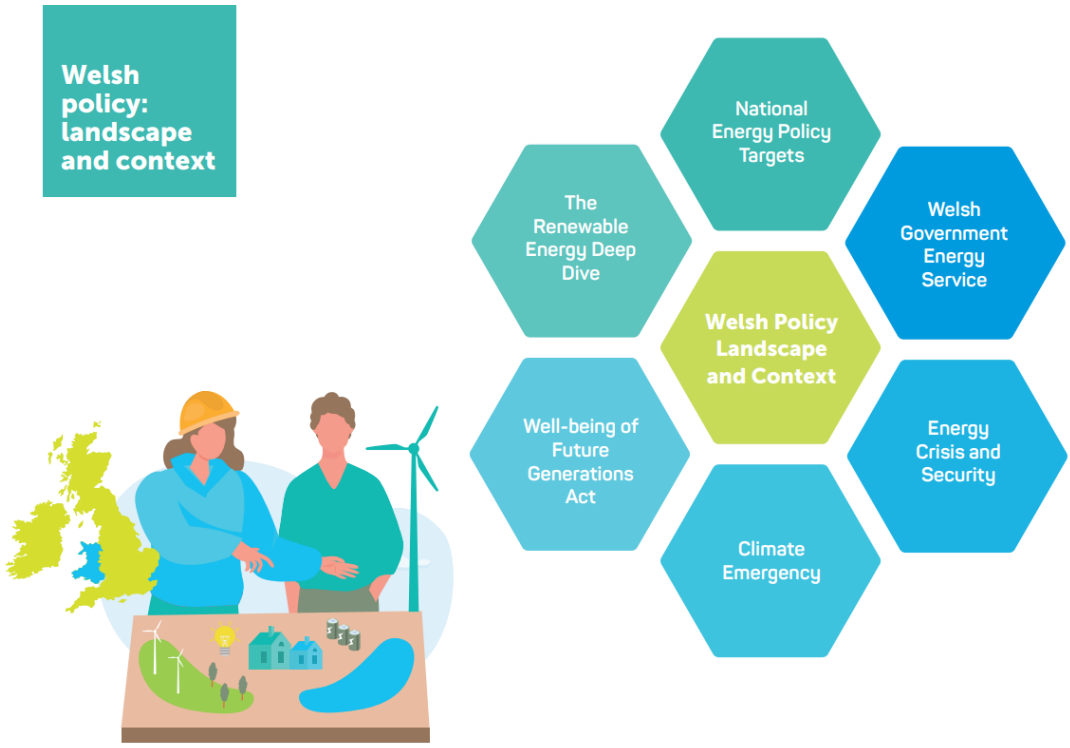
"...as a renewable energy or renewable storage development located in Wales, which is wholly owned by a social enterprise whose assets and profits are committed to the delivery of social and/or environmental objectives".(Gov.Wales, 2019)

Community Energy sits within the Welsh Government's aspirations for energy projects to have local or shared ownership (Gov.Wales, 2020), (Gov.Wales, 2022). Welsh Government has set targets for community ownership and local ownership of energy projects. These include a commitment "*to expand renewable energy generation by public bodies and community enterprises in Wales by over 100 MW between 2021 and 2026.....to meet our longer term target of 1 GW of renewable energy generation capacity to be locally owned by 2030"* (Gov.Wales, 2021). A further target of at least 1.5 GW of renewable energy generation capacity to be locally owned by 2035 has been proposed by the WG Climate Change Minister (Gov.Wales, 2023), following the recommendations of the Renewable Energy Deep Dive (Gov.Wales, 2021). Despite the term "locally owned" encompassing more than just community energy, it does in part show Welsh Government's level ambition and commitment to community ventures which should be encouraging to any new groups just getting off the ground. In relation to these targets as of 2022, 27.5 MW of renewable energy generation capacity was owned by community energy organisations (CEW, 2022).

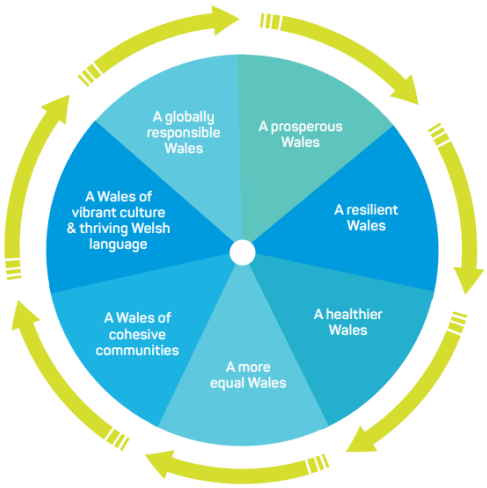
Looking to the future Welsh Government policy landscape for community energy, there are two note-able current drivers:

- The cooperation agreement between Welsh Labour and Plaid Cymru (Gov.Wales, 2021). This stipulates the formation of a "*net zero energy company – work towards the creation of Ynni Cymru, a publicly-owned energy company for Wales, over the next two years, to expand community-owned renewable energy generation."* The exact detail of Ynni Cymru and how it will expand community-owned renewable energy generation is hoped to be released imminently and almost definitely before the end of 2023.
- The Renewable Energy Deep Dive has made numerous recommendations to WG which form the basis of its direction (Gov.Wales, 2023). In relation to community energy these include: scaling up resources to support community and local renewable energy in Wales; ensuring that the community owned sector is involved and gains input into Ynni Cymru and improving access to the public estate for the community energy sector. As the Renewable Energy Deep Dive advisory team has good representation from the community energy sector it is hoped that this will continue to be a positive influence for communities wanting to engage with energy.

In addition to the above community energy also directly relates to a number of other Welsh Government policy landscape and context areas as shown by this info graphic from the Welsh community energy state of the sector report (CEW, 2022).



Finally, community energy relates so well to the Well-being of Future Generations Act that it would be remiss not to mention the connection (Gov.Wales, 2015).



Benefits

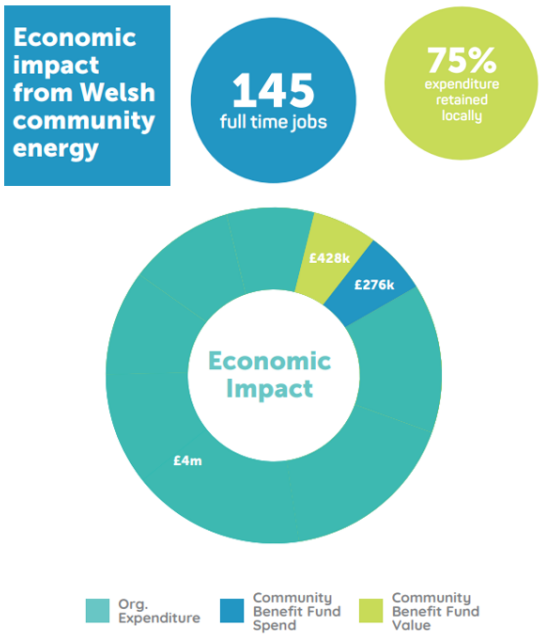
Various groups that have attempted to summarise the benefits of community energy, here are some of the more notable attempts (CEE, n.d.), (EST, 2021), (REScoop n.d.), (ICEER, 2020) & (Brummer, 2018) . This section attempts to synthesise these summaries with the perspectives from those involved in community energy organisations that are local to the project site. The benefit sections below are also summarised in the mind map in Appendix A. It is clear community energy delivers a huge array of benefits in many areas and at many different levels. This provides clear encouragement for communities to get involved and for agencies, businesses and all levels of government to support communities in this important area.

Economic

The standard model for community energy in Wales has been to establish a community owned renewable energy generator, usually wind, solar or hydro, and for this to act as an enterprise to generate income for the community. The financial benefits from these community energy enterprises can be seen up and down the nation, with money generated spent on local priorities. When successful the increase in economic benefit before and after the establishment of these projects is clear to see with the greater presence of financial resources both circulating in local economies and funding local ventures. What these additional economic resources are used for is only limited by the imagination of communities that manage these projects. There are too many different examples of how these resources are being spent to list them all here. Needless to say the resources are often targeted at areas vital to local communities to help safe guard their residents and local services that are often being eroded.

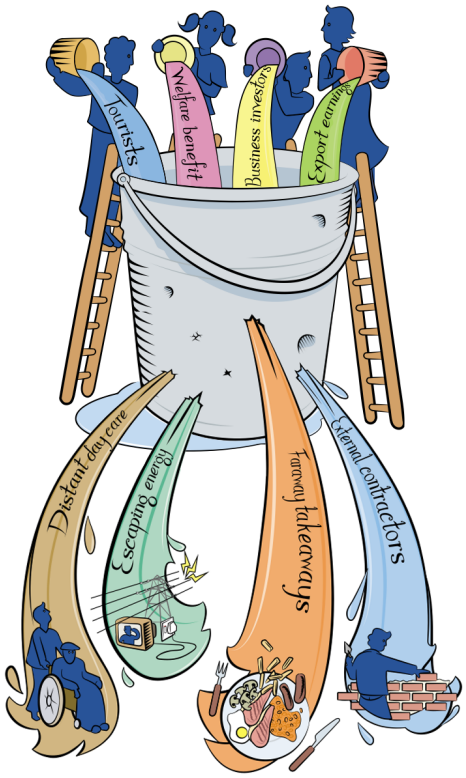
In addition to the money generated by energy generation enterprises the actual establishment of Community Energy Organisations (CEOs) usually has a distinct economic multiplier effect. When community actors, with a drive to address social and environmental concerns, come together and overcome the considerable barriers in establishing a energy enterprise, then in comparison it is easy to secure further grant funding and deliver other community projects. CEOs, especially when a permanent staff base has been established, often become extremely effective vehicles for delivering grassroots, grant funded projects, which pull in considerably more resources. If the CEO is a not for profit that has managed to finance a large and expensive energy project with a considerable annual turnover, even if the net return is not extensive and the project can be seen to be well and transparently managed, then experience has shown that this makes the entity a highly valued partner for delivering grant funded community based projects. As mentioned below, a great degree of support for the establishment of CEOs comes from Welsh Government (WG), which initiates a working relationship which develops the CEO into a valued partner for other WG initiatives.

The resources, both human and financial, generated from the above are often multiplied further by CEOs through developing other income-generating social enterprises. These again can bring more resources into communities while at the same time addressing local social, economic and environmental challenges. It is common for revenue from renewable energy sales to unlock many other economic possibilities for communities that were not accessible previous to the establishment of the CEO.



CEOs that generate some or all of the economic activity mentioned above will also generate employment which further boosts the local economy. Especially where a CEO is located in a rural, post-industrial or area dependent on seasonal tourist income, provision of worthwhile employment opportunities has a noticeable effect on local areas, keeping schools, shops and other local services in operation. They can revitalise communities that have been eroded and help to stem and partially reverse the flow of valuable human resources out of these areas.

CEOs are extremely effective at economic localisation and one of the best vehicles for plugging the economic leaks out of a community. The New Economics Foundation (NEF) have used the metaphor of a leaky bucket for local economies; if more resources flow out of the leaks in that bucket, than are poured into through economic income to an area, then the economy will constantly suffer (NEF, 2002). As electricity is a basic community need that is generally bought from the outside, it is usually a constant leak on local economies. Community energy effectively addresses this. In addition the more that CEOs can utilise the revenue from energy sales locally through employment and social enterprise initiatives then the local economies will be enhanced further. NEF describe this as "the money trail" and have developed a "local multiplier 3" score to assess whether revenues are circulated at least three times in the local economy (NEF, 2023). The leaking bucket effect of course extends to regional and national economies. The energy mix in the South Wales region of the National Grid has the highest carbon intensity of the whole of the mainland UK regions (SBN, 2022). This is primarily due to generation in this region being dominated by electricity from the Pembroke Power Plant that derives its energy from Qatari



Liquified Natural Gas (LNG). When people switch on the lights in the South Wales grid area, which includes the whole of Pembrokeshire, a lot of the money they pay for this electricity not only leaves Pembrokeshire, but also leaves Wales, the UK and Europe and goes to Qatar. If we follow the money trail for electricity produced by Qatari LNG, it goes back to Qatar Energy which is owned by the Qatari State, which is in turn ruled over by a dictatorship in the form of the unelected constitutional monarch, the Emir of Qatar. The repression of political dissent and women in this country is well reported and the terrible treatment of migrant workers was highlighted during the 2022 FIFA World Cup (Amnesty, 2022). How much better, for both ethical and economic reasons, to switch as much of this energy production as possible away from this problematic source to community energy.

Another aspect of localisation that community energy offers, that has a considerable positive local economic impact, is selling electricity through the "Energy Local" model. Here renewable energy generation produced on a low voltage network is sold directly to local households enabling a better price for the community generator and reduced bills when the households consume the electricity (EL n.d.). Despite this model being very beneficial for community energy, there have been numerous challenges with this approach. It is not currently possible with generators on HV connections and considerable lobbying work is being done by Power for People to make UK legislation amenable to direct selling (PfP n.d.).

Community energy generators by virtue of being small scale producers have the potential to become licence exempt electricity suppliers with the result that they can sell direct to large distributed consumers without grid levies being paid and a cut being taken by a supplier company middle man. Power Purchase Agreements (PPAs - contracts to purchase electricity from generators including CEOs) which take advantage of this small scale exclusion have the benefit of returning more revenue to the community. This type of arrangement is a very recent way that CEOs can sell their production hence no useful references to this have been found.

CEOs deliver efficiencies to the National Grid by providing electricity closer to where it is consumed. Community generators currently get payments for this benefit in the form of: Generator Distribution Use of System (GDUoS), Distribution Losses, Transmission Losses and Assistance for Areas with High Distribution Costs (AAHDC) (ADE, 2016) (GE n.d.). As an extension to this, CEOs have the potential to help the national grid further by providing grid balancing and flexibility. CEOs combined role of having local generation assets and a community membership base make them uniquely positioned to match generation with demand control. This matching operation brings efficiency savings and thus financial savings to the grid and therefore has the potential to be a service that can generate revenue for CEOs. Considerable work on looking at the feasibility of CEOs offering these balancing and flexibility services has been done by Regen in partnership with other organisations (Regen, 2018), (Regen n.d.), (Regen, 2019). More work has been done by the Open LV project regarding community monitoring of Low Voltage (LV) substations which has helped assess the feasibility of CEOs delivering these services (Open LV n.d.). The rapid development of grid scale battery storage systems has the potential to provide additional opportunities for CEOs to be paid for these balancing and flexibility services when they own these storage assets in conjunction with generation assets (ENA, 2017). It should be noted that despite the future potential, currently there are limited working and replicable examples where CEOs are getting paid balancing and flexibility services.

Finally, CEOs usually offer ethical investment opportunities, through share offers to fund their renewable energy enterprises. A focus is usually placed on ensuring that members of the local community have an opportunity to invest through accessibility combined with low individual share prices. This results in local people getting the economic benefits of a good return on the investments and keeps money in the area that might have instead gone to external investments. Investors also can come from outside the community, which again benefits the local economy through bringing money into the area.

Resilience

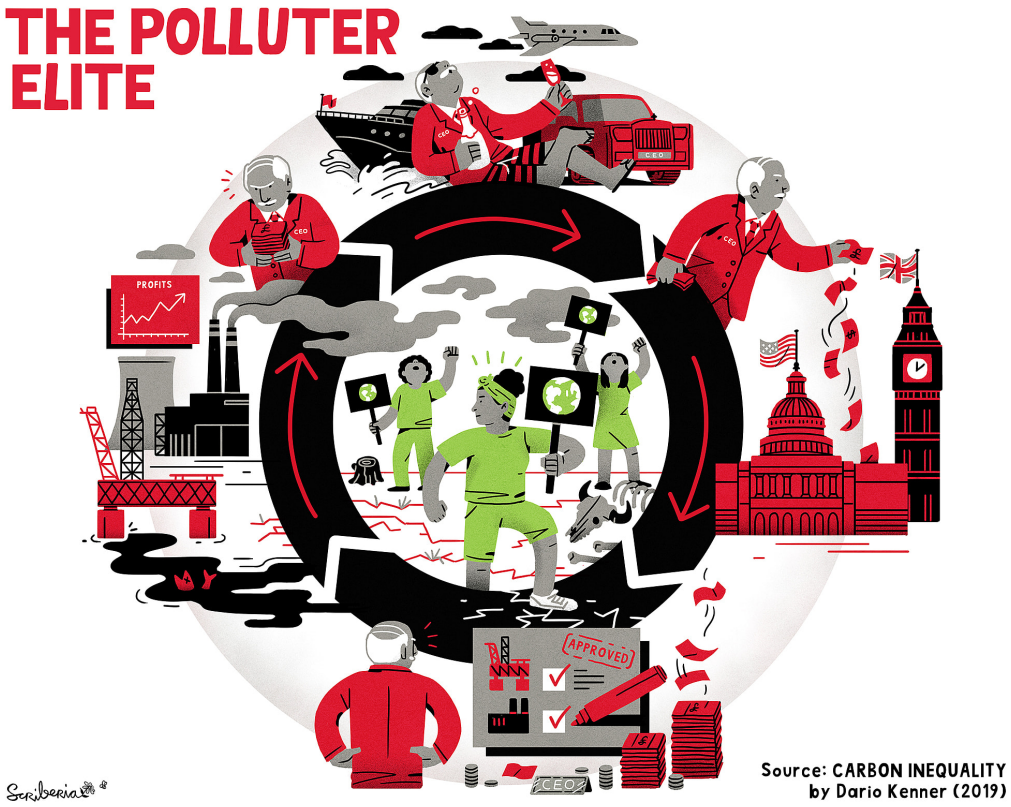
Community energy projects help bring local resilience in numerous ways. As discussed above, the economic benefits delivered by community energy are a form of considerable resilience. In addition, local generation has the potential to protect communities from huge energy price shocks like which has been caused by Russia's invasion of Ukraine. If CEOs are supplying their local community via an "Energy Local" arrangement then separation from the global energy market means that they can maintain lower energy prices for their direct consumers. As mentioned, due to the difficulty of implementing "Energy Local" arrangements, not many CEOs are currently able to provide that protection. Even if CEOs are not selling their electricity directly to consumers, a degree of resilience during energy shocks occurs locally as price hikes are returned to the community in part due to larger revenues from electricity sales by the CEO's generators.

Although it is very rarely done, CEOs have the potential to make areas energy self-sufficient. There are examples from Germany where town councils have essentially nationalised the part of the grid that serves them and have then encouraged CEOs to make them self-sufficient for local renewable energy. A successful, documented example of where this has happened is in the German town of Wolfhagen (Europa, 2020). Ultimate resilience would involve the ability of these portions of the grid to be islanded, so that they function when regional or national grid systems fail. The opportunity for self sufficiency seems greater in Germany with the way its grid is arranged, however self sufficient renewable microgrids do exist in the UK including the Methil Docks Business Park Microgrid which is powered by the Levenmouth Community Energy Project (LES, 2021). Island grid systems to a single metering system (i.e. behind the meter) to achieve resilience from grid failure are a lot simpler to set up than microgrids. It has been proposed by CARE that if community facilities became essentially mini CEOs with a mixture of micro-renewables and battery storage together with island grid links then these facilities could become places of refuge and resilience during a prolonged national grid failure.

Social & Political Change

Much of the drive behind community energy has been a societal frustration with, and consequent desire to remedy, the failure of politics to combat climate breakdown successfully. Despite minor advances, the painful failure of governments and politicians, that will catastrophically impact on future generations, is clear (CH, 2022), (Economist, 2020), (Guardian, 2022). CEOs are part of a change to break this failure that involves a bottom up lead that encourages top down political action. Communities are leading by example through CEOs, which allows politicians to go further in their climate friendly actions, knowing there is clear grass roots positive action for change. Local CEOs are excellent platforms that allow communities to engage with decision makers on a local, national and international level. Likewise decision makers need to engage with CEOs to turn failure into success in relation to the climate breakdown (NL, 2021).

CEOs are at the forefront of the just transition to net zero. Ideally, the transition to net zero should not solely address the transition to renewables away from fossil fuels, but also the huge social inequalities that the fossil fuel era has maintained. The fossil fuel, polluter elite have used their power and political influence to both be the drivers of the political failure mentioned above and to concentrate wealth in their hands at the expense of wider society (Kenner, 2019), (Kenner and Heede, 2021).



The net zero transition in the UK is at risk of following the same pathway of fossil fuel industry in the UK. In the UK North Sea, oil & gas wealth from the extraction of an essentially national collective asset, went disproportionately to the fossil fuel elites as compared to parallel operations in the more egalitarian and consequently wealthier Norway (NRGI, 2015). With the current expansion of off shore wind generation much of the wealth of this national collective asset, the wind blowing over our territory, is being lost to the general public in the same way. In addition to a large amount of investment by fossil fuel corporations, a large amount of the investment in UK offshore wind is held by public entities who will reap the benefits for their citizens. Unfortunately these public entities do not reside in the UK and so it will not be UK citizens getting the benefit from these investments. UK public entities only account for 0.03% of offshore UK wind investment. The City of Munich alone has nearly three times this investment in UK offshore wind and it is dwarfed by the 20.4% stake the Danish Government has (CW, 2022). CEOs are at the polar opposite of the transition to net zero described above, where wealth is syphoned away from the UK general population, as they maximises return for the people living most locally to the point of generation.

Education

CEOs provide considerable educational opportunities for communities. Community members who often have no experience of renewable energy ultimately get to the stage where they can research, deliver, manage and maintain, often complex generation assets. From a standing start they develop knowledge, experience and skills in site assessment, preliminary studies, planning policy, the planning process, government policy, finance, negotiating legal agreements, contract management, construction, grid connection, energy monitoring and energy technologies. As all these processes are in the hands of community residents rather than solely outside consultants, this upskilling stays in the community. Even if these projects are delivered by a relatively small number of community members they become very accessible examples of renewable technologies for the rest of the community. Being public projects they are almost always available for school or other site visits by the wider public so that renewable technologies can be seen in action. Often CEOs have undergone considerable difficulties to establish generation assets. These stories of adversity and overcoming generate a multitude of conversations about all the many important aspects of community energy. These conversations, together with the community resources that CEOs generate, go a long way to create positive attitudes and trust in renewable energy to counter the traditionally sceptical or hostile view sections of the media have towards these technologies. The knowledge, skills, experience and empowerment that community members get through CEOs often translates to developing other community benefit projects, so that a multi functional local base for both community engagement and building is established.

Given the space that CEOs inhabit, within the realms of energy, community work and addressing both environmental and social issues, it is a natural progression, that many Welsh CEOs have made, to make the step to addressing local fuel poverty and to delivering energy efficiency awareness. These attributes of CEOs make them very effective in implementing the key mobilisation strategies which enable energy efficiency behaviour change (CARE, 2021, a), (CARE, 2021, b). In relation to energy and efficiency, there is no greater aid to its sensible utilisation than knowing its preciousness through the challenges of producing and distributing it. Work in fuel poverty and energy efficiency leads to both important public education outcomes and difficult to achieve behaviour change. CEOs are in the business of having community conversations about energy, the environment and social outcomes; and awareness is best delivered by local, trusted intermediaries that have integrity.

Community Vitality

Local wealth generation in itself creates community vitality. The ownership of this wealth generation in local hands means that generated resources are delivered to local priorities. This helps sustain what is local more effectively than resources that come from the outside of communities. CEOs boost local pride through supporting and sustaining local language, culture, traditions, events, heritage and natural resources (CARE, 2023), (PO, 2022) & (TCDT, 2022).

CEOs bring people together to work together on solving important issues and the results can be impressive and rewarding, with long beneficial legacies. This has a knock on effect in communities, inspiring and empowering them to take on further important local challenges. Bringing people together usually makes a community more aware of its members so that they are more likely to look out for each other in times of need. Better resourcing makes looking after one another in the community easier. As pro social behaviour and

generosity, leading to wider senses of social connection, are prime determinants of human happiness, there can be no better way to en-vitalise a community (WHR, 2019). In most instances, local communities know their issues better than anyone and are usually the best at implementing long-lasting change. To best mobilise a community it is important to let communities innovate, create their own solutions and for change to come from with in; this is what CEOs offer.

Climate Breakdown

It is arguably in regard to climate breakdown that CEOs have there biggest benefit and also why so many community groups work and fight so hard to establish them. CEOs directly tackle the climate breakdown by promoting pro-environmental behaviour change and by producing carbon neutral energy to replace carbon intense forms of energy. By replacing fossil forms of energy they constructively lower atmospheric CO_2 levels, mitigating against the climate breakdown and in so doing minimise the damage and destruction this has on humanity and the natural world.

Producing carbon neutral electricity on the South Wales region of the national grid, which includes Pembrokeshire, is extremely important, as mentioned above, as it displaces, the dirtiest electricity in the whole UK in terms of carbon intensity (SBN, 2022). This high carbon intensity of the South Wales region, in comparison to the other UK regions, can be seen at any point in time via the National Grid Electricity System Operator's Application Programming Interface (NG ESO, 2023) This makes the carbon savings of CEOs based in the South Wales grid region considerable as demonstrated by the carbon savings declared by CARE in its annual reports (FCA, 2022) and thus their climate breakdown mitigation work in this region the most impactful in the UK.

CEOs work in behaviour change in relation to climate breakdown is of equal importance. The issue of climate breakdown is a collective problem that requires collective behaviour and attitude change. Everyone has a role in the climate breakdown and everyone has a stake. Through their work at the grass roots level CEOs reach parts of the collective populace that other organisations cannot reach. Their work presenting positive solutions to the climate breakdown with integrity within the community contributes to behaviour change. As does community wide conversations, social norming of positive change and peer comparisons of behaviour.

Mental Wellbeing

Eco-anxiety in the UK is a genuine problem with a massive three-quarters of the population worried about climate breakdown, and younger people more likely to be anxious about the environmental situation (ONS, 2021). Interactions between CARE and school teachers in West Wales have repeatedly shown that they are grateful to CARE, as a CEO, to enable them to demonstrate positive local solutions to the climate breakdown to their students, otherwise they do not like covering the issue as a result of the anxiety it generates. In this way, it could be said that CEOs and the work that they do are a good antidote to eco-anxiety. The work of providing hope to the younger generation is vitally important. It is also important to the mental wellbeing of members of the current generation for them to have the integrity of knowing, that no matter what might come for future generation, that they did what they were able, to take action. How else can the current generation look younger and future generations in the eye. CEOs provide empowerment, purpose and a like-minded community to enable those associated with them to combat the negative affects of eco anxiety that include

increased risks of depression, low mood, extreme mental distress, post-traumatic stress disorder, suicide, and further deterioration in those with a history of mental illness (BMJ, 2021).

Organisation Legal Structures

A community group needs to adopt a suitable legal structure from the outset. Not only is a legal entity needed to apply for the majority of grants and to qualify for loans, but different legal structures are more suitable depending on the goals of the group and project being set up. The following are examples of community group legal structures:

Industrial and Provident Society

- **Community Benefit Society (BenCom)**. This is set up to benefit a particular stakeholder group. They cannot operate like a private company and IPSs can offer community shares (less than £20,000 limit). Cwm Arian Renewable Energy is an example of a community benefit society.
- **Co-operative Society.** This is run by and for the interest of its members. Co-operatives pay out dividends to members, sometimes on the basis of participation not investment. Each member gets one vote, regardless of the number of shares they own. For further free advice, contact the Co-operative Hub.

Community Interest Companies (CICs) cannot be formed or used solely for the personal gain of a particular person, or group of people. They have an asset lock and a limit on dividends. CICs are supervised by the CIC Regulator. CICs cannot run community share offers.

Charities are run by trustees, supported by donations and have charitable status (tax relief). They are regulated by the Charity Commission.

Joint Ventures involve a community group and one or more other bodies like a private investor who may bring business or technical skills, capital, legal expertise, local land etc.

Often a community group may begin as one type of organisation but require the set up of other types to facilitate a particular project or idea. An example of this is the set up of Awel Aman Tawe ,which began as a charity, however it's seminal and subsequent projects, Mynydd y Gwrhyd wind farm, and then community owned rooftop solar PV, required a different legal structure to enable community ownership through a shareoffer. Hence Awel Co-operative (wind) and Egni Co-operative (solar) were set up, each with specific objectives and boards of trustees. Awel Aman Tawe is now the charitable body that operates these two co-operatives. Each Co-op pays the charity a management fee which helps to fund the employment of the officers and administrators that run it. The co-operatives do not employ anyone directly, existing primarily as the vehicles of community ownership only.

Welsh Gov's guidance document for shared ownership of energy project also contains further advice on legal structures and their implications (Gov.Wales, 2022, Pg.15). Engaging with a solicitor with community energy experience to advise on the most appropriate legal vehicle for the community energy group's purpose is highly recommended.

Funding Sources

Funding sources for community energy projects are currently numerous and plentiful. However, sources can be dynamic, with limited budgets or timeframes for which grants are available for. Many also contain conditions, such as regular reporting or evidence of milestones and expenditure. It's important for a community energy group to keep on the pulse with regards to available funding to ensure continuity of employment for any staff as well as continuity of momentum for a project to ultimately be delivered. Below are but a few of the current live available sources of funding:

Welsh Government Energy Service. As well as offering technical, commercial, and procurement advice for energy projects, WGES also awards resourcing grants to facilitate the resourcing of community energy organisations to achieve their project aims. Preparatory grants to fund the initial feasibility and development aspects of a community energy project, such as consultancy and legal fees. Followed by access to capital grant funding from Welsh Government budget's along with low interest loans from Development Bank of Wales.(WGES n.d.)

Ynni Cymru. A new joint energy project development vehicle between Welsh Labour and Plaid Cymru with an aim to accelerate and revolutionise the energy industry. Ynni Cymru is a relatively new announcement and it's specific processes are yet to be unveiled. However, it is hoped that it will be a major source of funding and support for community energy projects across Wales.

PCNPA Sustainable Development Fund. An annual fund of £100,000 (in 2023/24) aiming to support community led projects that contribute towards a reduction in carbon and help respond to the climate emergency.(PCNPA n.d.)

UK Shared Prosperity Funding - Pembrokeshire Growth Fund. Grants of between £500-£50,000 available to support businesses demonstrating "innovation, Research and Development and/or future proofing projects linked to the local innovation strategy" resulting in the creation and safeguarding of jobs. (PCC, 2023)

Milford Haven Port Authority - Green Energy Fund. Grants of up to £5000 for supporting local charitable organisations and other not-for-profit organisations to improve their environmental sustainability. The Fund will support projects that are looking to reduce carbon emissions, reduce waste and/or improve energy efficiency.(MHPA n.d.)

Heat Network Efficiency Scheme open to applicants (England & Wales)• The Heat Network Efficiency Scheme (HNES) opened to applicants in February 2023. It is a £32million grant support programme spanning 2023-2024 (Year 1) and 2024-2025 (Year 2).• The scheme will provide funding to public, private and third sector applicants in England and Wales to support improvements to existing district heating or communal heating projects that are operating sub-optimally and resulting in poor outcomes for customers and operators.• APSE Energy has recently published a briefing on the HNES guidance, if you would like to be sent a copy of this briefing, please email jjefferson@apse.org.uk• The latest round of funding will close to applicants on the **7th July 2023.**

£1 million community fund for nature launched by WWF and the RSPB (UK wide)• The Save Our Wild Isles Community Fund is supported by Aviva and will give £2 for every £1 raised by community projects.• Successful projects will have a focus on nature restoration, nature connectedness and pro environmental behaviours, and community cohesion and connection.• The match funding applies to each individual donation up to £250, with a total match available of£5,000 per community project.

Grants to support community groups who are taking action on climate change (Wales)• Sustainable Steps Wales – Egin Grants is offering grants of between £100 and £15,000, to fund projects that are about engaging with climate change and living in a more sustainable way.• Projects across Wales will be funding and could relate to food, transport, energy, or waste and consumption.• Eligible projects will have already received mentoring from Egin (the Sustainable Steps Wales mentoring service)• Applications are ongoing with the fund expected to be open until **January 2027.**

£10m in funding to support community projects that reduce energy consumption (UK wide)• Grants of up to £1.5m over 2 to 5 years are available for 8-12 projects.• The projects should either encourage communities to use energy in an environmentally friendly way,help communities to promote energy efficiency or enable communities to engage with opportunities to generate clean energy.• Virtual events about the funding are being held on the 18th April, 16th May and 20th June, you can sign up here.• Applications will be accepted from groups such as registered charities, community organisation,not-for-profit companies and schools/colleges/universities.• It is expected that this fund will be open to applications until at least **December 2023.**

Grants for Good Fund (UK wide)• Every 3 months the Matthew Good Foundation shares £15,000 between 5 shortlisted projects.• Applications must be on behalf of a local community group, charity, voluntary group or social enterprise that has a positive impact on communities, people or the environment and has an average income of less than £50,000 in the last 12 months.• The application process is simple and requires contact details, a brief outline of the organisation's work, and how you'll use the funds.• As funding is awarded every 3 months, applications will always be considered for the next funding round. However, the deadline for the next round of grants is the **15th June 2023**.

Funding available to help communities address climate change (UK wide)• The National Lottery Community Fund's Climate Action Fund is offering grants of up to £1.5m to projects that focus on the link between nature and climate. Most successful applicants will be offered between £300,000 and £500,000.• The grants are suitable for community and voluntary organisations, charities and the public sector.• The Community Fund website states that they want to fund projects which use nature to encourage climate action within the community. "We expect these projects to bring other important social and economic benefits. Like the creation of strong, resilient and healthy communities or the development of "green" skills and jobs."• The application deadline for the Climate Action Fund is **ongoing**.

Funding for schools to run investigative STEM projects (UK wide)• The Royal Society is providing grants of up to £3,000 to schools through the 'Tomorrow's ClimateScientists' funding scheme.• Schools can apply for grants of up to £3,000 from the to run investigative STEM projects in partnership with professionals from academia or industry.• The Society is running free training sessions with teachers and project partners to assist with the application process.• The next deadline for applications is the **30th June 2023.**

Sports Wales providing Energy Saving Grants to help sports clubs to become more energy efficient (Wales)• Grants of up to £25,000 are available for sports clubs to spend on energy efficiency improvements.• Funding is available to not-for-profit sports clubs and community groups.• The funding can be put towards purchasing solar panels, insulation/building fabrics, lighting(excluding playing/training floodlights), improved heating and hot water systems and sustainable water sourcing.• The deadline for applications is the **28th June 2023.**

Grant scheme to create 'Tiny Forests' (Wales)• Grants of up to £40,000 for one site, or up to £250k for multiple sites are available for projects which will create new areas of dense, native woodland in Wales.• The 'Tiny Forests' should be around 200m² in size and successful projects will be accessible to people and give local communities the opportunity to get involved and plant trees.• Projects will be required to monitor the 'Tiny Forest' using Earthwatch's methodology, this will involve carrying out monitoring a minimum of twice a year for the first two years after planting.• The closing date for funding applications is the **15th October 2023**.

Supporting Organisations

There are an extensive number of organisations that provide support to CEOs. Representatives from many of these organisations were present at the Egni Trefin meeting held on 13th June 2023.

CEW and the CEO Community:

Community Energy Wales (CEW) is a membership organisation for CEOs in Wales which is partnered with its matching counter parts:

- Community Energy England (CEE),
- Community Energy Scotland (CES),
- Northern Island Community Energy (NICE) and
- Renewable Energy Sources Cooperative (REScoop) in Europe.

CEW is a great source of third sector assistance, whose sole focus is to establish and support CEOs in Wales. CEW is currently extremely lucky to have two dynamic people that share the chief executives role, Leanne Wood, former leader of Plaid Cymru. and Ben Ferguson who is based in Pembrokeshire and has extensive experience in community energy. CEW's supporting roles include among other things (CEW, 2023) include:

- sharing valuable information between members via newsletters, websites and one-off webinars,
- coordination of Welsh community energy annual conference,
- convening the annual State of the Sector Report of community energy in Wales,
- representing CEOs at a governmental level,
- convening working groups on a whole range of relevant topics to mobilise collective action on important related issues such a energy efficiency and low carbon heat,
- Accessing collective funding for and coordinating the resulting projects such as Charge Up Wales (TNL, 2021), (Trydani, 2023)

- Hosting Cyfrani, Wales' Community Investment Network.

CEW represents the vibrant community of CEOs who by them selves have a strong history of providing huge amounts of peer mentoring support to each other. Likewise, CEOs in Wales regularly get collegiate support for their work from the other CEOs membership organisations from across the UK and Europe. Existing CEOs within Pembrokeshire, including CARE and Transition Bro Gwaun (TBG), have Community Energy Resource Grant (CERG) funding to promote community energy in West Wales, on top of the usual sharing that they do.

Governmental Support:

WG is hugely supportive of CEOs. Many CEOs would not be in existence with generating assets without their support. WG funds the Welsh Government Energy Service (WGES) which delivers support to the public sector and community groups to develop renewable energy projects (CT, 2022), (Gov.Wales, 2023). The WGES in the past have provided CEOs with or have been the conduit for:

- dedicated project support officers providing expert advice at every stage of the process
- preparatory grants for preliminary studies and works usually ahead of planning approval
- assistance with drawing down project finance from the Development Bank of Wales and WG
- community energy resource grants to fund CEO staff time to develop renewable energy projects.
-

WG have an online Community Energy Toolkit which provides lots of advice for prospective CEOs (Gov.Wales, 2019).

PCC are a definite local resource of support for CEOs in the county. PCC are blessed with at least two excellent resource people: Energy & Sustainable Development Team Manager, Steve Keating and Net Zero Carbon Project Manager, Dr Rhys Morgan.

PCNPA also have a decarbonisation team relevant to CEOs, led by Head of Decarbonisation, Jessica Morgan.

National Grid (formerly Western Power Distribution):

This enterprise is essential locally for connecting community energy assets up to the electricity network. They also give support to community energy organisations, which is outlined in their Net Zero Communities Strategy (NG, 2022). National Grid have their own Community Energy Engineer, Faithful Chanda, currently for the whole NG region which, in addition to South Wales, stretches from Land's End to Skegness. It has been disclosed that each of the four regions may also have its own dedicated Community Energy Engineer. National Grid also have a good resource page for community energy with a dedicated hot line (NG, 2023).

Regen:

Regen is an independent not for profit centre of energy expertise and market insight, whose mission is to transform the world’s energy systems for a zero carbon future. They work on community energy in Wales with many important players of the sector including WG, National Grid and NG ESO, to conduct research and produce reports and educational documents. Many of Regen's useful co-produced materials, including

numerous on community energy, can be found on the publications section on their website (Regen, 2023,a). They have a community energy page on their website that gives details of their 4 member community energy team which allows you to sign up to their community energy newsletter (Regen, 2023, b). An example of one of their important collaborative works for the sector is A guide to Ofgems's proposals for changes to network charging - for community energy groups (Regen, 2021).

Pembrokeshire Coastal Forum (PCF):

PCF is a Community Interest Company that works to protect the coast and marine environments for current and future generations to enjoy. It is an organisation that acts as a bridge between coastal communities and the various actors including marine energy, whether that is wind or tidal. It helped found and partners with Marine Energy Wales (MEW) which is active across a host of projects, collaborations and stakeholders to spearhead the development and deployment of marine renewable technology. Operating as a single point of access for the industry in Wales, through our work areas in wave, tidal stream, tidal range and floating offshore wind. Under PCF there is also the Marine Energy Engagement Plan (MEEP) which aims to work with coastal communities which has its own sign up for notifications of developments (PCF, 2023).

Energy Efficiency Partners:

For community energy generation work that tips over in to delivering energy efficiency then CARE has partnered with a number of supportive organisations. These have included:

- National Energy Action (NEA)
- Centre for Sustainable Energy (CSE)
- Smart Energy GB
- Citizens Advice
- National Grid

Of these CSE and NEA have very useful dedicated resource pages (CSE, 2023) & (NEA, 2023).

Community Engagement

As part of the feasibility study the community of Trefin was engaged to disseminate current information regarding the project and its aims, as well as collect data on their perspectives and concerns regarding a community energy project in the area. The community were consulted initially via a survey, available to complete online or in person, followed by an open community meeting.

Survey Results Summary

The survey itself contained 13 questions designed to determine the community's desire to contribute to a net-zero Wales, quantify their awareness of community energy, gain their perspectives and concerns on predominant community energy ideas for the area, and assess the community's appetite for investment and their capital available to do so. As the survey questions were extensive it has been excluded from the main body of this report, however they are available as an Appendix document. Similarly, the graphical

presentation of the results is also extensive and is best viewed as an Appendix document to the report. The survey ran from May 16th to June 4th, with it being publicised through Trefin Improvement and Councillor Neil Prior's mailing lists and social media platforms. Three days were also spent by Daniel Blackburn visiting residents door to door in Trefin to discuss the survey and encourage responses.

We present below the main findings of the survey:

- 61 responses all from postcodes within Pembrokeshire, with all except two responses coming from the Llanrhian Parish.
- The community is most concerned about their household bills.
- There is a strong feeling for the importance of net-zero Wales
- Many in the community are considering technologies for their home. In particular solar, heat pumps, batteries and insulation. There are some in the community that are not considering these. Perhaps due to their age or situation.
- Domestic Solar PV
    - 8% currently have solar PV yet 82% of respondents believe they have room for them.
    - 13% are definitely planning to install them already.
    - 41% would consider installing them if clear advice was given from PCNPA.
    - 67% would considering installing them if there was financial assistance available.
    - 31% of respondents would consider leasing their roof space to a community group to facilitate a solar PV installation.
    - 6.6% were not interested in installing domestic solar PV.
- Over half are unfamiliar with community energy, a further 3rd are only generally aware. 13% know of projects in Wales. No one has invested in community energy previously.
- The primary views on potential benefits to Trefin was to reduce household bills, creating a community benefit fund, followed by reducing local business bills.
- The project ideas with most support, in order, were:
    - Micro-hydro
    - Insulating & smart energy solutions
- and then tied:
    - Field scale solar PV
    - Domestic solar PV
    - Medium scale wind turbine
- and followed by:
    - Local business solar PV
- The highest concerns the community had were regarding:
    - Impact on wildlife
    - Missing out due to lack of time or capital
    - Noise
    - Securing permissions
- The middle concerns were:
    - Visual Impact
    - No voice in the project
    - Challenges of funding and management
    - Change to the character and feeling of the village
- The least concerns were:
    - Financial risk

    - Construction traffic
    - Proximity to the village
- There is a strong appetite for investment within the community with the majority wanting to invest but not knowing how much, or able to invest between £50-500. ~10% of respondents stated that they could not afford a minimum investment of £50.
- Based on the survey responses only an estimate of available community investment capital is:

Lleiafswm Minimum	Cyfartaledd Average	Maximum Uchafswm
£31,450	£108,425	£186,500

Community Meeting Summary

On 13 June, 2023, Egni Trefin and CARE co hosted the community energy meeting to consult and inform parish residents about the feasibility project, the above survey results and the potential benefits of CEOs. The evening also gave the opportunity for the community to give their opinion on potential renewable energy projects and meet key local experts and players that support both renewable energy locally and community energy. There were 30 people in attendance and the general feeling from the meeting was there was a buzz and much excitement about the possibilities that lay ahead for the community.

The agenda and schedule of the meeting was as follows:

7:00 to 7:15	Meeting guidelines and introduction to the Egni Trefin Project. Neil Prior, Pembrokeshire County Councillor and Cabinet Member for Transformation.
7:15 to 7:25	Introduction to CEW and links between Community energy and the Welsh Language. Dyfan Lewis, CEW Projects Officer, Enillydd Coron yr Eisteddfod Genedlaethol 2021, dyfan@communityenergywales.org.uk.
7:15 to 7:25	Introduction to CARE, what the scoping is all about and the possible projects that the scoping is pointing to. Daniel Blackburn, CARE Renewable Energy Project Coordinator, daniel@cwmarian.org.uk
7:25 to 7:35	Results from the survey Alex Ferraro, CARE Renewable Energy Project Officer, daniel@cwmarian.org.uk
7:35 to 8:20	Q&A, then break out group discussion (One Welsh language group) to answer the following questions 1. What possible renewable energy projects would you like to see? 2. What RE projects do you think are possible? 3. What renewable project would best benefit the area? 4. Is this just for Trefin?
8:20 to 8:25	Community Benefit and the CARE experience. Daniel Blackburn, CARE Director and Treasurer (as above)
8:25 to 8:30	CEW and the bigger picture of community energy. Ben Ferguson, CEW Executive Director, ben@communityenergywales.org.uk
8:30 to	The Transition Bro Gwaun community wind turbine - benefits and community funds. Tom

8:35	Latter, TBG Director, tom.latter@btopenworld.com
8:35 to 8:40	Renewable energy roll out at Pembrokeshire County Council. Dr Rhys Morgan, PCC Net Zero Carbon Project Manager, rhys.morgan@pembrokeshire.gov.uk
8:40 to 8:50	Welsh Government Energy Service and Eco Dewi - his two CEO hats. Paul Cowley, WGES Technical Manager, Eco Dewi Core Member, paul.cowley@energyservice.wales
8:50 to 8:55	Pembrokeshire Coastal Forum & Marine Energy Wales. Stephen Thompson, Marine Energy Test Area Project Delivery Manager, stephen.thompson@marineenergywales.co.uk
8:55 to 9:00	Rounding up Neil Prior

Here were the notes from questions answered by the three breakout groups:

Question 1: What possible renewable energy projects would you like to see?

- Group 1: Projects identified were: solar PV, solar thermal, wind, ground source and air source heat pumps, hydro and retrofitting dwellings for higher energy efficiency. Challenges were identified with solar and retrofit in relation to the character of the village. The issue of whether solar panels should be owned by the individual homeowner or a community group was raised. The comment was posted in this group about whether the availability of grants should affect which energy projects are possible.
- Group 2: Projects identified were: air source heat pumps, solar (particularly large scale if the land is available) & wind. It was mentioned in this group that there were economies of scale from acting as a group.
- Group 3: Projects identified were: hydro, wind and solar. In their answer this group referenced the renowned Welsh bard William Crwys Williams who wrote the famous poem "Melin Trefin" about the water mill whose ruin is a very notable feature of Aber Draw Bay adjacent to the village (Jones, 2016). The demise and decline illustrated by that poem potentially resonating with the situation of the Welsh language in the area. It was therefore seen as symbolic if a hydro project could be established on the same stream as the mill, allowing for respect for that old tradition to continue in a new form. The feasibility of this has been assessed and the project would be challenging. However, the possibility of the Buzz Hydro system should be explored. In relation to solar, there was broad support for this in the community.

Question 2: Which of these projects would you most like to see happen?

- Group 1: Ranked the following projects with a numerical score from 1 to 3 with 1 being the most likeable – Solar on roofs (1), Renewables on community buildings (1), Energy efficiency (1) & wind (3). Wind scored low as concerns were expressed in the group regarding NIMBYism and durability of turbines themselves.
- Group 2: This group would like to see something happen but no priorities given.
- Group 3: The following were mentioned: roof top solar particularly the solar panels that look like slates; ground mounted solar - but where - potentially incorporated into a vineyard; Wind - what is the national park's reason for objecting.

Question 3: Which project would best benefit the area?

- Group 1: The issue of scale and distribution was raised, but in relation to this a "local energy" system where residents could benefit from the low cost electricity produced was welcomed. There was interest in capturing waste heat from dairy units.
- Group 2: As the group used the breakout session to ask lots of questions about renewable energy from

the experts in the group this section was not completed.
- Group 3: The suggestion was for more than one project, many small projects of the same type together with a larger project.

Question 4: Is this just for Trefin?
- Group 1: This should ideally be for the whole of Llanrhian Parish but the economics of certain projects may mean it is limited to Trefin.
- Group 2: This should be parish wide.
- Group 3: Trefin as a pilot, and then sharing within the parish.

Renewable Energy Assessments

Micro-Hydro

Micro-hydro power is a form of hydroelectricity generation that utilises the flow of water from a higher to a lower level to produce energy. The energy available is proportional to the flow rate of water and vertical drop or head. It encompasses plants from 500W to 100kW, some of which may only provide power to a single home. The most feasible locations for micro-hydro schemes in Wales are usually "run of river" setups. These schemes involve diverting a portion of a river's flow behind a low weir, through a turbine, and returning it downstream to the same watercourse. A "run of river" micro-hydro scheme requires several key elements:

- A consistent and adequate source of water within the river.
- Sufficient water depth is achieved by constructing a weir across the watercourse at the intake point.
- This ensures a steady supply of water to fill the penstock or intake pipeline with no air intake
- The turbine, generator, and supporting equipment are typically housed in a small shed called the turbine house. Providing protection and security for the equipment and electricity connection. After passing through the turbine, the water is returned to the watercourse via a tailrace.
- Finally, the generated electricity is either connected to the electricity network or supplied directly to the user's premises.

Alternative novel hydro power designs for the micro-hydro scale exist. These are typically non-commercial designs that are at prototype or concept stage. An example of this is the "Buzz Hydro"(Buzz Hydro n.d.) concept which utilises a floating frame mechanism and an undershot crossflow type turbine. It is at concept stage with the designer currently looking for collaborative partners. The intention of such concepts are to generate consistent continuous low power from moving water flow only without abstraction from the watercourse itself at RPMs (Revolutions Per Minute) that have minimal affect on aquatic wildlife. However, this results in an energy resource orders of magnitude less than run of river schemes as there is almost negligible gravitational head, i.e. change in water elevation, available to convert to mechanical and then electrical energy. Therefore applications of use need to be extremely low powered, potentially at 12/24V off-grid, or generators need to be multiplied on the same reach of water to produce for single 230V properties. The concept at present is therefore best suited as a research and development project to be coupled to potentially off-grid enterprises nearby, such as vegetable producing polytunnels as part of a market garden,

rather than a commercial community energy project endeavour. The concept as currently designed is also highly visual on the watercourse itself, which poses a planning issue in terms of altering the landscape setting of it's surroundings. The further sections in this report are therefore focused on the tried and tested, commercially available, "run of river" type micro-hydro scheme.

Permissions

1) Planning Permission

Micro-hydro power requires planning permission from the local authority as it entails changes to natural resources and new infrastructure to be built. Planning documentation is likely to require:

- Maps & layouts
- Engineering drawings of sections and elevations of new or altered structures incl. weir, powerhouse, pipelines, access tracks etc.
- Photomontages of weir and powerhouse
- Robust Design and Access Statement detailing the design rationale, planning context, benefits etc.
- Environmental Statement based on an included Ecology Survey.
- Geomorphology photo survey of the watercourse
- Hydro-morphology Report detailing the effect on sediment transfer through the watercourse
- Water Abstraction and residual watercourse flow data
- Construction Method Statement

A scheme of the scale likely for Trefin Energy will incur a planning application fee of ~£600 from the Pembrokeshire Coast National Park.

2) Abstraction & Impoundment Licences, Fish Pass Approval

Natural Resources Wales (NRW) requires all hydropower developments to be designed in certain ways depending on the characteristics of the watercourse and requirements for environmental protection of the species within that watercourse. Detailed guidelines of the design of run of river hydropower systems is provided by NRW here. It is an excellent resource for learning how a hydropower scheme may be developed and forms the basis for how relevant licences may be applied for and approved.

At present NRW provide two hours of free pre-application advice to respond to specific aspects of complex schemes, beyond this two hours advice is charged at their standard rate. NRW operate a tiered fee system for hydropower licencing depending on the capacity of the generator. For a sub 25kW micro-hydro project scheme the fee for the relevant licenses is currently £375.

3) Land Drainage Consent

Land drainage consents are to ensure any temporary works, such as those involved with diverting the watercourse to enable construction, and permanent works such as culverts or weirs, do not increase risk of flooding or environmental degradation. Local Flood Authorities, in this case Pembrokeshire County Council, issue land drainage consents on "Ordinary Watercourses" at their discretion. Along with the relevant forms,

the typical information included in an application is:

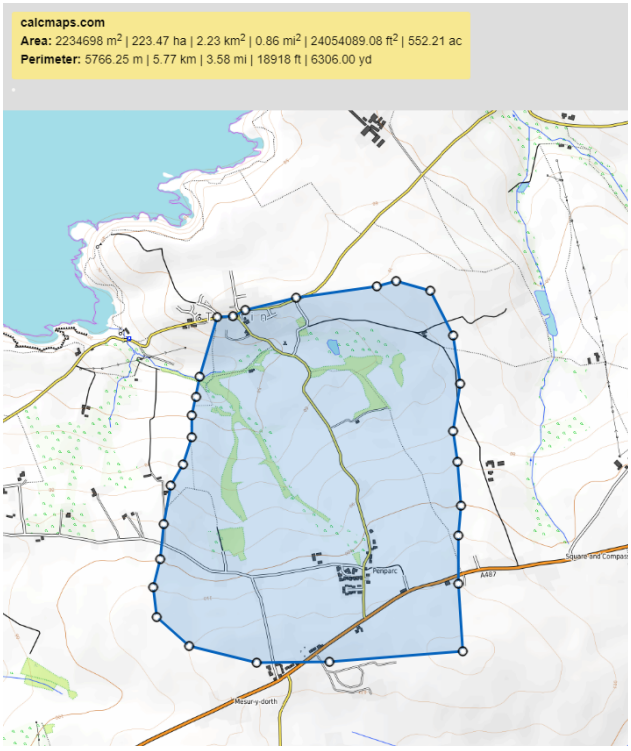
- Plans showing the location of works
- Detailed drawings and calculations of what you wish to do
- A method statement for the works, including details of how the works will be carried out and any environmental protection/mitigation measures that will be put in place

More information from NRW on Land Drainage Consent can be found here (NRW, 2023). The typical fee for an application is £50.

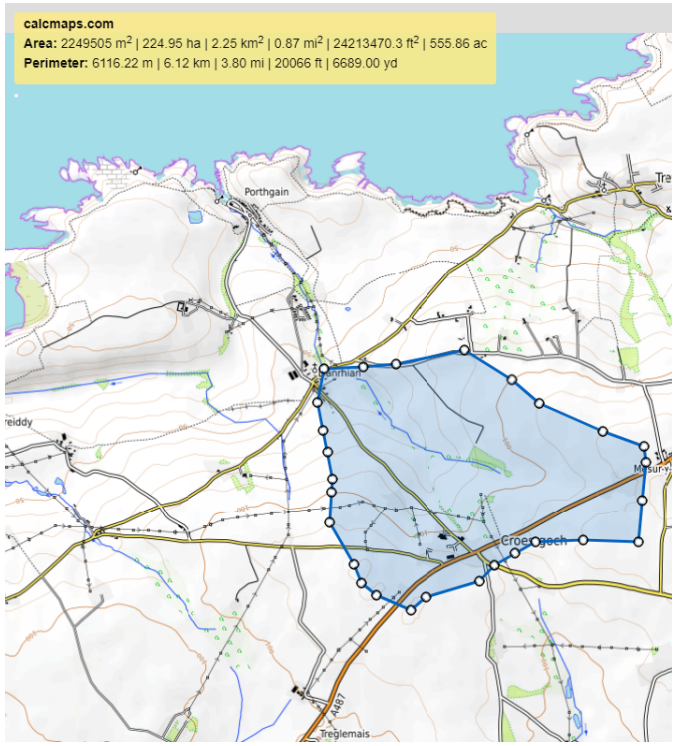
Resource

Assessment of the hydropower potential of the watercourses flowing through Trefin and Llanrhian/Porthgain has been undertaken. To enable these calculations annual river flow data is required. Due to the limited budget and timeframe available for the project to purchase flow data for the relevant watercourses, suitable nearby flow data to act as a proxy was requested from hydropower consultancy Ellergreen Hydro Ltd (Ellergreen Hydro ltd n.d) . Previous feasibility work had been undertaken at Cwmffrwd on the Afon Piliau tributary of Afon Teifi in North Pembrokeshire using LowFlows software, thus providing flow data that is re-scaleable to the catchment areas of the two potential watercourses to give an approximation of water resource and indicative energy production figures. This flow data was generously provided free of charge by Ellergreen Hydro ltd. The table below details the resulting scaled Qmean values. Full annual flow tables are provided in Appendix B.

	Afon Piliau	Trefin	Llanrhian/Porthgain
Catchment Size (km²)	3.531	2.22	2.25
Abstraction OS Co-ordinates	SN 16185 40592	SM 83826 32214	SM 81995 31445
Annual Qmean Flow (L/s)	97	60.9	61.8
Annual Q95 Flow (L/s)	11	6.9	7



Trefin Catchment Area



Llanrhian Catchment Area

NRW classify sites into 3 separate Zones, dependent on the river flow and gradient characteristics, to determine the level of water abstraction permissible. Both watercourses fall within Zone 2; for lowland watercourses with a gradient of less than 10%. The following abstraction rates are therefore permissible:

Abstraction rates for Zone 2 sites with depleted reach		
Low Flow Protection (Hands off Flow)	**% take of available flow**	**Maximum Abstraction Rate**
Minimum of Q95	50%	1.3 x Qmean

Note here that the % of take of available flow is set at 50%, a low proportion in order to protect the numerous wildlife habitats created by the riffles and pools formed by the slow water velocity due to the low overall gradients. This percentage abstraction of available flow severely impacts the annual yield potential of a hydropower scheme.

The table below summaries and compares potential hydropower scheme designs and their estimated annual electricity yields for the Trefin and Llanrhian/Porthgain watercourses:

Micro-hydro Options Comparison for Trefin & Llanrhian/Porthgain		
Design Parameter	**Trefin**	**Llanrhian/Porthgain**
Brief Description	Intake located immediately below confluence of tributaries to the south of Trefin village, accessed via adjacent tracks in fields and PRoW. Penstock to travel on North side of watercourse passing adjacent to sewage treatment work. Joining works entrance track, passing over Ffordd y Felin to the pathway towards original millhouse. New powerhouse to be sympathetically located and built nearby to original, acting as additional tourism attraction, considering coastal erosion and sea levels.	Intake located within the woodland North of Llanrhian Chapel close to PRoW, downstream from the historic Felin Llanrhian. Penstock to bear NWN maintaining low gradient to meet 2nd track & PRoW to West leading to Felindre House. Penstock continues NWN across fields to meet PRoW at northernmost corner passing field boundaries into Porthgain common land. Powerhouse located on common land adjacent to Porthgain entrance rd, built to match style of existing historic buildings in the vicinity.
Intake Crest Level (m AOD)	29.5	46
Turbine Level (m AOD)	16	10
Gross head (m)	13.5	36
Turbine Max Flow @ 1.3xQmean (L/s)	79.17	80.3
Hands Off Flow @ Q95	6.9	7
% of available flow licensed	50%	50%
Penstock Length (km)	0.48	1030
Penstock Diameter (mm)	400	400
Weir/Screen Head Loss (m)	0.5	0.5
Net head @ Design Flow (m)	12.43	34.24
Annual Maintenance Downtime	5%	5%
% Annual Flow Abstracted excl flood flows	27.1%	26.7%

Maximum Power (kW)	7.6	21.1
Estimated Annual Output (MWh)	17.949	49.376
Equivalent Houses @ 3500kWh/house/yr	5.1	14.1

Community Attitude

Our survey underlines that there is strong community support to develop a hydropower scheme in Llanrhian Parish with the option coming out on top as most supported. Trefin, Porthgain, and Llanrhian have history of industrial use of hydropower, either to process aggregate quarried in the vicinity or to grind cereals from agricultural production to then be exported by sea. The buildings and ruins from these eras lend the villages their character and also attract the tourism that drives the local economy. There is therefore a romanticism of revival of these once utilised resources that goes beyond a community energy scheme of purely economic benefit.

Trefin's Historic Coastal Millhouse

Income Models

(a) Generator is connected via private wire to a local business. Power is sold to the business under a legal Power Purchase Agreement. A long term negotiated price per unit is agreed that is beneficial for the business as it undercuts import rates available from electricity suppliers, and is sufficiently high enough to create a viable business model and potential community surplus for the community energy project.

(b) Generator is connected to the distribution network to export power to the grid. A specific "licence exemption for small generators under 5MW" PPA is utilised, which nullifies the embedded costs of using the grid network. Savings are split 50/50 between generators and large distributed consumers such as Dwr Cymru. Long term fixed rates above grid export market values can be secured.

(c) Energy Local (EL n.d.) A facilitated scheme that allows local domestic consumers to match their half hourly consumption with that of a local generator connected to the low voltage distribution network at a negotiated price. The price provides savings for consumers against standard grid import rates, while providing the generator with higher revenues per unit than a standard PPA. It requires the domestic consumer to have smart meters installed and switch to the same electricity supplier as the generator exports to. This income model is appropriate for very small scale field solar PV only.

(d) Turbine and generator are connected to the distribution network to export power to the grid. A standard 12-24month export is signed up to with an electricity supplier.

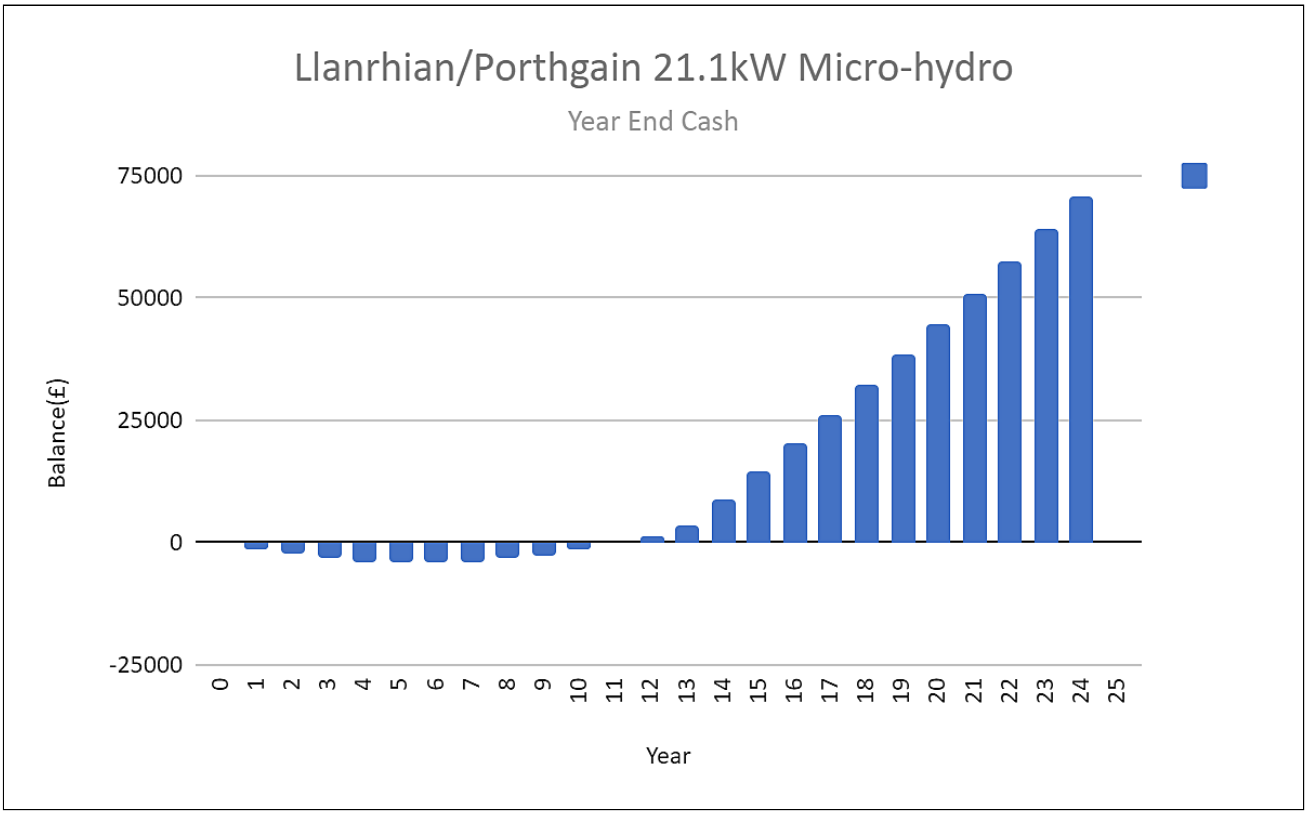
Financial Appraisal

The table below summarises the simple financial appraisal of the two watercourses covering 3 scenarios of best to worst. Only in the best scenario (a) for Llanrhian/Porthgain, where installation is low cost and rate per unit exported is high does a simple payback time come below 10yrs. This calculation does not take into account the cost of capital finance, such as a shareoffer at 5%, or on-going operation and maintenance costs which would significantly add to the long term costs of such a scheme. The ability for a micro-hydro scheme at Llanrhian/Porthgain to cover it's loans and on-going costs is unlikely unless rates for purchasing the power generated are closer to 25p/kWh. Given the ongoing energy crisis in the UK this may be possible but will require negotiation with suitable local businesses with an energy demand that ideally peaks in winter and reduces in summer to follow the seasonal pattern of generation of the hydropower scheme.

Micro-Hydro Assessment Summary									
Watercourse	**Scenario**	**Maximum Power**	**Est. Annual Yield**	**Capex/ kW installed**	**Design & Planning Consents**	**Est. Capital Cost**	**Est. PPA Rate for Exported Power**	**Est. Annual Income**	**Simple Payback Time**
		kW	kWh	£	£	£	£/kWh	£	Yrs
Trefin	**Best Case**	7.6	17,949	£3,000	£7,000	£29,800	£0.15	£2,692	11
	Mid-ground	7.6	17,949	£4,500	£10,000	£44,200	£0.10	£1,795	25
	Worst Case	7.6	17,949	£6,000	£13,000	£58,600	£0.07	£1,256	47
Llanrhian/Porthgain	**Best Case**	21.1	49,376	£3,000	£7,000	£70,300	£0.15	£7,406	9
	Mid-ground	21.1	49,376	£4,500	£10,000	£104,950	£0.10	£4,938	21
	Worst Case	21.1	49,376	£6,000	£13,000	£139,600	£0.07	£3,456	40

The Llanrhian/Porthgain "Mid-ground" scenario, representing a reasonable likelihood if the project was pursued, was modelled in greater depth to provide further financial information. Below is the summary of the results with assumptions noted below. This is followed by a Year End Cash chart for the project. Full spreadsheet figures are provided in Appendix C.

Llanrhian/Porthgain 21.1 kW Micro-hydro Financial Appraisal Summary		
Turbine Capacity	21.1	kW
Estimated Annual Yield	49,476	kWh
Emissions Savings	11,535	kgCO2e
On-site PPA Rate	25	p/kWh
Export Rate	10	p/kWh
Consumed/Exported Ratio	80/20	
Total Capital Cost	£94,950.00	
Grant Ratio	50%	
Grant Amount	£47,475.00	
Shareoffer Amount	£47,475.00	
Yr1 Landowner Rent	£3,075.00	
Yr 1 O&M Contract	£768.75	
Other Operational Costs	£1,555.46	
Community Benefit Fund	£0.00	
25yr Project IRR	2.0%	
Net Present Value	£42,941.74	
Direct Employment Created	0.02	



Assumptions:

- Import & export rates remain static for the 25yr lifetime
- Shareoffer @ 5.5% interest over 10 year term
- Landowner information is unknown. A nominal annual landowner rent of £3000, linked to inflation, has been applied.

- Metering @ £450 one off, £70/yr thereafter
- Staff time at £14.06/hr (includes 25% overheads contribution)
- Comms @ £50/yr
- Inflation @ 2.5%
- Energy Inflation @ 1.5%
- No community benefit fund contribution
- On-site/local consumption set at a default 80%. No consumption data for the local business of The Shed or The Sloop has been assessed.

Case Studies

Ynni Ogwen - 100kW Community hydropower scheme in Dyffryn Ogwen, Eryri (YO n.d.)
Ynni Padarn Peris - 55kW Community hydropower scheme in Llanberis (CEW n.d.)
Friends of Taff Bargoed - 100kW Community Hydropower scheme in Taff Bargoed (CEW n.d.)
Egni Mynydd - 237kW (in development) Community Hydropower Scheme in Mynydd Llandygai (EM n.d.)

Field Scale Solar PV

Field scale solar PV refers to solar PV developments that are ground mounted utilising areas of land from 1 acre to over 5 hectares, typically from 100kW to over 5MW in capacity. They consist of groups of panels at ~400Watt each, mounted in multiple arrays, which form rows and columns with intervening gaps between them for access purposes and to prevent shading of the rows behind. Layouts vary from site to site depending on the characteristics. The arrays are mounted on aluminium frames which are then secured to the ground using multiple methods such as pilings or ground screw anchors. The arrays usually face south, held at a fixed angle between 20-40° from horizontal, to maximise the irradiation available from the sun. The height of the panels can vary between 1-4m off the ground level depending on the desired uses of the land beneath i.e. for continued grazing or wildflower growing. Field scale solar projects can be targeted by thieves at times and so security fencing, CCTV, and alarm systems are often stipulated by insurance companies, however actual requirements depends on the location, visibility of the array to the public, and the prevalence of crime in the area. In addition to the array a project will also require temporary areas and storage for construction, permanent containers on concrete foundations for electrical equipment such as inverters, transformers, & control switchgear.

Generally field scale solar PV is considered low maintenance, with panel cleaning to maintain maximum yields, managing vegetation, and regular inspection and testing being the primary requirements. However, failure of electronic components is common and projects must maintain sufficient finances to fund unexpected replacement costs, and planned replacements typically from Yr10 onwards.

Permissions

1) Planning permission

Field scale solar PV systems require planning permission from the local authority. Typical applications will need to include but will not be limited to:

- Design & Access Statement incl glint/glare/reflection studies, photomontages of views.
- Construction Method Statements incl access and traffic studies.
- Ecology Reports
- Environmental Statements

2) Grid Connection

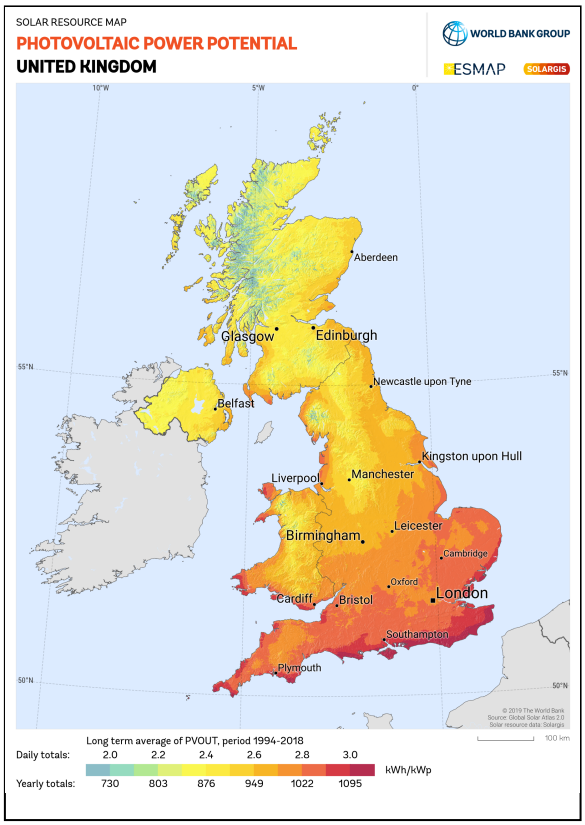
Field Scale solar PV systems require grid connections or private wires to significant industrial consumer s of electricity (they cannot supply low voltage dwellings directly). This can add considerable cost to a project depending on proximity to a suitable capacity electricity line & substation. The Llanrhian area is connected via 11KV lines which may be suitable however this is dependent on the local infrastructure and existing connections to the network and can only be determined through a grid connection application to the distribution network operator.

3) Landowner Consents

Negotiation with a landowner will be required to secure Option and Lease legal agreements detailing the permitted use, limitations, fees, and duration of the arrangement between the community energy organisation and the landowner. This is usually a lease with a duration to match the planning permission of the generator. Land rent, typically £750/acre or a proportion of profits, are also detailed.

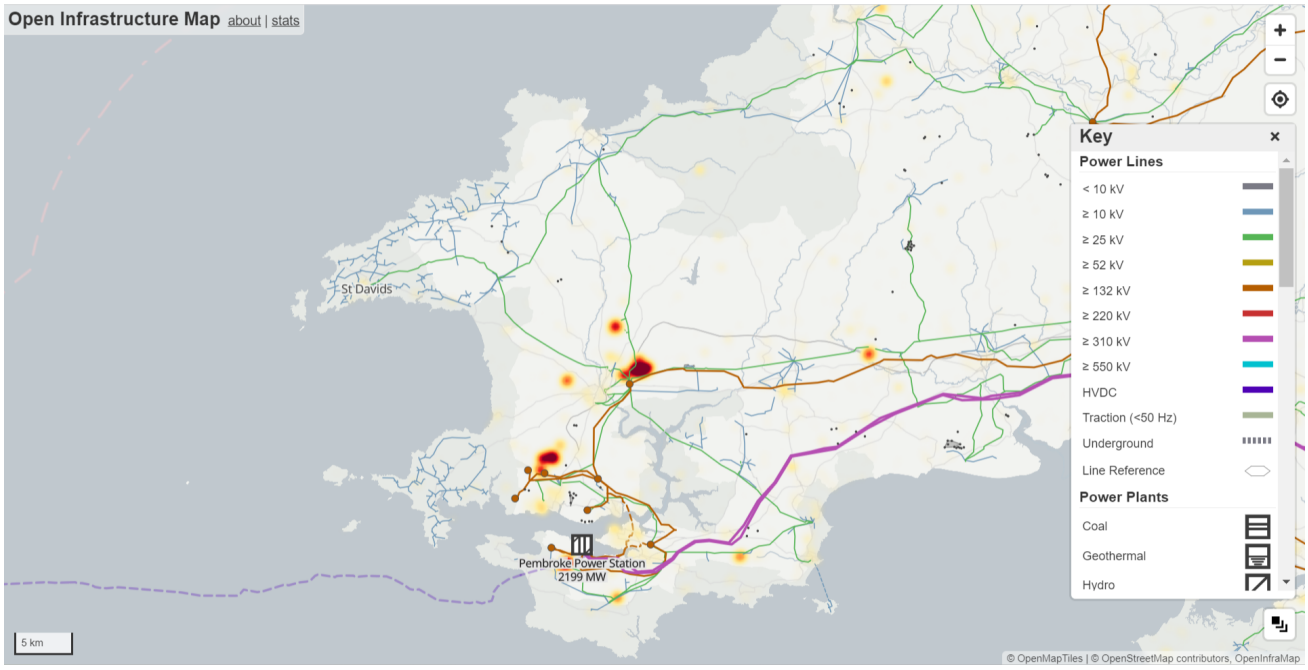
Resource

Pembrokeshire has a comparatively higher level of annual solar irradiation than much of Wales, similar to areas of Cornwall & South England. In terms of resource it is well placed to generate electricity from solar PV as represented in the map below:



UK Solar PV Generation Potential (SolarGIS n.d.)

However, North Pembrokeshire lags behind the south of the county in terms of solar PV development. This is largely in part to the limited capacity of the distribution grid serving it than lack of resource, as illustrated by the following map where yellow to red colouring indicates areas of low to high generation from solar.



Map of Pembrokeshire grid network with solar generation intensity (OIM n.d.)

There are numerous obstacles to locating a field scale solar PV project in close proximity to the villages of Trefin and Porthgain:

- PCNPA supplementary planning guidance has much to say on the sensitivity of these areas to field scale solar PV development, with sensitivity classed as moderate to high.
- The Trefin and Porthgain conservation areas will also increase difficulty in creating a visually acceptable development.
- Field sizes are generally small and predominantly north facing, providing limited location opportunities for development.
- The 11kV grid network is present however the villages represent the furthest proximity of the line from their associated substations, meaning grid connection and available capacity could be an issue.

Due to these obstacles the likelihood of a successful field scale solar PV project in proximity to Trefin, Porthgain, Abereiddy, within the PCNP is limited and would be a protracted process. There is little benefit to locating a large field scale solar PV site next to the villages as local business and dwellings would not consume directly from it. Though there is some scope for locating a very small 100-350kW solar PV system connected at 400V in close proximity to the villages in order to utilise novel income sources and reduce local electricity bills such as "Energy Local". However, at this size there is limited economies of scale and the cost per kilowatt installed will be high.

A larger field scale solar PV system project located outside of the national park on the southern side of the

A487 would benefit from:

- Plateaux tops / flat land and gentle slopes with a southerly aspect to maximise efficiency.
- Outside of PCNPA and areas influencing the Trefin and Porthgain conservation areas
- Lower population density and multiple hedgerows obscuring views.
- Greater field sizes for larger scales
- Better access from the A487 for construction vehicles

No specific landowners have been engaged at this stage. Rather than pre-empt potential landowner collaboration, the solar resource potential has been assessed generally for two areas as shown in table below.

Options Output Comparison		
	1 - Very small scale Trefin located	**2 - Small scale located south of A487**
Inverter Capacity (kW)	350	1000
Array Capacity (kWp)	438	1300
Optimized Slope Angle	39°	40°
Optimized Azimuth	6°	6°
Total Modelled Losses	-18.23%	-18.25%
Estimated Annual Yield (kWh)	461,979	1,385,024
Estimated No. Houses year (@4000kWh/year)	115	346
Specific Yield (kWh/kWp)	1,054.75	1,065.40

Community Attitude

Field scale solar PV was supported jointly second as a project idea by the community. Associated concerns were "Impact on Wildlife"(High), Securing Permissions(High), Visual Impact (Mid). Some individuals supported solar PV above wind due to its lesser visual intrusion, longevity, and easier maintenance.

Income Models

(a) Energy Local (EL n.d.) A facilitated scheme that allows local domestic consumers to match their half hourly consumption with that of a local generator connected to the low voltage distribution network at a negotiated price. The price provides savings for consumers against standard grid import rates, while providing the generator with higher revenues per unit than a standard PPA. It requires the domestic consumer to have smart meters installed and switch to the same electricity supplier as the generator exports to. This income model is appropriate for very small scale field solar PV only.

(b) Generator is connected to the distribution network to export power to the grid. A specific "licence exemption for small generators under 5MW" PPA is utilised, which nullifies the embedded costs of using the grid network. Savings are split 50/50 between generators and large distributed consumers such as Dwr Cymru who are able to arrange such PPAs. Long term fixed rates above grid export market values can be secured.

(c) Generator is connected to the distribution network to export power to the grid. A standard 12-24month

export is signed up to with an electricity supplier.

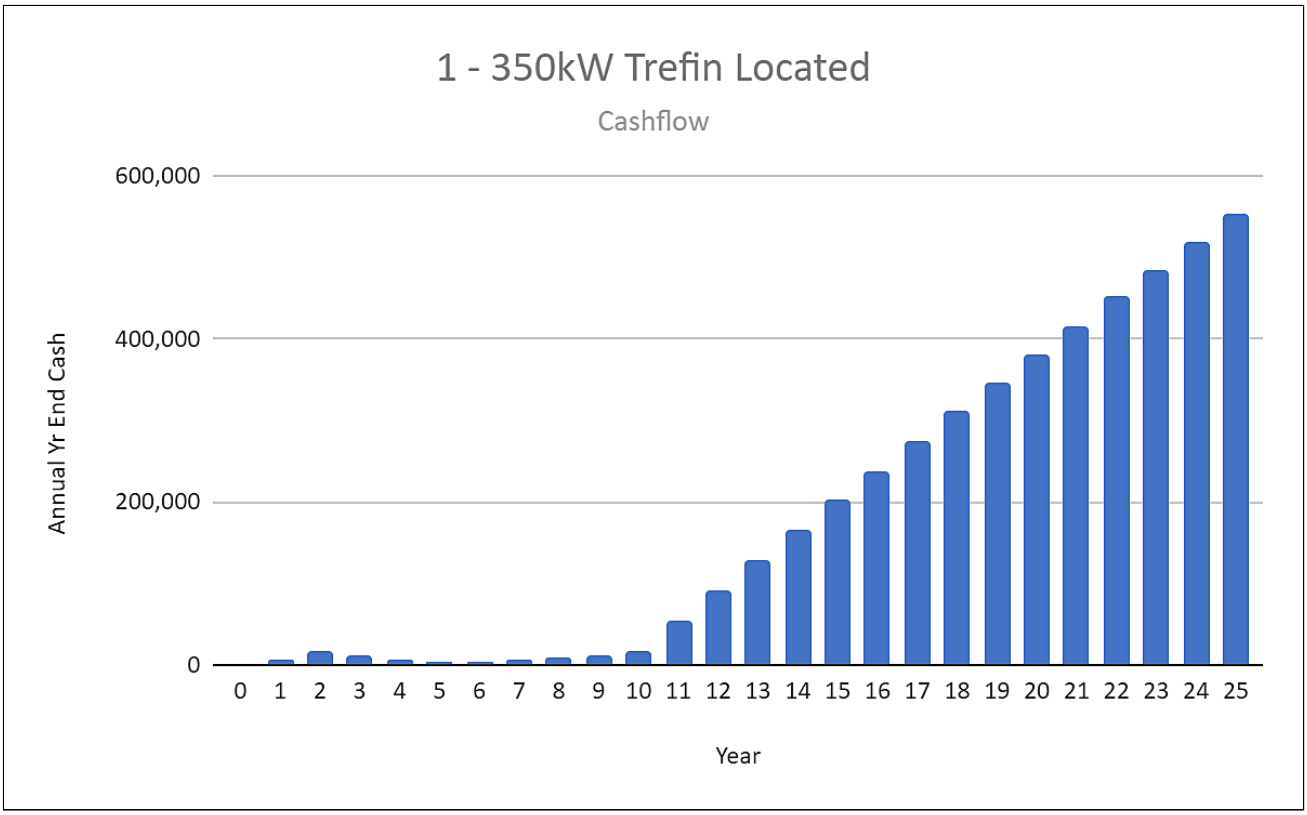
Financial Appraisal

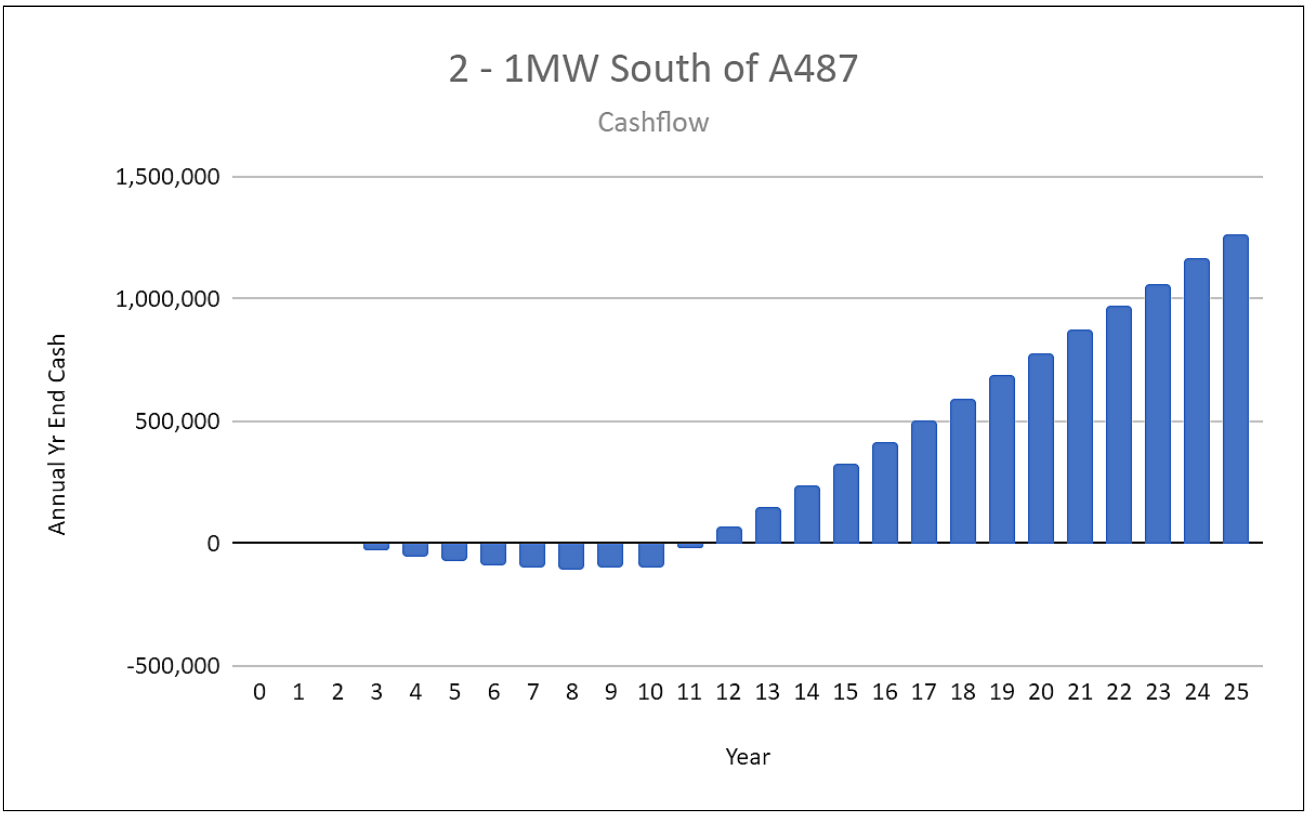
Full spreadsheets of the financial modelling of each option are included in the appendix. The results are summarised in the following table with the relevant assumptions informing the model below, followed by Year End Cash graphs. Option 3 has been included to illustrate the difficulty in long term financial prospects of a large generator relying on low income export to the grid. Spreadsheet figures for options 1 &2 are available in Appendix D & E respectively.

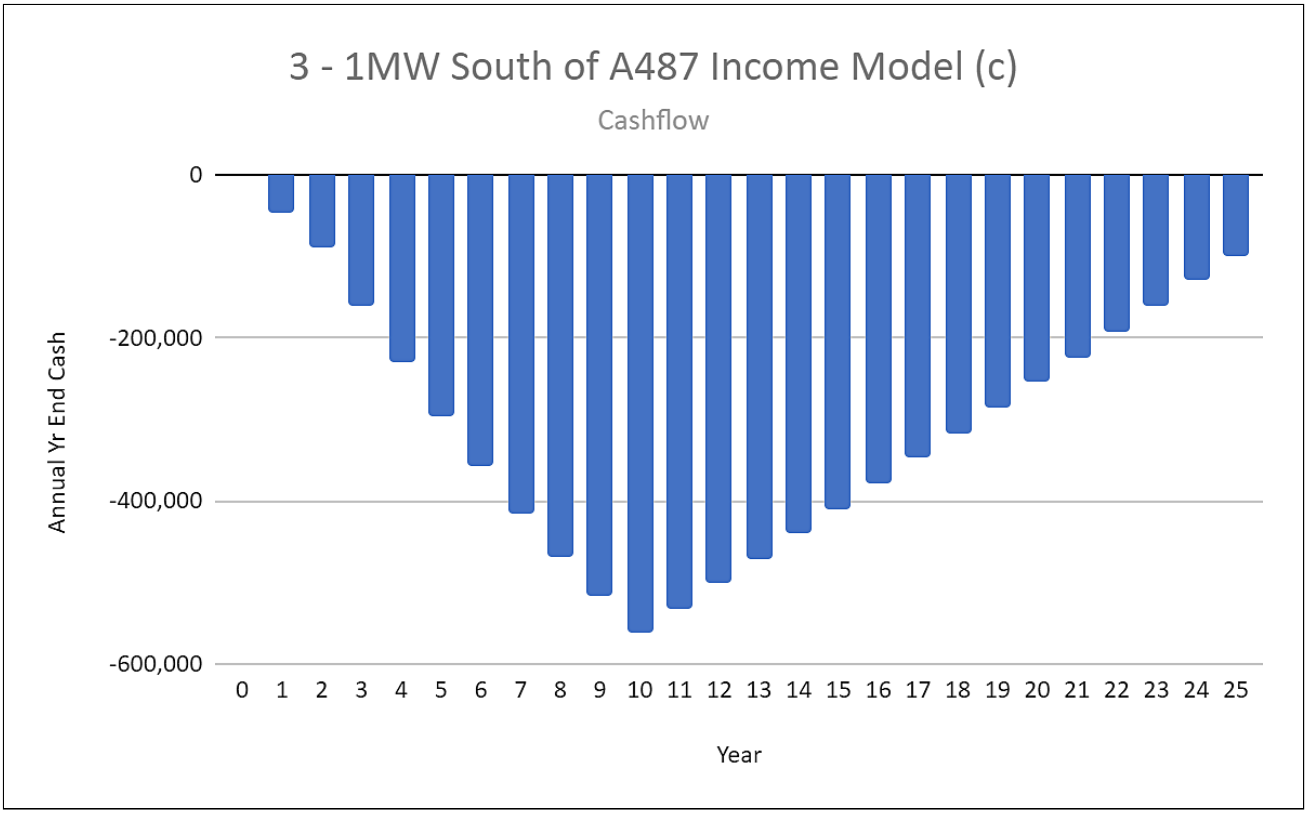
Field Scale Solar PV Financial Appraisal Summary			
	1 - 350kW Trefin Located	**2 - 1MW South of A487**	**3 - 1MW South of A487**
Income Model	(a) Energy Local	(b) Dwr Cymru PPA	(c) Standard export PPA
Local Energy Use Tariff (p/kWh)	21	-	-
Surplus Export Tariff (p/kWh)	7	10	7
Development	Grant Funded	Grant Funded	Grant Funded
Grid Connection (£)	120,000	250,000	250,000
Components and Construction	657,000	1,579,500	1,579,500
Capital Grant @ 60% of total	466,200	1,097,700	1,067,700
Capital Shareoffer @ 5.5% interest	310,800	731,800	731,800
Year 1 Income	72,341	141,965	99,375
Year 1 Opex	19,029	27,554	27,554
Project IRR	2.0%	2.7%	-6.4%
Project NPV @ 25yrs	348,231	761,301	-217,465
Cumulative Community Benefit Fund @ 25yrs	65,872	65,872	-
Direct Jobs Created FTE	0.2	0.2	-

Assumptions:

- Energy Local modelled at a conservative 60% of generation consumed by Energy Local members.
- Capex modelled at £1500/kWp for 1, £1215/kWp for 2 & 3.
- Land rent in Yr 1 is at £750/acre, linked in inflation.
- O&M @ £30/kWp for 1, £25/kWp for 2 & 3
- Insurance @ £20/kWp for 1, £15/kWp for 2 &. 3.
- Metering @ £450/annum.
- Staff time at £14.06/hr, 7.5hrs per week.
- Communication Costs at £500 for 1, £750 for 2 & 3.
- Community Benefit Fund set at £2000/yr from Yr3 onwards.
- Shareoffer capital and interest repayment term = 10 yrs.
- CPI set at 2.5%.
- Energy inflation at 1.5%.
- Shareoffer set at competitive 5.5%.


1 - 350kW Trefin Located
Cashflow
600,000
400,000
200,000
0
Annual Yr End Cash
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Year


2 - 1MW South of A487
Cashflow
1,500,000
1,000,000
500,000
0
-500,000
Annual Yr End Cash
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Year



Stand alone field scale solar economics are challenging, particularly as components costs have increased by ~50% from historic lows due to global economics driven by high demand, reduced manufacturing capacity in China, lack of manufacturing capacity in Europe, and Britain's exit from the Single Market. Field scale solar projects therefore need to secure more complex income streams such as private wires or direct PPAs to receive sufficient revenue.

Field scale solar PV projects also find lower capital installation costs by sharing existing grid connections with operating wind turbines. These grid connections are rated at a certain capacity for the wind turbines maximum output, however wind power is variable and intermittent hence there are many hours within a year where the maximum capacity of the connection is not being utilised and spare capacity exists. Solar-hybrid parks are co-located adjacent to the wind turbine to take advantage of this intermittency and seasonality. They are appropriately sized to make efficient use of the spare grid connection capacity available. By monitoring in real time what is being exported over the grid connection the solar hybrid park increases or curtails its generation in response to the wind turbines export to ensure the maximum grid connection capacity threshold is never breached. In this manner the solar hybrid park can avoid the cost of a new grid connection but this does come at the expense of some potential yield and must be carefully modelled to ensure viability. Two community energy groups, Ynni Teg(YT n.d.) in North Carmarthenshire, and Cwm Arian Renewable Energy (CARE n.d.) in North Pembrokeshire have gained planning permission for such projects and are in the process of finalising capital funding for their construction.

Battery storage coupled to field scale solar PV may be able to access greater revenues through shifting export to different periods for greater time of use tariffs, or to increase the proportion of matching consumption with Energy Local users, or to provide network balancing services. However, the modelling required for this is

extensive and is not possible to achieve for this study given the limited timeframe. If field scale solar is pursued then further modelling exercises should include for battery storage.

Case Studies

Gower Power Co-op - 5MW and 1MW community owned solar PV farms on the Gower (CEW n.d.)
Cwm Arian Renewable Energy - 522kWp community owned solar-hybrid farm, Tegryn (CARE n.d.)
Ynni Teg - 575kWp community owned solar-hybrid farm, Meidrim (YT n.d.)
Bretton Hall Solar - 30MW community owned solar PV farm in Flinshire (YN n.d.)

Community Building Rooftop Solar PV

Opportunities exist for community energy groups to improve their local area and services by aiding in the reduction of the cost of running the community buildings where these services and events are provided. Buildings such as village halls, sports club houses and schools are crucial focal points of community life and if burdens on them are lessened or removed then they in turn invigorate the community utilising them. There are generally two ways by which community buildings can be helped:

1. Community energy groups can encourage, aid and advise, or even apply on behalf of the organisations that use, lease, or own small community buildings with relatively low electricity demands, to seek grant funding from suitable funding sources to secure improvements to those buildings that reduce energy bills. Improvements such as insulation, heat pumps, and solar PV systems are possible through this route. The community organisations then own these materials or systems outright and will benefit from the savings they create for years to come. These buildings generally have such low consumption as not to be viable for option 2 below. Identified community building for grant opportunities within Llanrhian Parish include:
    a. Trefin Community Sports Clubhouse - 5kWp solar PV system installed in conjunction with a new roof that is already funded. This would produce in the region of 4,450kWh/year.
    b. Llanrhian Church Hall - 5kWp solar PV system. The Grade II listed building status of this hall will require careful design considerations and permissions.

2. Larger community buildings such as schools have a higher electricity demand and as such require larger interventions to reduce their electricity bills proportionately. This opens up opportunities for community energy organisation to provide a proportion of that consumption from on-site rooftop solar PV owned by the community. The building landlord leases the roof space to the community organisation to install the building connected solar PV system. Electricity consumed from the solar PV system is sold to the building occupier at a negotiated rate much less than grid import rate to create significant savings on the occupiers electricity bills, and also high enough to be financially viable for the community energy group. Any surplus electricity is exported to the grid under an export PPA.

    Schemes such as this already exist in Wales. Most notably Pembrokeshire Council have collaborated with Egni Co-op (EG n.d.), UK's largest rooftop solar PV co-op based in Aman Valley, to provide solar PV systems to 6 schools across the county to date including Golden Grove in Pembroke and

Ysgol y Frenni in Crymych. Pembrokeshire Council are seeking to continue this collaboration with a 3rd party group having recently invited tenders to bid for a further roll out of rooftop solar PV on their estate. Croesgoch Primary School is known to be part of the shortlist for this next phase. There is therefore an opportunity for the residents of Croesgoch and the wider community of Llanrhian Community Parish to potentially invest in a 30-40kWp community PV system at Croesgoch school via investing in a share offer of an already established community energy entity engaged with Pembrokeshire County Council.

3. In a similar method to the above, community groups can work collaboratively with local businesses, with suitable rooftops and levels of consumption, to install community owned solar PV systems on their roofs to provide reduced rate solar electricity to the business premises. Businesses see savings on their electricity bills while income is raised for community benefit. The community energy organisation owns and maintains the solar PV systems for 20-25yrs before gifting them to the business. As in point 2 above, this is now an established community energy route meaning practical and technical methodology along with drafts of legal documentation are already in existence and willing to be shared by other community energy groups. However, it is prudent to bear in mind that this model requires a higher level of administration compared to a community energy organisation operating a single large scale generator and generally requires multiple sites to achieve economies of scale. Individual modelling for specific businesses is beyond the scope of this feasibility report, however there are multiple small business in the Parish that may be suitable, some are listed below. Farms in the area, with large consumption and large rooftops also present collaboration opportunities for systems above 50kWp but are not listed below.

    a. The Ship, Trefin - 13kWp solar PV system - generating ~9,900kWh/year
    b. Caffi y Ragna - 12kWp solar PV System - generating ~ 9000kWh/year
    c. The Old School Hostel - Replacing solar thermal with solar PV + hot water diverters
    d. Several Church of Wales Chapels (though many are Grade II listed)
    e. Square and Compass Inn - 12kWp solar PV system - generating ~ 10,200kWh/year
    f. The Shed (Ty Mawr, grade II listed), Porthgain - 20kWp solar PV system- generating ~ 17,000kWh/year
    g. The Sloop, Porthgain - 15kWp solar PV system - generating 11,000 kWh/year
    h. Antramont Arms, Croesgoch - 8kWp solar PV system - generating 6,500 kWh/year

This short list already creates a total renewable energy capacity in the region of 100kWp, generating approximately 85,000kWh per year, offsetting 19.8 tonnesCO_2e annually. Financial modelling of the above has not been undertaken as it requires information on current businesses consumption & electricity tariffs.

Domestic Solar PV

Domestic solar PV has been supported in the UK through the provision of the Feed in Tariff from 2010 to March 2019. It provided a financial incentive for homeowners to invest in retrofitting solar PV to their homes by paying a tariff for every unit of electricity generated. More recently installations on properties with low Energy Performance Certificate (EPC) values and those vulnerable or on low incomes have been funded via

government and local authorities through "Nest" and "Energy Company Obligation" grants, which is currently open for application on it's 4th iteration as "ECO4" (PCC n.d.). Currently, owners of domestic PV systems are able to save on their electricity bills and also export onto the grid and receive payments for it, enabled by smart metering, via the Smart Export Guarantee, to pay back the capital cost of the system. A community energy group could provide information, encourage, and advise residents to take advantage of all of the above to increase domestic solar PV proliferation in the Parish in general.

Domestic solar PV schemes are therefore not an established model for community energy organisations. Reasons for this include but are not limited to:

- Limited economies of scale due to individual systems for each property
- High administrative load due to number of systems
- High set up costs due to multiple legal fees
- Limited lucrative income sources
- Modelling uncertainty due to household differences in energy use and behavioural change
- Traditional views of home energy provision and consumption being the responsibility of the homeowner
- Resistance of homeowners to enter into additional legal agreements concerning a property due to potentially selling the property in future.

However, if a financial and administrative model is possible, numerous community benefits could be unlocked:

- Community energy organisations facilitate a rapid conversion of a village or community to primarily renewable energy consumption, potentially fully decarbonising.
- Homeowners directly benefit from property connected solar PV electricity reducing household bills.
- Homeowners without sufficient capital resource but fall outside the scope of ECO4 provision are able to receive a PV system (dependent on Income and Set Up model).
- Community surplus is created for the further improvement of the community.
- Local jobs are created in running the project as well as through installation and maintenance services.

Permissions

Rooftop solar PV systems are a permitted development right in Wales (WG n.d.). However, the PCNPA has additional powers to ensure the "special qualities" of the Park are not damaged by the development of rooftop solar PV in particular within Conservation Areas such as those in Porthgain and Trefin. The guidance for this has been outlined in previous sections.

Multiple properties within Trefin have already installed rooftop solar PV systems of the standard above roof retrofitted type. Several are outside the Trefin Conservation Area, one or two are outside the Trefin Conservation area but directly overlook it, and at least 2 are within the Trefin Conservation Area but are to the rear of the building and not on the principle elevation facing the main views from within the Trefin Conservation Area. New housing developments, such as the Passive Houses being constructed at the time of writing, and other in planning, also specify solar PV systems on the buildings.

There is therefore already precedent for retrofitted rooftop solar PV in Trefin, which PCNPA has not objected

to, and an increasing prevalence of the technology year to year without stipulation for more visually sensitive, but expensive, technologies such as solar slates. Our discussions with PCNPA, particularly with Jessica Morgan, Head of Decarbonisation indicate support of village scale community roll out of rooftop solar. However, this support is caveated that further discussions must be held with the Planning Department. Head of Planning, Sara Morris, was contacted regarding the project idea, but no response was received by the time of publication.

Our opinion is that properties outside the Trefin Conservation Area fall within permitted development rights, while those within the Trefin Conservation Area will fall within permitted development rights if the system is sensitively located out of view of the Conversation Area, i.e. on a rear elevation, in order to preserve the conservation area character.

Resource

As stated previously, Pembrokeshire has a good solar irradiation resource, as does Llanrhian Parish as a whole. However the following resource and financial modelling of a domestic solar PV model of community energy will remain focused on Trefin due to its inherent characteristics and to maintain a realistic initial project size. Trefin itself has developed primarily along a South West to North East road and been built on North to South sloping topography, resulting in a very high proportion of roof pitches facing South West, South, or South East. The exception are houses developed along North Rd and Ffordd yr Afon which have more West-East orientated rooftops.

Aerial View of Trefin
Note shadowed north facing roof pitches and light south facing roof pitches.

As well as the villages orientation, most of the roof surfaces can be retrofitted with standard components and techniques as they are predominantly traditional slate or concrete tile. There are some rooftops surviving of lathe and cement, these would not be appropriate for retrofitting with solar, notwithstanding that they are key buildings in the Trefin Conservation Area.

Trefin 2021 Census Data (ONS, 2021)	
Population	220
Housing Type	**No.**
Detached	156
Semi Detached	75
Terraced	11
Flat (purpose built)	1
Flat (converted)	4
Residence in Commercial Building	1
Total	**248**
Counted Properties within Trefin Conservation Area	97
% of Households Deprived in 1 or more Dimensions	61.8%

The above data provides a starting point for resource modelling. In detail solar PV system modelling for each household is beyond the scope of this feasibility report due to time constraints, therefore a generic 4kWp domestic system as well as estimated consumption has been modelled for the Trefin locality:

System Capacity	4.	kWp
Est. Avg. Annual Household Demand	3,500.	kWh
Annual PV System Production	3706	kWh
Est. Solar PV On-site Consumption	889	kWh
Self Sufficiency as of House demand	25.40%	
% of Solar PV Production Consumed	23.99%	
Year 1 Energy Cost Without Solar PV	£1,305	
Year 1 Energy Cost With PV Savings	£1,011	
Year 1 Energy Savings	£293	

System Production Modelled in free opensource design software OpenSolar (OPS, 2023)
Energy Savings based on Octopus Outgoing Tariff: 41p/day + 33p/kWh

Three scenarios representing 3 scales of project have been created by applying the generic system to a total number of households:

Scenario	No. Properties	Est. unsuitable roof exclusions	No. of Systems	System Size	Total Capacity	Est. Avg Annual Yield	Yield Per System	Project Annual Yield	CO2 Savings Equivalent
				kWp	kWp	kWh/kWp/year	kWh/year	kWh/year	kgCO2
All Trefin	248.	25.	223.	4	992.	926.5	3,706	919,088	214,276
Trefin excl. conservation area	151.	15.	136.	4	604.	926.5	3,706	559,606	130,467
PCC Social Housing Only	22.	2.	20.	4	88.	926.5	3,706	81,532	19,008

Community Attitude

Domestic solar PV was placed jointly second as most supported project idea by the respondents of the community survey. 82% believed they had roofspace for solar PV. 41% would consider installing them if clear advice was given from PCNPA, a greater proportion, 67%, would considering installing them if there was financial assistance available. Relating to a community project to deliver domestic rooftop solar PV, at the time of the survey only 31% of respondents would consider leasing their roof space to a community group to facilitate a solar PV installation.

Income Models

As previously stated, as yet there are no community energy projects based on delivering domestic solar PV that are un-reliant on the Feed in Tariff for financial viability. Income models are either limited or complex to deliver. Potential options are outlined below:

(A) Smart Energy Guarantee (SEG) - The community energy group facilitates the installation of a smart meter at each property as well as switching to an electricity supplier that pays for exported power via the SEG. The community energy group claims or is nominated as the payee of these export power payments. The SEG is variable depending on electricity supplier and on wholesale market prices, it can alter over the project lifetime. Octopus currently have an SEG rate of 4.1p/kWh for export only customers, or 15p/kWh if the property is also an import customer on their "Octopus Outgoing" tariff (Oct n.d.).

(B) The electricity supplier installs a smart meter to facilitate half hourly export readings. A specific "licence exemption for small generators under 5MW" PPA is utilised, which nullifies the embedded costs of using the grid network. Savings are split 50/50 between generators and large distributed consumers such as Dwr Cymru who are able to arrange such PPAs. Long term fixed rates above grid export market values can be secured. Consultation with Dwr Cymru has concluded that there are no minimum thresholds for the amount of export power or system capacity, the only stipulations being that the generator is half hourly metered and owned by a community energy group. It is therefore technically possible for a community energy projects to en mass sign up domestic solar PV systems.

(C) "Green Deal" Type Savings Recouperation - Households receive a community owned PV system for free, but payments equal to the modelled estimated annual savings from that PV system are due to the community

energy group to recoup the capital cost over time. In the generic household example above this would equate to £293 in Year 1. Households are able to alter their behaviour to increase the actual savings on their bills. Export payments via the SEG (A) could be claimed by the household or the community energy group, or export payments via a licence exempt PPA (B) could be claimed by the community energy group only.

(D) Capital Cost Contribution/Membership Fee - Households pay a one off percentage contribution towards the cost of their PV system to join the community energy project as a member. They retain all savings realised by the solar PV system to recoup this cost over time. The community energy group claims any export payments from the SEG (A) or licence exempt PPA (B). The community energy group could also levy an annual maintenance fee payment.

In all examples above, the community group can leverage economies of scale to reduce capital costs to below that accessible by a single domestic purchaser. As well as this buying power, community energy project can attract capital grant funding depending on the business case and community benefits realised by the projects. The above models can be combined to create sufficient financial viability for the project, such as (D)+(B), or to facilitate inclusion of low income households with limited to no capital, such as (C)+(B). Note that the more complex the income model and the greater number of options offered, the greater the administrative burden on the community energy organisation. Careful consideration is required to determine what is financially viable but also works for the majority of households.

In general after a suitable period allowing the community group to recoup capital costs and generate a community benefit surplus if desired, the lease and income arrangement can be halted, with the PV system then being gifted to the property. Alternatively, a revised arrangement between the property owner and the community group can be put in place.

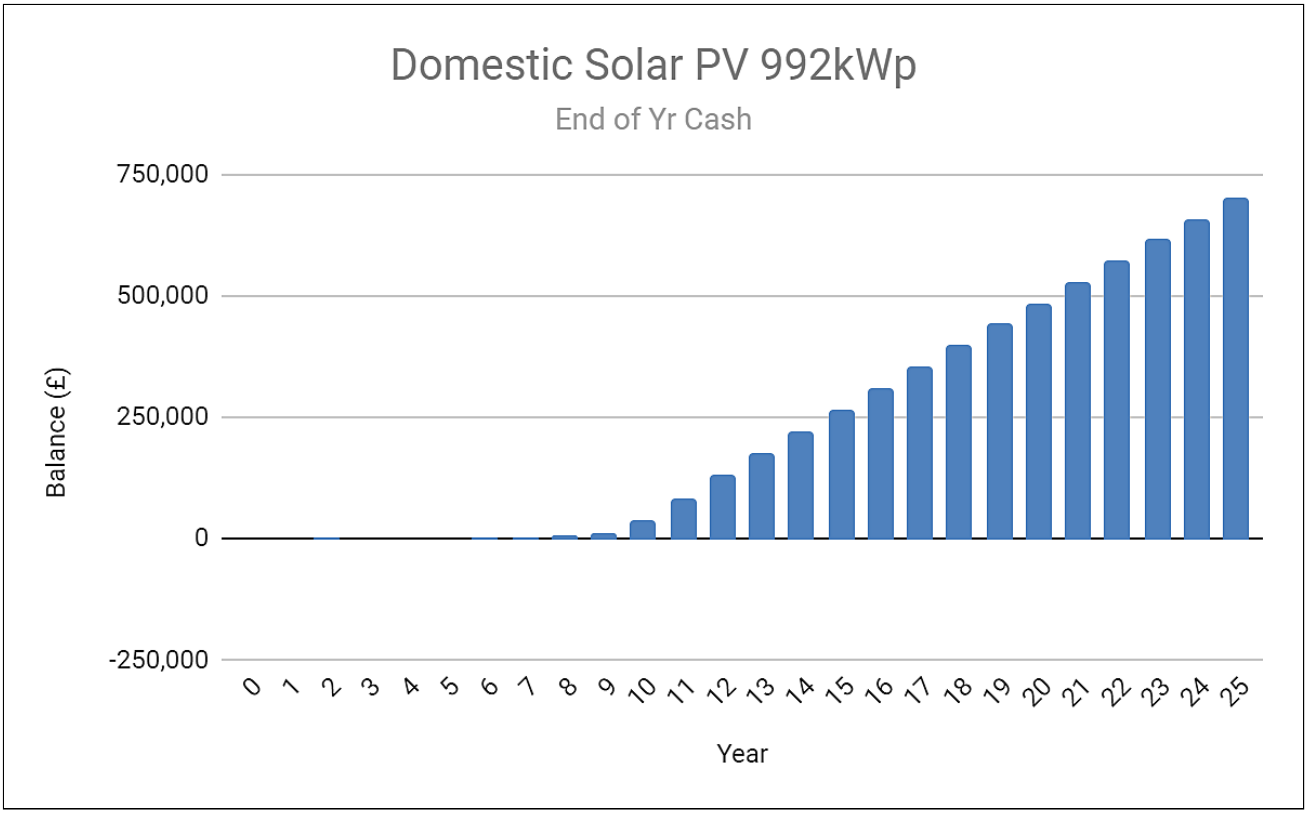
Financial Appraisal

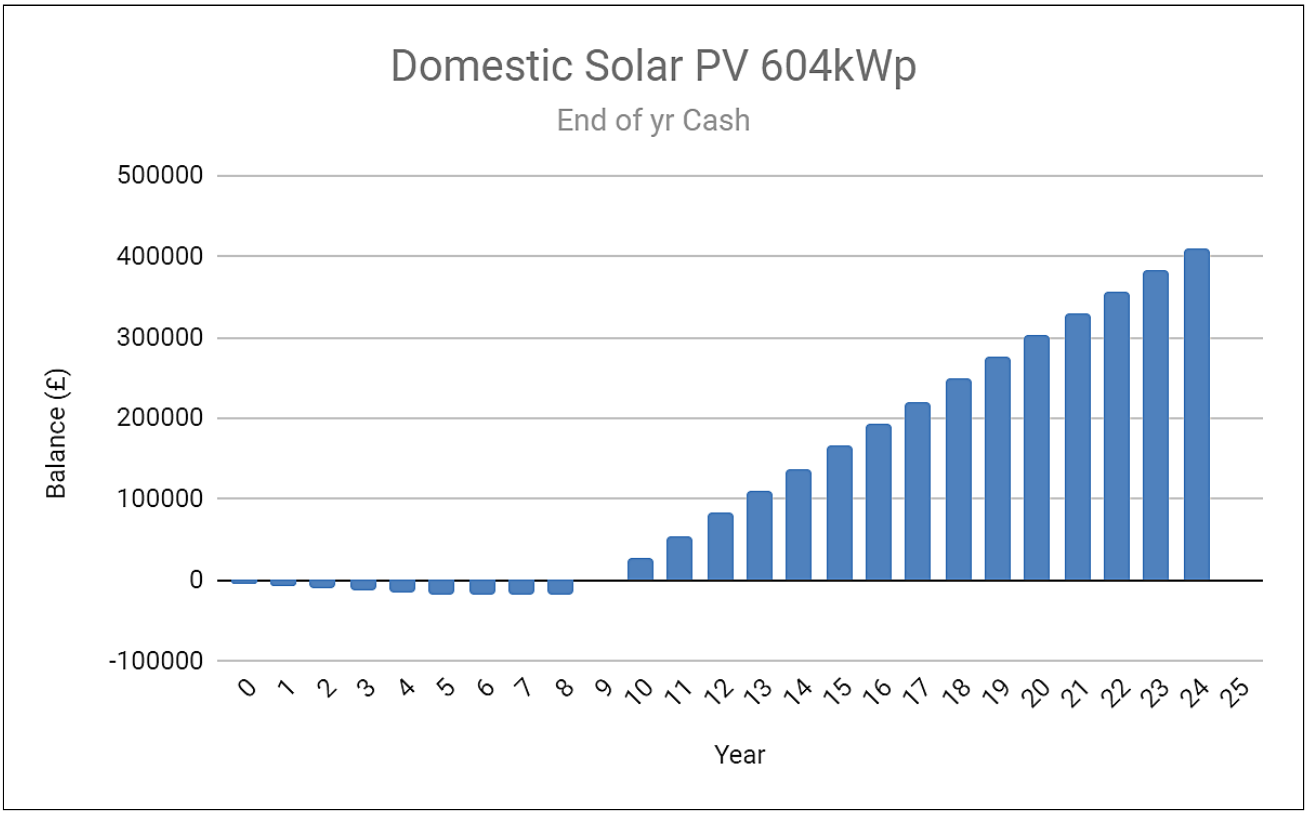
Due to time constraints it is has not been possible to model all potential income model combinations. The following appraisal is therefore based on the 3 increasing project scales using income model combination (D)+(B). The results are summarised in the following table with the relevant assumptions informing the modelling below. These are followed by Year End cashflow graphs. Spreadsheet figures are available in Appedinces F-H.

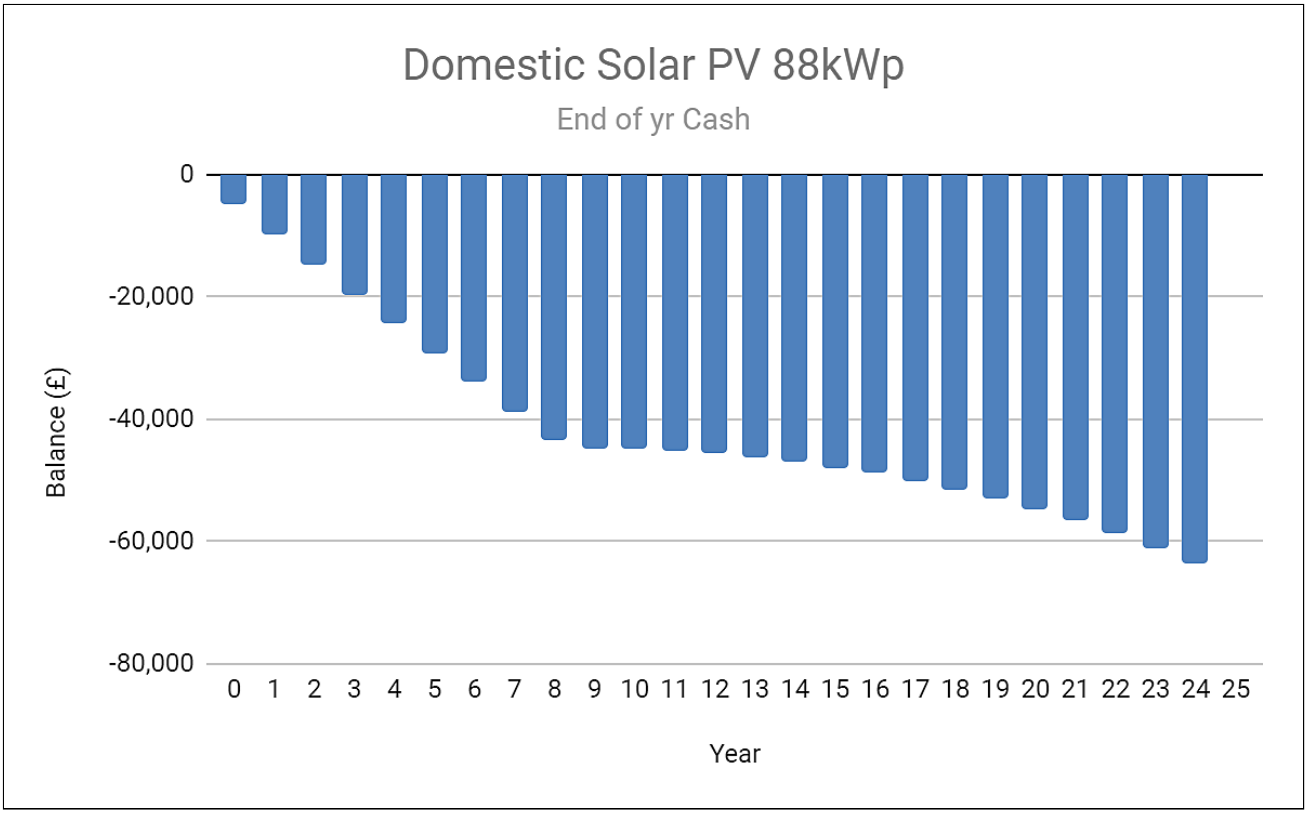
Domestic Solar PV Financial Appraisal Summary			
	All Trefin	**Trefin excl. conservation area**	**PCC Social Housing Only**
No. of Systems	223.	136.	20.
Total Capacity (kWp)	992.	604.	88.
Cost (£/kWp)	£1,100	£1,200	£1,400
Total Capex (£)	-£1,191,550	-£786,000	-£132,200
60% Grant Funding (£)	£714,930	£471,600	£79,320
Solar Membership Funds (£)	£245,300	£149,600	£22,000
Loan Amount Required (£)	-£231,320	-£164,800	-£30,880
Year 1 Operating Costs (£)	£47,486	£28,703	£7,283
Minimum End of Yr Balance (£)	-£632	-£18,695	-£63,593
Project IRR (%)	6.8%	5.2%	-
Project 25 Yr NPV (£)	£423,307	£239,990	-£48,939
Community Funds Raised (£)	£106,386	£33,244	£0
25Yr Cumulative Household Bill Savings (£)	£1,681,075	£1,025,230	£150,769
Direct Jobs Created (FTE)	0.3	0.2	0.1

Assumptions:

- All development costs, including legal fees, staff time, and structural surveys are grant funded
- One of Capital Contribution/Membership Fee @ 25% Full Cost = £1,100
- Maintenance Fee = £80/year
- Export Tariff = 10p/kWh
- Metering @ £450/house
- Capital Grant @ 60%
- Operation & Maintenance Cost @ £50/kWp
- Insurance Cost @ £40/kWp
- Staff time at £14.06/hr (includes 25% overheads contribution)
- Comms @ £10/kWp
- Component Replacement Fund @ £120/kWp over 10years
- Community Benefit Fund
    - £3000/yr from Yr 3 for 992kWp
    - £1000/yr from Yr 5 for 604kWp
    - £0 for 88kWp
- Shareoffer capital and interest repayment term = 10 yrs.
- CPI set at 2.5%.
- Energy inflation at 1.5%.
- Shareoffer set at competitive 5.5%
- House demand and percentage of PV consumption is static for the 25yrs, assuming that any behavioural change over time is offset by increasing electricity demand due to EV charging and heat pump consumption.


Domestic Solar PV 992kWp
End of Yr Cash
750,000
500,000
250,000
0
-250,000
Balance (£)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Year


Domestic Solar PV 604kWp
End of yr Cash
500000
400000
300000
200000
100000
0
-100000
Balance (£)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Year



As can be seen above, the success of a community owned domestic solar PV project based on this income model relies on the following main attributes:

- Sufficient uptake and installed capacity to achieve economies of scale.
- Households able to afford the membership and maintenance fees.
- Securing a long term export tariff at 10p/kWh or more.
- Securing a high proportion of development grant funding and capital grant funding to de-risk the project financially.

This type of community domestic solar PV project is theoretical at this stage. Our opinion is that it is a model with possibilities but caveat that it would require a significant learning curve or require prior community energy and industry experience to set up.

Battery storage has not been included in the modelling at this stage. Further investigation into the financial balance of including battery storage with the solar PV system will be required. Likely affects could be a much higher percentage of solar PV energy consumed by the household with correspondingly reduced export. Potentially this may favour a different combination of income models such as (C)+(B)

Case Studies

- ➤ Bath & West Community Energy - Solar Streets 2 - 16 Property Trial of Solar PV & Batteries (BWCE n.d.)
- ➤ Chase Community Solar - Cannock Chase - 312 Council Properties (CH, 2022)

New endeavours are also being explored that do not rely on the FiT:

- ➤ Power Station - Community Solar Project, London (PW n.d.)

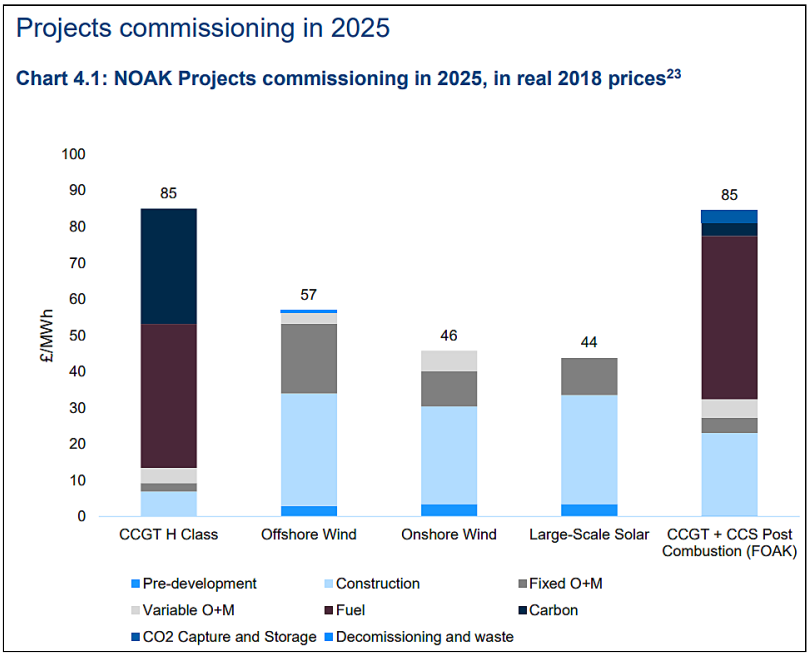
Medium Scale Wind

Wind turbines are widely recognized and well-understood as a reliable form of renewable energy, and have become the mainstay of community energy development in Wales. They harness the lift forces of the wind to spin aerodynamic blades, which in turn rotate a rotor, creating a mechanical force that generates electricity. The energy produced by a wind turbine depends on the speed of the wind and the surface area covered by the rotating blades. Consequently, a larger swept area allows the turbine to generate more power. Typically, wind turbines are granted planning permission for a period of 25 years, although there is the possibility of re-powering, which involves replacing the existing turbines with a new generation of equipment.

Wind turbines can be deployed individually, in small clusters consisting of 2 to 5 turbines, or in larger groups known as wind farms, which typically comprise 5 or more turbines. Within the confines of Pembrokeshire, deployment options are limited to single turbines or, in specific instances, small clusters of 2 to 3 turbines. Regardless of their configuration, wind turbines consist of several essential components, including the tower, hub, blades, nacelle (which houses the generator and gearboxes), and a transformer. The transformer may either be situated within the nacelle itself or at the base of the tower.

In addition to the turbines themselves, large-scale wind energy projects require specific infrastructure elements. These include establishing road access to the site, typically through a bell mouth or a similar access point connected to the main road. In some cases, minor road widening may be necessary to accommodate larger turbines. On-site tracks are also required for construction and ongoing maintenance purposes. Furthermore, turbine foundations, one or more anemometer masts (which measure wind speed), electrical cabling, an electrical sub-station/control building, and a connection to the electrical grid are necessary components. Temporary crane hardstanding areas and construction compounds are also needed during the construction phase.

Onshore wind power remains one of the cheapest forms of energy generation available to the UK, even when taking into account their higher maintenance needs:



Source: Department of Business Energy & Industrial Strategy - Electricity Generation Costs 2020 (BEIS, 2020)

Permissions

1) Planning permission

Wind turbine projects require planning permission from the local authority as described in the "Planning and Policy Guidance" section. Typical applications will need to include but will not be limited to:

- Design & Access Statement incl "Zone of Theoretical Visibility" studies, photomontages of views, shadow flicker assessments, noise, and cumulative impact studies.
- Construction Method Statements incl access and traffic studies.
- Ecology Reports
- Environmental Statements

2) Grid Connection

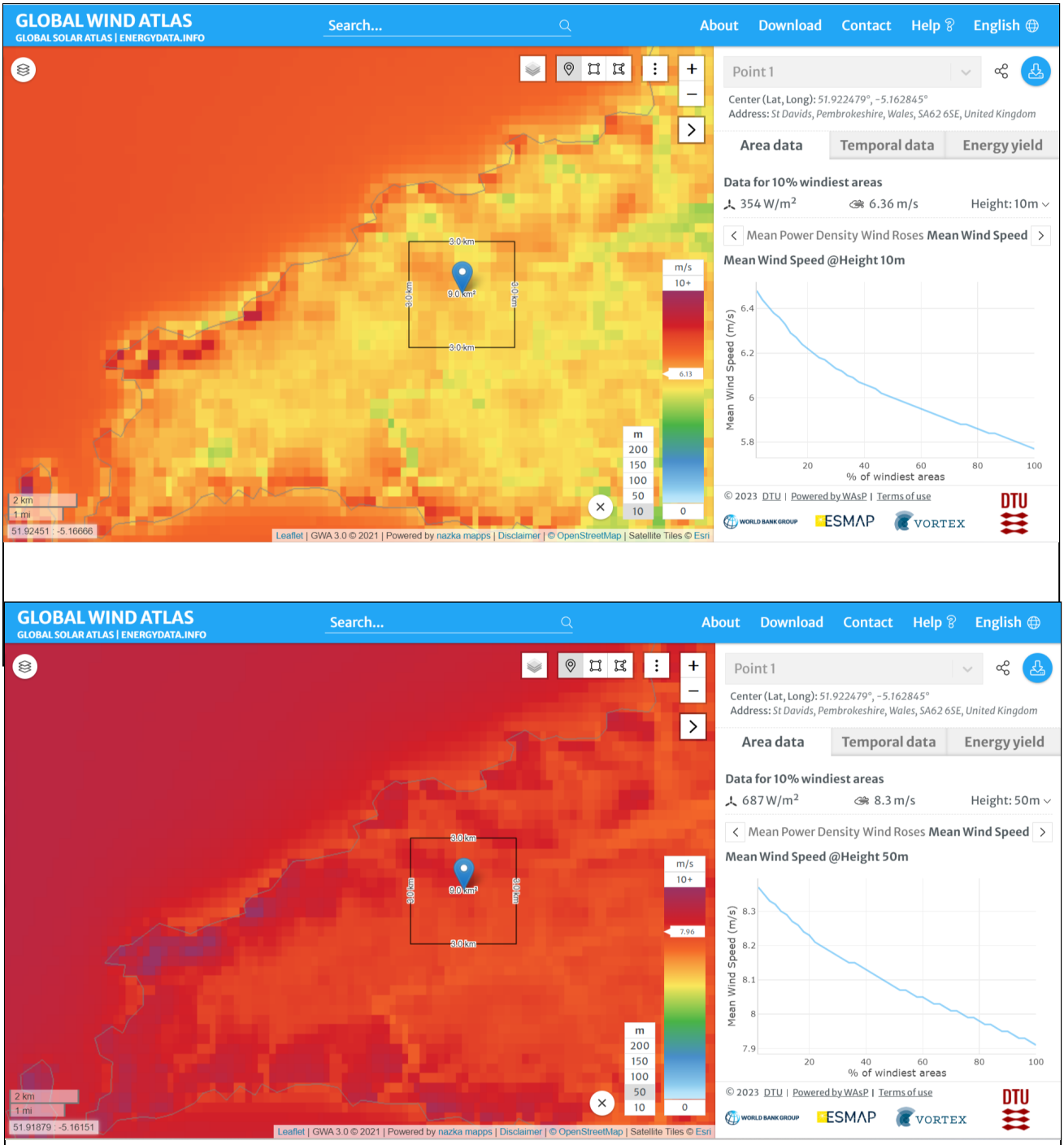
Medium scale wind turbines require grid connections or private wires to significant industrial consumers of electricity (they cannot supply low voltage dwellings directly). This can add considerable cost to a project depending on proximity to a suitable capacity electricity line & substation. The Llanrhian area is connected via 11KV lines which may be suitable however this is dependent on the local infrastructure and existing connections to the network and can only be determined through a grid connection application to the distribution network operator.

3) Landowner Consents

Negotiation with a landowner will be required to secure Option and Lease legal agreements detailing the permitted use, limitations, fees, and duration of the arrangement between the community energy organisation and the landowner. This is usually a lease with a duration to match the planning permission of the generator.

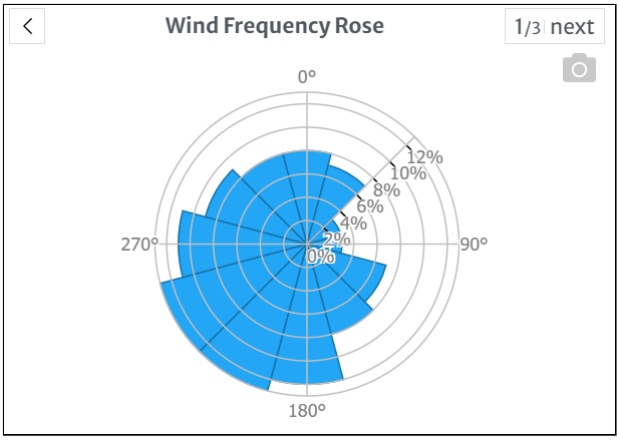
Resource

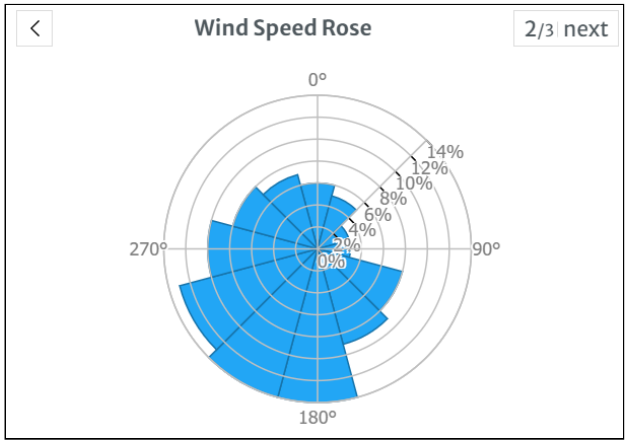
The supplementary planning guidance from the PCNPA determines that the LCA of Trefin has a "Moderate-High" to "High" sensitivity to wind development scales of very small to large respectively. Therefore, it is advisable to avoid and not pursue any community wind power project within the boundaries of the PCNPA. However, there are opportunities within the Llanrhian Parish but outside the PCNPA as detailed below. These areas of Pembrokeshire County Council have planning permission precedent for many small wind turbines at 50kW (~25m tip height) as well as one or two medium scale wind turbines in the region of 200-300kW (~45m tip height), most recently the erection of a Micon 250kW turbine just to the south of Square and Compass in June 2023.

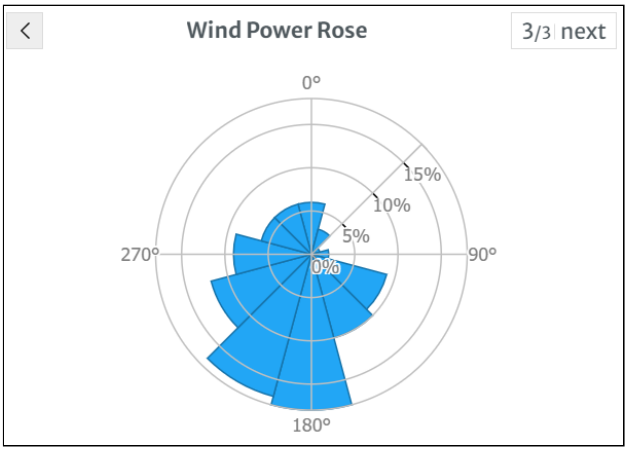


Source: Global Wind Atlas(GWA n.d)

Global Wind Atlas utilises publically available meteorology data to create a world map of wind speed statistics at 3x3km squares. It is a useful freely available tool to indicate an areas potential for wind power. With the centre of this square located near to Croesgoch the mean wind speed at 10m above ground level is given as 6.36m/s, while at 50m this increases to 8.3m/s. A wind speed above 6m/s at 10m AGL is considered commercially viable. A medium scale wind turbine will likely have a nacelle/hub at around 30m AGL. The Llanrhian Parish does have an excellent wind resource thanks to it's close proximity to the Irish Sea. Going into more detail, Global Wind Atlas also provides Wind Roses, to visualise from which direction these winds are blowing during a year:





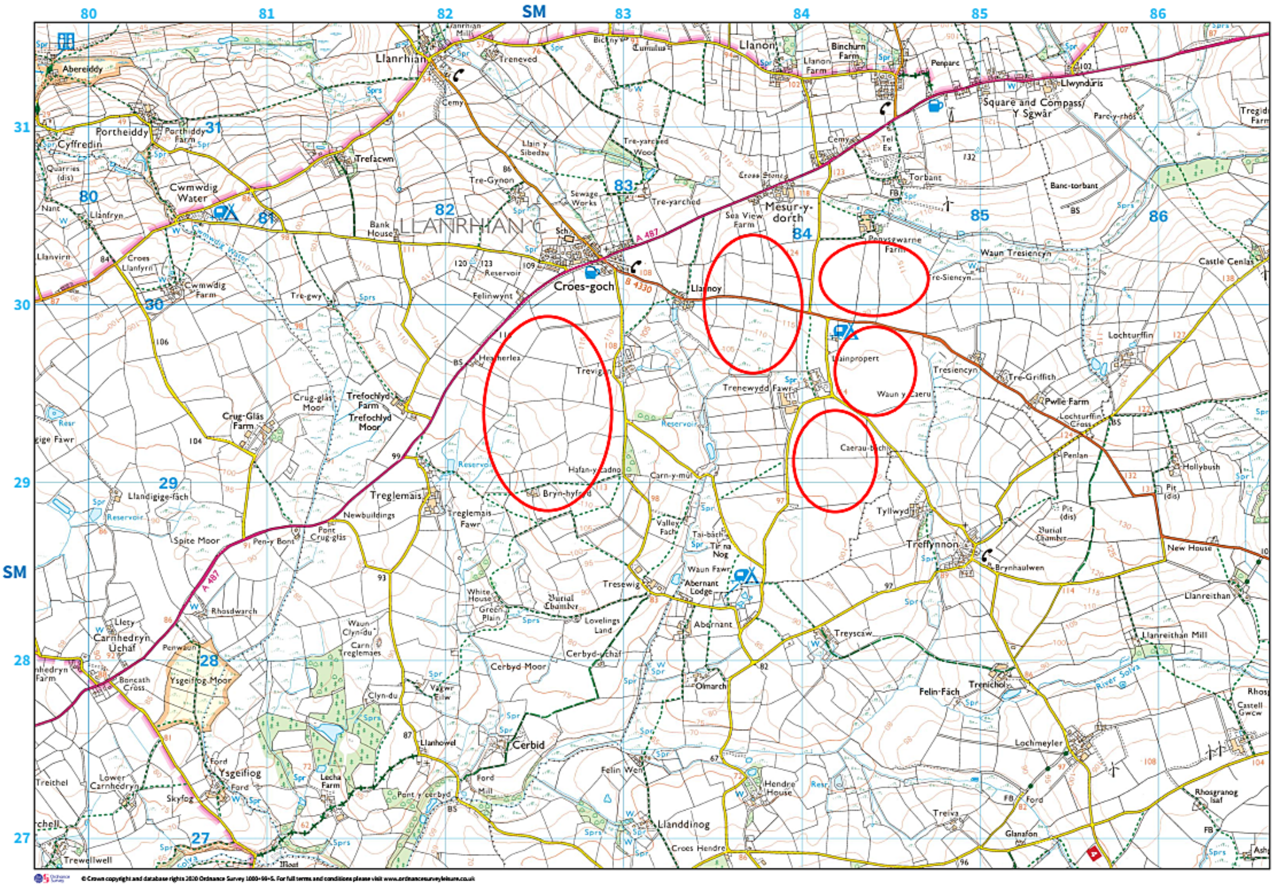


The wind roses indicate that the wind predominantly comes from the South West quadrant, with majority of power from South West South region. Ideally a wind turbine needs to be sited within the topography to take advantage of these wind directions by being placed with unobstructed views to the SWS close hilltops with slopes leading upwards towards the turbine from this direction to accelerate the wind to greater speed as it crests the hill.

Close proximity to the 11kV grid lines for grid connection and roads for access is also requirement for a good wind site:

Source: Open Infrastructure Map (OIM n.d.)

Considering topography and infrastructure needs, the following map suggests areas that may be of interest for a community energy project to develop a medium scale wind turbine. These suggestions are made without any prior knowledge of landownership as identification and engagement with landowners is outside the scope and remit of this feasibility study. Further discussion and consultation would be required by the community energy group to identify willing collaborative landowners, as well as further technical appraisal to determine the site location more accurately.



A generic point within these areas has been selected for a yield assessment. The choice of turbine, a re-manufactured Vestas V27 225kW, has been informed by a redacted report on re-manufactured turbines by Second Wind Energy (SWE n.d.) which will be provided separately to this report. The market for re-manufactured turbines is healthy in the UK due to lack of domestic turbine manufacturing, a cost effective price point, and proven track record for reliability and maintenance of the available turbines. The V27 has a low tip height of 43.5m AGL to reduce visual impact. A full specification is included in Appendix I.

Wind Proposal		
Wind Speed @ 10m AGL	6.36	m/s
Turbine Option	Vestas V27 (re-manufactured)	
Hub Height	30	m
Blade Diameter	27	m
Rated Capacity	225	kW
Tip height	43.5	m
Est. Capacity Factor	45.2	%
Gross. Annual Output	932,125	kWh
Losses	15	%
Net. Annual Yield	792,306	kWh
Emissions Saved Equivalent	185	tonnesCO2e/yr
Equivalent Homes @ 3500kWh/yr/house	226	homes

Source: Renewables.Ninja Online Yield Estimator (RENIN n.d.)

Community Attitude

A medium scale wind turbine came jointly second in the project ideas most supported by the survey respondents. Relevant high concerns were impact on wildlife, missing out due to lack of time or capital, noise, & securing permissions. The middle concerns were visual impact, having no voice in the project, challenges of funding and management.

Outside of the survey, at the community meeting, statements were made regarding concerns with wind turbines due to their maintenance needs compared to other technologies. Others saw wind as less favourable as generation could not be directly supplied to households for bill reductions.

Income Models

(A) Turbine and generator are connected to the distribution network to export power to the grid. A standard 12-24 month export is signed up to with an electricity supplier.

(B) Generator is connected to the distribution network to export power to the grid. A specific "licence exemption for small generators under 5MW" PPA is utilised, which nullifies the embedded costs of using the grid network. Savings are split 50/50 between generators and large distributed consumers such as Dwr Cymru. Long term fixed rates above grid export market values can be secured.

(C) Generator is connected via private wire to a local business already grid connected at 400V 3 phase. Power is sold to the business under a legal Power Purchase Agreement. A long term negotiated price per unit is agreed that is beneficial for the business as it undercuts import rates available from electricity suppliers, and is sufficiently high enough to create a viable business model and potential community surplus for the community

energy project. In the areas identified for a potential wind project the main businesses would be agricultural. Note: Business consumption may not always match up with energy generation, therefore a varying proportion of generated electricity will always be exported to grid under a standard export PPA.

(D) Energy Local (EL n.d.) A scheme that allows local domestic consumers to match their half hourly consumption with that of a local generator connected to the low voltage distribution network at a negotiated price. The price provides savings for consumers against standard grid import rates, while providing the generator with higher revenues per unit than a standard PPA. It requires the domestic consumer to have smart meters installed and switch to the same electricity supplier as the generator exports to. This income model is only appropriate for a generator connected to the 3phase low voltage 400V network, only domestic properties connected to the same primary substation as the generator could join and benefit from the Energy Local scheme. The vast majority of Llanrhian Parish is supplied from the Brawdy Primary Substation meaning most domestic properties could become Energy Local members. Note: Domestic EL members consumption may not always match up with energy generation, therefore a varying proportion of generated electricity will always be exported to grid under a standard export PPA.

Financial Appraisal

Re-manufactured Vestas V27 turbine costs:

Cost Breakdown	
Item	**Cost**
Planning Permission	£40,000
Turbine Supply & Refurb	£225,000
Transportation to Site	£30,000
Installation inc cranes	£60,000
Annual O&M (yr1+yr2)	£30,000
Grid Connection	£120,000
Total	£505,000
per kW installed	£2,244

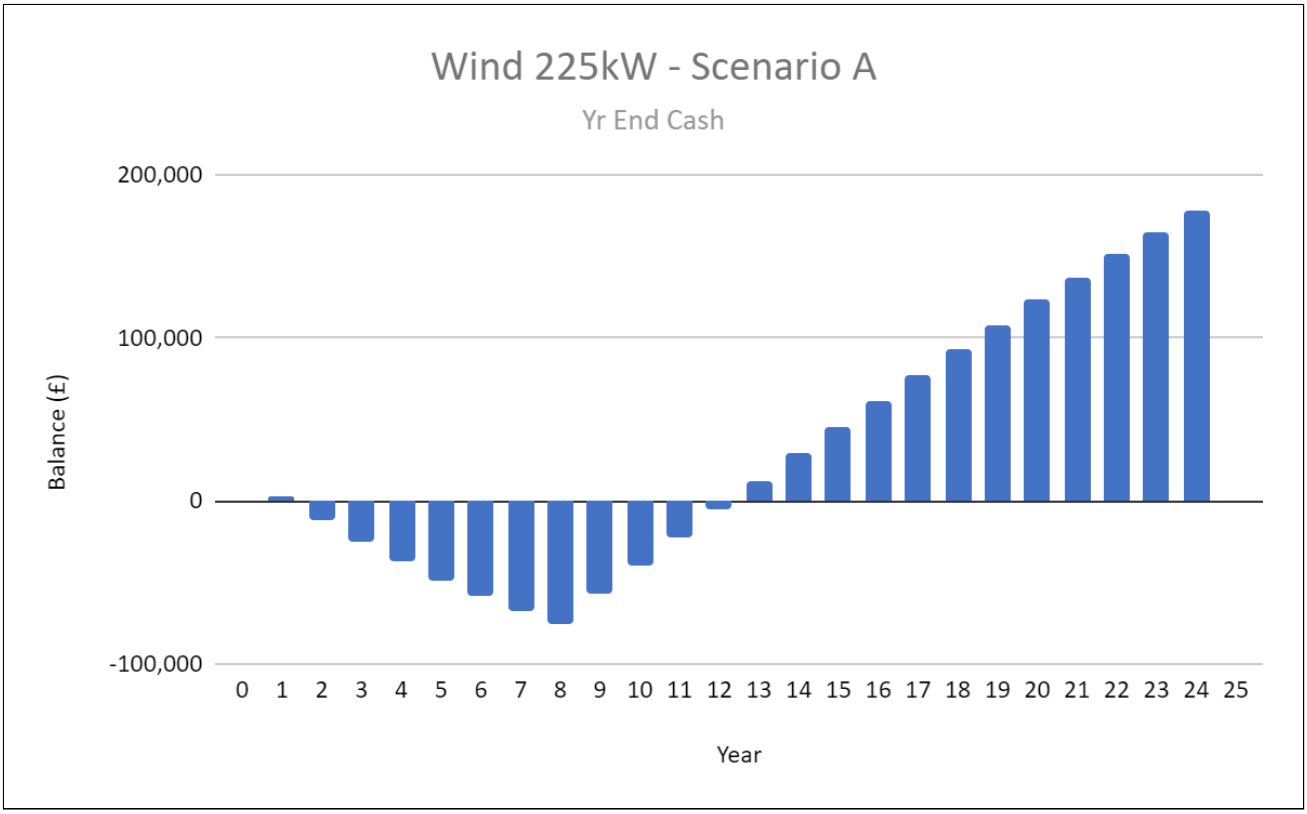
Source: Second Wind Energy (SWE n.d.)

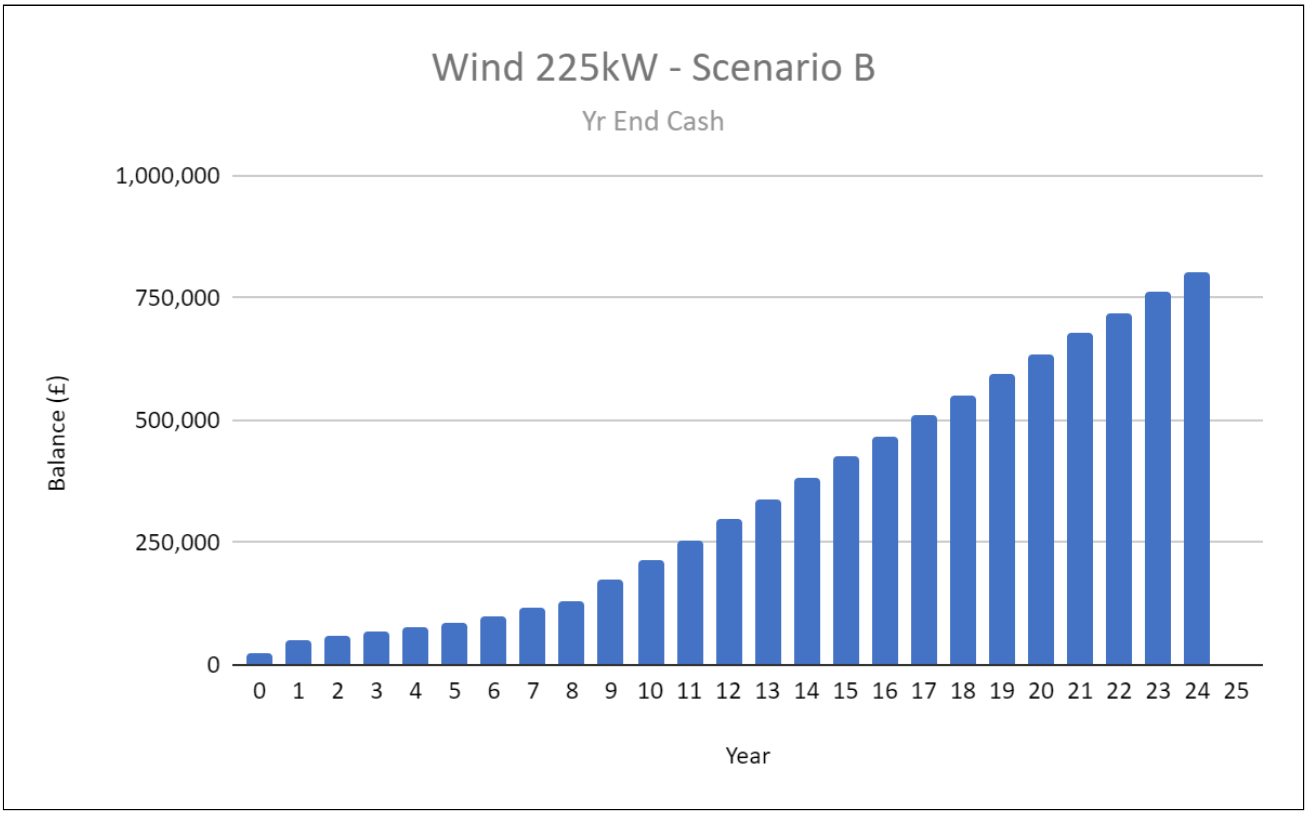
The four income models above form the financial appraisal scenarios A-D, which are also order from most straightforward to most complex to set up. The results are summarised in the following table with the relevant assumptions informing the modelling below. These are followed by Year End Cash graphs. Spreadsheet figures are contained in the Appendix J-M.

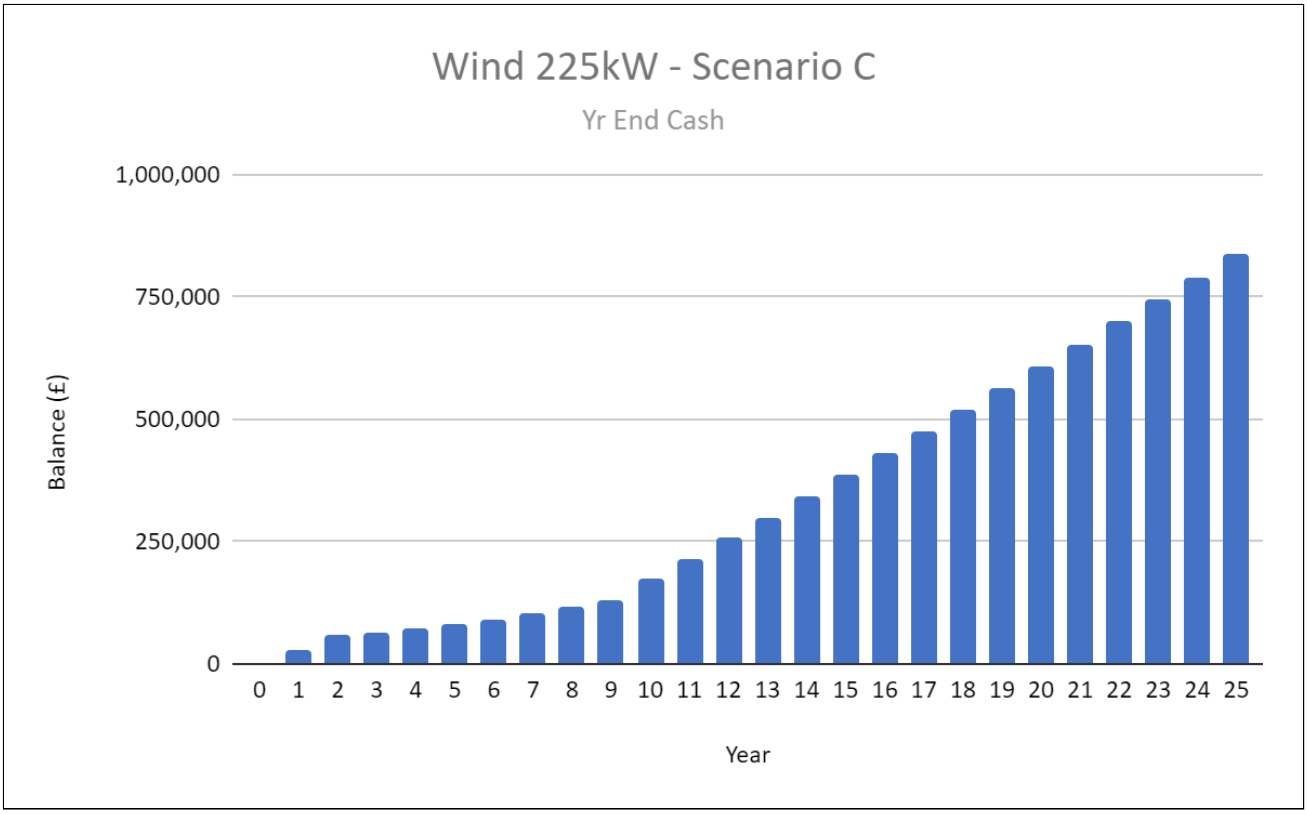
Scenario		A	B	C	D
PPA Arrangement		Standard Grid Export PPA	Licence Exempt PPA	Private Wire PPA	Energy Local
PPA Rate	(p/kWh)	7	10	15	21
Consumed/Exported Ratio	%	0%/100%	100%/0%	50%/50%	50%/50%
Shareoffer Rate	%	5.5	5.5	5.5	5.5
Term	Yrs	10	10	10	10
Shareoffer Amount	£	£232,500	£232,500	£232,500	£232,500
Grant Ratio	%	50	50	50	50
Grant Amount	£	£232,500	£232,500	£232,500	£232,500
Minimum Community Fund Contribution	£/yr	£2,000	£5,000	£10,000	£15,000
Yr1 Landowner Rent	£/yr	£6,000	£6,000	£6,000	£6,000
Yr 1 O&M Contract	£/yr	£15,000	£15,000	£15,000	£15,000
Other Operational Costs	£/yr	£13,304	£13,304	£18,132	£21,559
25yr Project IRR	%	-1.2	10.1	10.8	16.9
Net Present Value	£	101,897	557,327	577,887	£901,634
Direct Employment Created	FTE	0.2	0.2	0.3	0.4

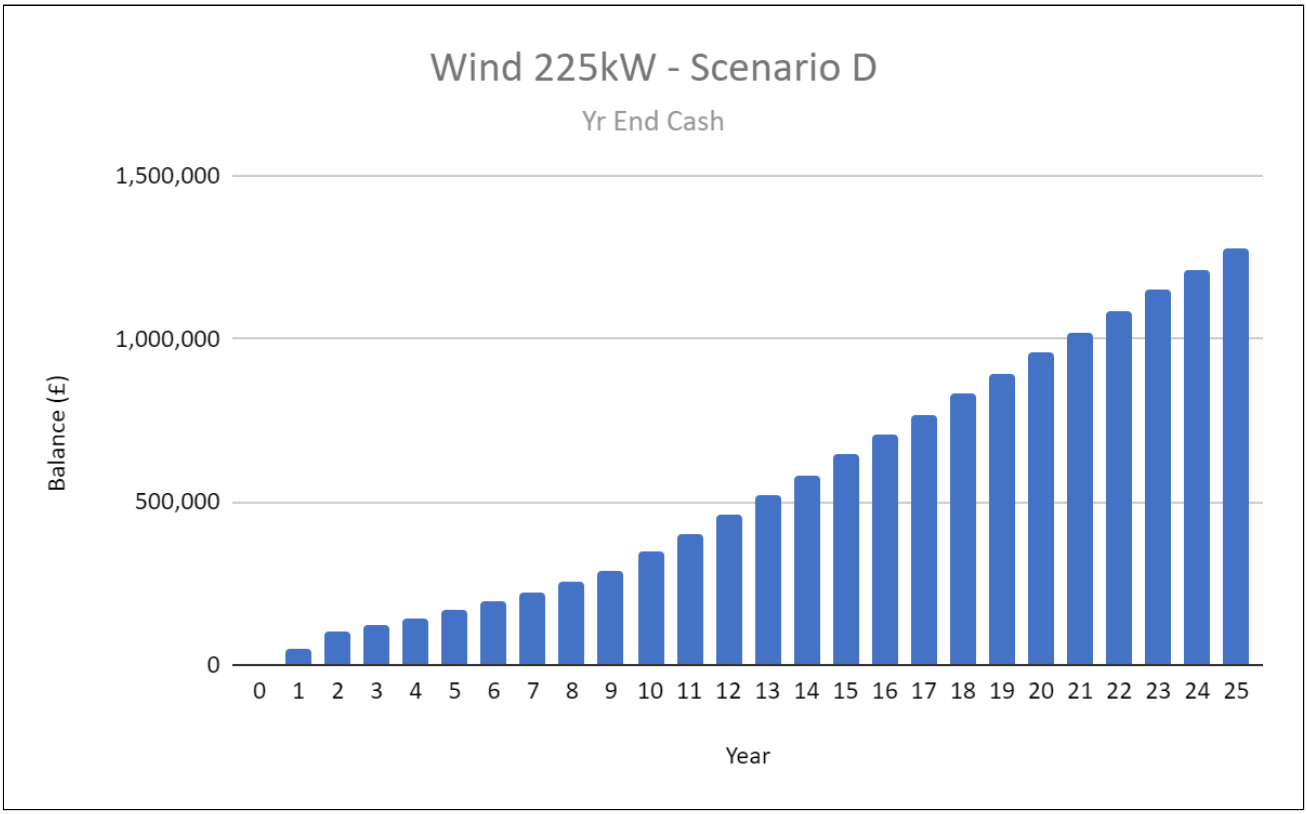
Assumptions:

- All development costs, such as consultancy, design, planning consents, legal costs etc, are nil sum as will be grant funded.
- PPA rates are modelled as static over the 25yr lifetime. In reality they may alter due to market forces.
- Standard export rate is set at 7p/kWh based on current forecasting available to CARE
- Construction capital is 50% grant funded.
- Operation & Maintenace Fees @ £15,000/yr.
- Insurance @ £5000/yr.
- Metering @ £450/meter.
- Staff time at £14.06/hr (includes 25% overheads contribution)
- CPI set at 2.5%.
- Energy inflation at 1.5%.
- Shareoffer set at competitive 5.5%
- Metering, Comms, & admin costs all increased for complex set up of Scenarios C & D


Wind 225kW - Scenario A
Yr End Cash
200,000
100,000
0
-100,000
Balance (£)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Year


Wind 225kW - Scenario B
Yr End Cash
1,000,000
750,000
500,000
250,000
0
Balance (£)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Year





The financial appraisal shows that Scenarios B, C, & D are all bankable & lucrative investment projects for community energy groups should development costs be kept to a negligible level via securing grant funding. These 3 scenarios would be able to cope with some level of reduction in capital grant funding should 50% not

be available, or a drop in income stream occur. Further sensitivity analysis would be needed to confirm their resilience to other variables. All 3, particularly C & D contribute large meaningful sums of money to a community benefit fund.

Utilising Existing Wind Power for Community Benefit

Community energy benefits via reduction in household bills could also be realised prior to a community owned wind turbine being built by engaging with an existing privately owned wind turbine generator, such as the 250kW Micon turbine near Square and Compass, to implement the use of income model (D), Energy Local. This would require very little capital outlay, only information, learning, and discussion between the relevant parties to implement the scheme.

Consultation with Energy Local has confirmed that the scheme is currently able to operate a maximum of two generators for each low voltage area being supplied. Therefore engaging with a private wind turbine generator to implement Energy Local does not preclude Llanrhian Parish developing it's own community wind turbine in future to supply even more locally generated energy to local properties.

Case Studies

Cwm Arian Renewable Energy - 700kW Wind Turbine, Tegryn (CARE, 2023)
Ynni Teg - 900kW Wind Turbine, Meidrim (YT n.d)
Awel Aman Tawe - 4.7MW Wind Farm, Tairgwaith (Awel Co-op n.d.)
Community Energy Pembrokeshire - 900kW Wind Turbine, East Williamston (CEW n.d.)
Ynni Sir Gar - 500kW Wind Turbine - Llandeilo (YG n.d)
Grannell Coop - 500kW Wind Turbine - Cribyn, Lampeter (GCP n.d.)
Transition Bro Gwaun - 250kW Wind Turbine - Fishguard (TBG n.d.)

Micro Wind Power

Micro wind power is considered to be all turbines with a capacity of under 10kW with tip heights of below 25m tip height. These are property connected at 230/400V hence do not need a separate grid connection.

Opportunities exist in rural areas to use micro wind to power community buildings or businesses, as there is sufficient surrounding space compared to urban areas to site the turbine appropriately and attenuate any noise to acceptable levels for nearby dwellings. Wind power also complements the increased energy consumption of buildings over the winter seasons compared to solar PV.

Permissions

1) Planning permission

Turbines with tip heights less than 11.1m and swept areas under 9.6m^2, amongst other conditions, fall under permitted development in Wales (WG n.d.). Turbines above this size require planning permission from the local authority but are not expected to provide the same level of study and documentation as medium-large

scale wind projects. Typical applications will need to include but will not be limited to:

- Plans and drawings
- Design & Access Statement incl "Zone of Theoretical Visibility" studies, photomontages of views, shadow flicker assessments, & noise surveys.
- Construction Method Statements incl access and traffic studies.
- Ecology Reports incl bat surveys
- Environmental Statement

2) Landowner Consents

Negotiation with a landowner will be required to secure Option and Lease legal agreements detailing the permitted use, limitations, fees, and duration of the arrangement between the community energy organisation and the landowner. This is usually a lease with a duration to match the planning permission of the generator.

3) Private Wire Power Purchase Agreement

The community organisation will need to negotiate with the landlord of the property a price per unit of electricity consumed from the wind turbine. This could a be a fixed rate for multiple years which is then renewed, or a "tracker" based unit rate that is set at a percentage lower than the grid import rate for the property which is then revised annually as grid import costs go up or down. Landlord and generator could also agree minimum and maximum price caps as part of this PPA.

Resource

A common turbine of this scale seen in Pembrokeshire is the Evance R9000 5kW (specification at Appendix N), which is now owned by Ecotricity under the "Britwind" brand. It is recognised as one of the most reliable micro wind turbine designs available. Assuming a mast height of 18m, tip height of 21m, the annual mean wind speed for the Croesgoch area would be in the region of 7m/s. Yield estimation at this wind speed is 17,900kWh/year.

Via consultation with PCC, the annual electricity consumption of Croesgoch CP School was 52MWh in 2019 and 37MWh in 2022. Assuming planning permission, Pembrokeshire County Council PPA agreements, and landowner lease agreement are secured so that this turbine was located in the adjacent field to the West North West of Croesgoch CP School and connected to the school directly, it could provide it with 44.75% of it's annual electricity demand (based on 40MWh.year total electricity demand and 100% on-site consumption). As well as source of local renewable electricity, further benefits of a co-located wind turbine include utilising it and it's associated software and data as an educational resource regarding renewable energy and climate change mitigation measures.

Income Model

(A) The income model for a property connected community micro wind turbine would be similar to that of rooftop solar PV. Where electricity consumed from the turbine by the property is metered and charged for at an agreed unit rate under a legal Power Purchase Agreement. Any surplus is then exported to the grid to be

claimed under the SEG or other export income source.

(B) Sufficient grant funding or community donation is secured to fund the capital cost of the project on behalf of the school. The wind turbine is gifted to the school with all electricity consumed from the turbine provided at no cost therefore reducing the schools electricity bills significantly over the turbines lifetime. The community energy group, if possible, could continue to fund the wind turbines operation and maintenance fees.

Financial Appraisal

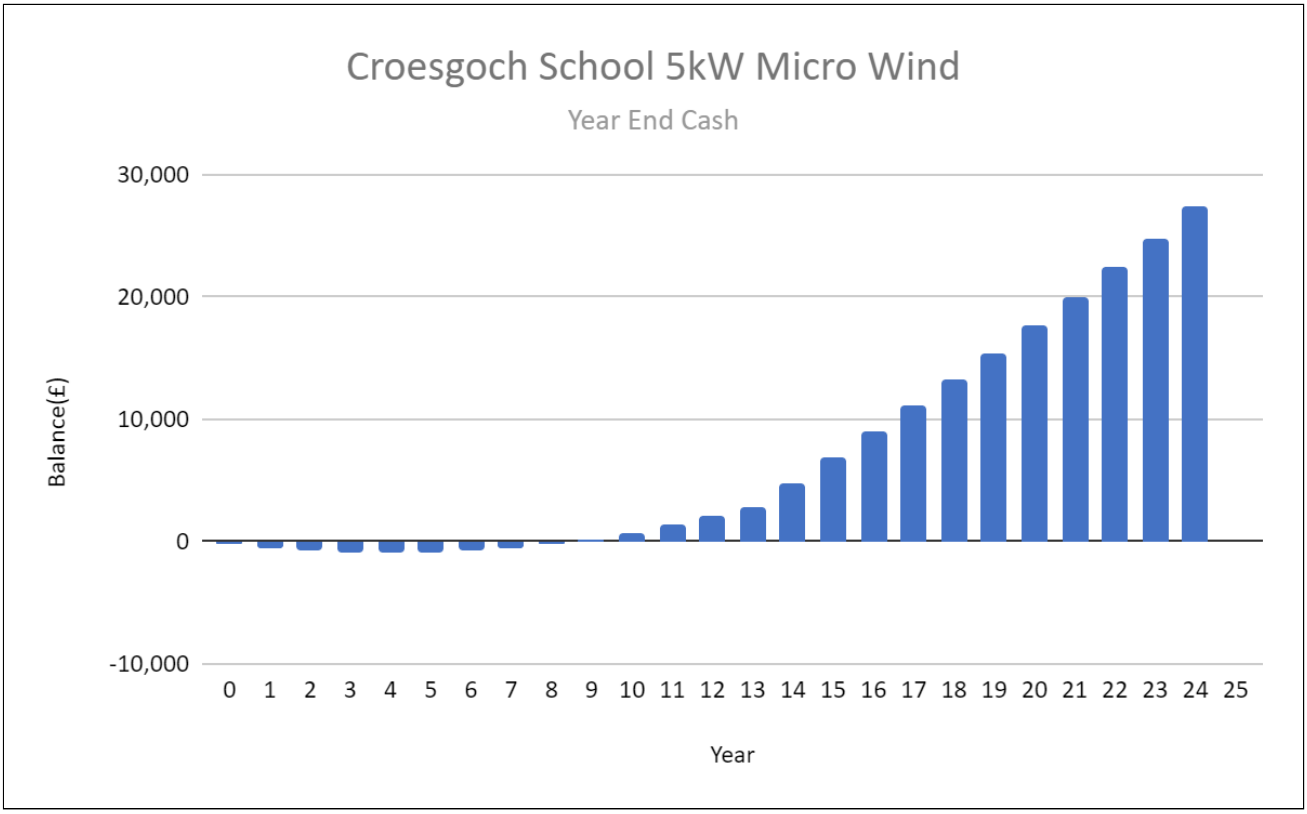
Income model (A) has been utilised to financially appraise a proposed 5kW community owned micro wind turbine at Croesgoch CP School. The table below summarises the finding with assumptions noted below. Followed by a End of Year Cash chart. Spreadsheet figures are contained in Appendix O.

Croesgoch CP School 5kW Micro Wind Financial Appraisal Summary		
Mast Height	18	m
Tip height	21	m
Max Output	5	kW
Estimated AMWS	7	m/s
Estimated Annual Yield	17,900	kWh
Emissions Savings	4.173	kgCO2e/yr
On-site PPA Rate	27	p/kWh
Export Rate	10	p/kWh
Consumed/Exported Ratio	85%/15%	
Total Capital Cost	£30,500.00	
Grant Ratio	50%	
Grant Amount	£15,250.00	
Shareoffer Amount	£15,250.00	
Yr1 Landowner Rent	-£768.75	
Yr 1 O&M Contract	-769	
Other Operational Costs	£1,305.46	
Community Benefit Fund	£0.00	
25yr Project IRR	3.0%	
Net Present Value	£16,871.00	
Direct Employment Created (FTE)	0.02	

Assumptions:

- Est. Annual Yield based on Britwind H5-R9000 specification sheet figures
- Import & export rates remain static for the 25yr lifetime
- Shareoffer @ 5.5% interest over 10 year term
- Metering @ £450 one off, £70/yr thereafter
- Staff time at £14.06/hr (includes 25% overheads contribution)
- Comms @ £50/yr

- Inflation @ 2.5%
- Energy Inflation @ 1.5%
- No community benefit fund contribution
- On-site consumption set at 85%. We anticipate a high ratio of on-site consumption due to the schools seasonal demand profile matching well with wind generation, as well as the low capacity of the turbine matching well with the schools baseload power consumption.



The financial appraisal indicates that a high on-site consumption unit rate of 27p/kWh or above would need to be negotiated to create a marginally viable investment, creating profit in Yr9, with 50% grant funding. This is primarily down to the high capital cost of the project compared to it's energy yield.

Case Studies

Ladygrove Primary School - 2.5kW Proven wind turbine, Telford (W&S n.d.)
Assessment of 13x school 5kW R9000 wind turbines, Scotland (HC n.d.)

EV Charging

EV charging is the provision of charge points for electric vehicles to encourage the rollout of this type of transportation technology. Supporting EV charging provides a service to the local community, car clubs and rural transport organisations to enable them to have the confidence to make the switch to a greener form of transport. When the electricity for charge points is provided by community renewables then this can both potentially benefit CEOs through energy sales and ensure that electricity for charging is from a renewable, local source. Despite this, the model of CEOs generating financial returns from selling their electricity

directly to car charging is not common in Wales. Many CEOs including CARE promote the use of EVs and now there is pan Wales electric car club, TrydaNi which is being delivered in partnership with CEW through its members (Trydani, 2023). In these cases, charging directly from CEO renewable assets is often limited as many of these are remotely located wind turbines that sell their electricity directly to the grid. Roof top solar assets are a much more suitable source of EV charging as they are located in places where EV users are more likely to park up. There are lots of examples where community facilities have both roof top PV together with a charge point in West Wales. In all these situations that CARE is aware of, EV charging is not matched at all closely to the solar generation of the facility. EVs come and plug in and the electricity either comes from the grid or from the PV - if this is generating at time of use. CARE has a community facility, Y Stiwdio, which goes a little further by combined the charger and PV with a battery system however little modelling was done on this system to work out the optimum PV and battery capacity ratios to provide an "average day" of charge usage (Stiwdio, 2022). This has been because of lack of project resources and not really knowing at this stage how popular the charger will become. As this is a new and rapidly expanding field there are a lot of unknowns ahead of community facilities investing in battery storage to match public charging. A CEO, of sorts, Gwent Energy - Community Interest Company (CIC) are the most experienced in the sector at installing both battery systems and EV chargers at community facilities (GE CIC, 2022). Gower Power have the only charge point in Wales, that this report is aware of, that is connected to a CEO asset with enough battery capacity to ensure that the electricity, pretty much, solely comes from the renewable generator (GP, 2020).

A more pressing issue that CARE together with the TrydaNi project have been cutting their teeth on is operating cost-effective charging systems that allow community facilities to get recompensed for their electricity. To date many facilities have been offering charging for free which is not a sustainable model for them given high energy prices and the rising popularity of EVs. CARE & TrydaNi are currently trialling "ICS – Intelligent Charging System, Chargers" as they are hoped to be a cost-effective system that will allow the general public to access community facility chargers and for the facilities to be compensated for this service (ICS, 2023). Recent quotes for the installation of the ICS ICSW22CPT twin port 22kW charger and an ICS ICSW7C single port 7kw charger were £3868 and £1540 respectively. Another payment of £300 is apparently required to enable the app driven multiple users payment system associated with these chargers.

Another community-based organisation that have created an interesting model for EV chargers at community facilities is Dolen Teifi (Dolen, 2022). Dolen Teifi is a community transport organisation based in Ceredigion that is pioneering the use of EVs for rural community transport. It uses community facilities, many with roof top solar to charge its community minibuses so that they can be collected easily by the rural volunteers distributed in their area of operation. Dolen Teifi arranges for the installation of charge points at community facilities free of charge provided that the facility provides electricity for their vehicles at cost price. Community facilities are then free to charge other users of the charge points what ever they feel is appropriate thus allowing for income generation.

Using community facilities with rooftop solar seems a good solution for providing charge for both community transport vehicles and car clubs where distributed public bases are required. In these situations, there is a preference not to install anything greater than 22kw chargers as this can lead to battery degradation when used regularly on the same vehicle. It is therefore usual to install 22kw chargers where three phase is available and 7kw chargers where there is only single phase.

Solar Thermal & Heat Pumps

Solar thermal has not been a technology synonymous with community energy to date. As a technology it requires a high level of integration with a property's central heating/plumbing, requiring a hot water cylinder to operate. Communal solar thermal heating systems exist primarily on rooftops of larger accommodation blocks with a shared heating source, however they are often privately owned by the developers of the accommodation. Domestic solar thermal and non-domestic solar thermal have previously been supported by a government scheme called the Renewable Heat Incentive (RHI). The domestic RHI closed to applications in March 2022, the non-domestic RHI in March 2021. This incentive has now been replaced with the "Boiler Upgrade Scheme"(UKGOV n.d.) which provides grants to eligible homeowners to upgrade from a fossil fuel boiler heat source to a low carbon heat source such as a biomass boiler or heat pump. In summary, solar thermal is not considered a viable option for a community energy project due to:

- High cost, long payback time. Highly variable depending on volume and timing of hot water consumption.
- No export opportunities
- No financial incentive income streams available.
- Inflexible compared to solar electric PV coupled with hot water diverters.

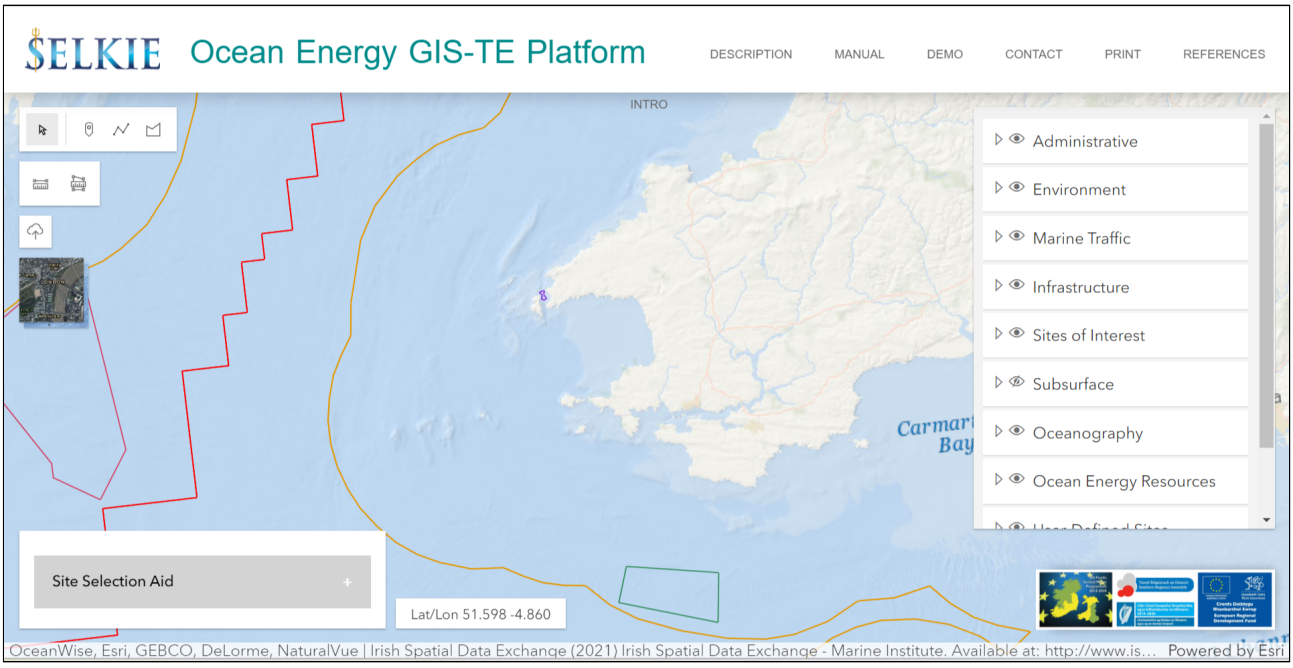
Provision of heat pumps for individual properties is also an uncommon community energy model in the UK and Wales. Partly due to the complexity of such a model, but also in that there is currently financial support available for homeowners to purchase heat pumps. As well as the Boiler Upgrade Scheme mentioned above, installations at properties with low EPC's, and those vulnerable or on low incomes, are being funded via government and local authorities through "Nest" and "Energy Company Obligation" grants, which are currently open for applications on it's 4th iteration as "ECO4" (PCC n.d.). Businesses in Pembrokeshire are also being supported to switch to low carbon technologies via the Pembrokeshire Carbon Reduction Grant, part of the UK's Shared Prosperity Fund (PCC, 2023). Where grants of between £1,000 to £25,000 are available towards a maximum of 50% of capital costs. For these reasons the role of a community energy organisation with regards to property heating technologies is to disseminate information, advise, and signpost houseowners to potential funding sources.

District heat networks fuelled either by heat pumps or Combined Heat and Power plants are also in their infancy in the UK with sites either in trial stage or privately owned. No community energy district heating projects have been established in Wales. District heating in the UK is challenging due to the manner in which we have historically developed our properties and infrastructure, Wales in particular has a low population density. It's distributed population makes the transfer of heat from one area, or property, to another technically difficult.

Future opportunities may exist for community organisation involvement in heat provision to villages. For Porthgain and Trefin this might include utilising a marine source heat pump to use the sea as a potential heat source, similar to a system installed by the National Trust at their Plas Newydd property (KM n.d.). Community Energy Wales currently run a "Heat Networks" working group on a periodic basis to meet and discuss potential developments in this sector.

Marine Energy

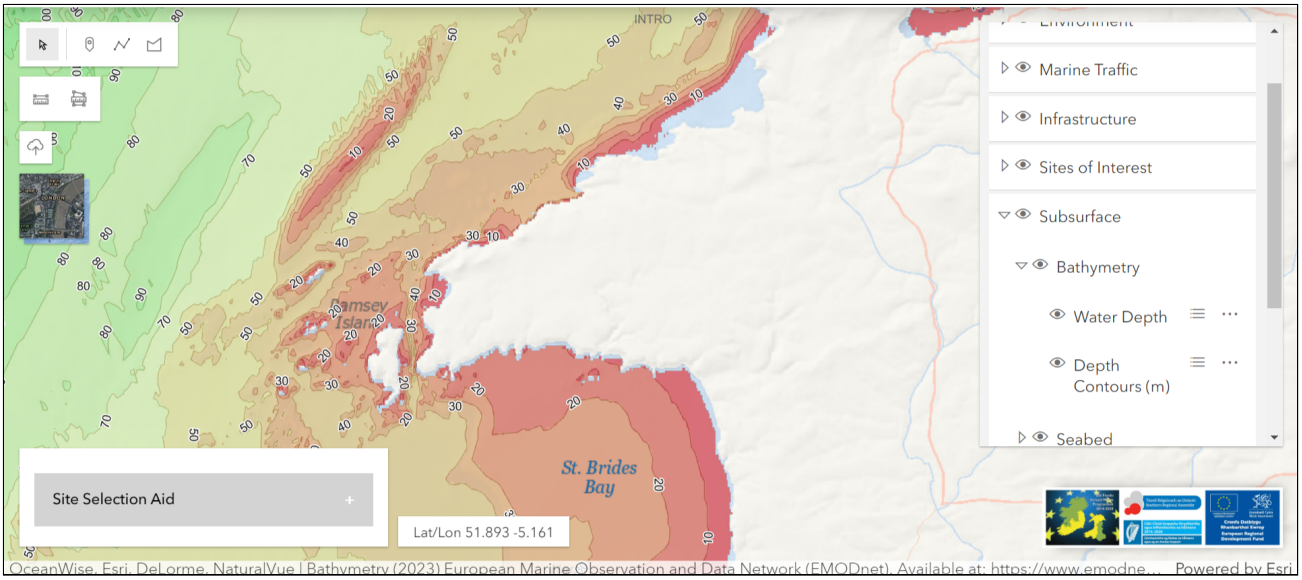
Marine energy (wave, tidal stream, tidal lagoon) has remained in the research and testing phase for much longer than other renewable energy technologies as it faces many more technical challenges than on-shore technologies or offshore wind power. Viable commercialised marine energy developments are yet to be developed by private organisations or community owned organisations. Despite the long road, Wales is aiming to be a marine energy leader in the UK with test areas and developments being supported by a dedicated industry body Marine Energy Wales (MEW n.d.) funded by Welsh Government & Milford Haven Port, with £104 million invested in the last year and now supporting over 400 employees in the sector. The below map shows the current leased areas of ocean for tidal stream (purple) in the Ramsay Sound and wave offshore south of Milford Haven(green):



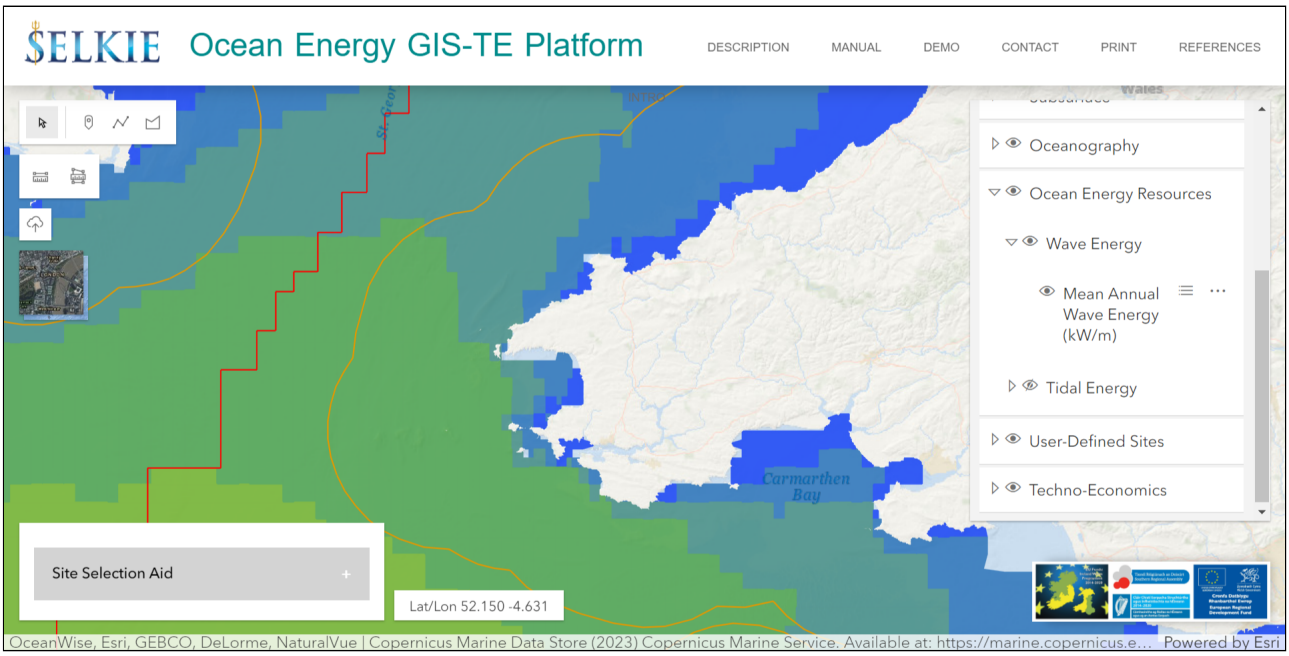
Source: Selkie Ocean Energy GIS Platform (RC n.d.)

Beyond these, marine energy test areas for new technology prototypes have been launched by Pembrokeshire Coastal Forum (PCF n.d.) in the Mildford Haven Waterway, with further sites proposed in Pembroke Port, Warrior Way, Dale and north of Freshwater West. The licensing process is complex and expensive, requiring engagement with the Crown Estate to secure offshore sites.

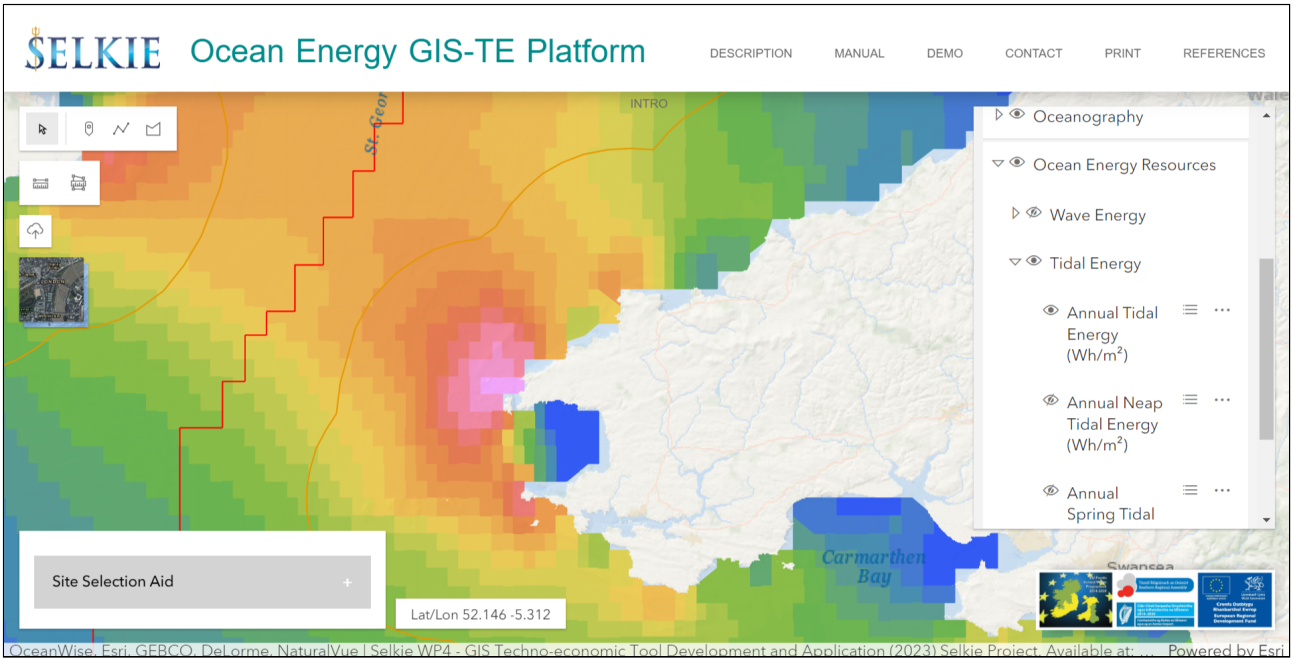
Due to the relative infancy of the sector, an in depth assessment of marine energy opportunities for the Llanrhian Parish coastline is not possible for this feasibility study. However, a brief overview of energy resource of the coastline can be made using the Selkie Ocean Energy GIS platform data:



The water depth off the coast of Trefin remains below 10m for approximately 1.5km, at Porthgain this distance reduces to 500m. This shallow water depth is limiting to the space available for sizeable machinery below the water surface, so limiting potential machine capacity.



Available wave energy diminishes the further north up the coastline from St Davids peninsula, as well as further east as the waves encounter a shallower seabed. This reduces the wave power availability for the Llanrhian Parish coastline compared to other areas of Pembrokeshire.



Tidal energy resource for Pembrokeshire is heavily concentrated at the St David's peninsula with some resource extending northwards up the coastline to the Abereiddy-Porthgain headland. Shallower waters extending further out to sea also diminish the tidal stream energy resource in the vicinity of Trefin.

This preliminary assessment suggests that scope for marine energy on the Llanrhian Coast will be limited to:

- Small tidal lagoon; particularly for Trefin due to shallower waters yet still a reasonable tidal range of ~5.5m.
- Tidal stream potential offshore at Abereiddy-Porthgain headland.
- Both remain technically limited by the grid infrastructure serving the area.

Developing a sustainable community energy group, via a more established route and onshore technology, which can then engage with Pembrokeshire Coastal Forum and Marine Energy Wales ongoing, will enable the coastal communities of Llanrhian Parish to potentially develop marine energy projects or capitalise on progress in future.

Grid Connection

In all but the smallest scales of renewable energy projects a grid connection will be required. Costs of grid connections for financial modelling have been estimated based on previous development experience as well as recent connections offers for other projects from National Grid (formerly Western Power Distribution). True grid connection costs are not known until a specific generation connection grid application (G99) has been submitted to National Grid and an offer returned. This process can take up to 90days. For a 3rd party such as CARE the application also requires a Letter of Authority from the landowner of the site or existing grid connection. As such grid connection applications have not been made as part of this feasibility study and should form part of further work for a specific project. Grid Connection applications require submittal of:

- G99 application forms

- Preliminary Plans & Drawings
- Generator Specification
- Single Line Diagrams of connection arrangements
- Any existing import and export MPANs
- Letter of Authority from landowner

Due to the comparatively weak grid infrastructure in North Pembrokeshire, grid capacity for new generation connections can, depending on location, be low or non-existent. It is therefore a development priority to investigate available grid capacity early on in a project as it can be an immediate showstopper. Connecting to capacity to limited grids is possible via export limited grid connections (G100). This is suitable for two complimentary technologies to share a grid connection, such as wind and solar, or where private wire connected projects have a high on-site consumption volume and low export volume.

Financial Options Matrix Comparison

To further aid in decision-making, the key financial results of the best returning scenarios of each modelled project idea have been collated into the following table:

Project	Micro-hydro	Field Scale Solar PV	Domestic Solar PV	Medium Scale Wind	Micro Wind
Income Model	Private Wire PPA/Energy Local	Licence Exempt PPA	Membership fees + licence exempt PPA	Energy Local	Private Wire PPA
Capacity (kW)	21.1	1000	992	225	5
Yield (kWh)	49,476	1,385,024	919,088	792,306	17,900
Emissions Savings (kgCO2e/yr)	11,535	322,904	214,276	184,718	4,173
Total Capital Cost	£94,950	£1,829,500	£1,191,550	£505,000	£30,500
Grant Ratio	50%	60%	60%	50%	50%
25Yr Project IRR	2%	2.7%	6.8%	16.9%	3%
Net Present Value	£42,941	£761,301	£423,307	£901,634	£16,871
Profit Turning Year	12	12	8	1	10
Annual Community Benefit Fund Yr 3 onwards	£0	£2,000	£3,000	£15,000	£0
Direct Employment Created (FTE)	0.02	0.2	0.3	0.4	0.02

Qualitative Options Matrix Comparison

The following is a qualitative comparison on potential community energy project types.

Project Type	Possible Technology examples	Chance of income in relation to community effort	Finance (and likelihood of receiving)	Benefits
Energy research project	Tidal stream, Novel hydro, Novel small wind.	Very poor	Grant (possible)	Innovation, learning, influencing attitudes, creating conversations.
Energy demonstration	Small scale wind Hydro Retrofit houses.	Poor	Grant (likely)	Low carbon energy generation, education, CO_2 reductions, learning, influencing attitudes, creating conversations, combating climate break down.
Energy & households	Supporting house holds with PV, low carbon heat, smart energy solutions, insulation, and other energy efficiency.	Potential	Grants (currently available)	Economic benefits for households, Low carbon energy generation, CO_2 reductions, learning, influencing attitudes, creating conversations, combating fuel poverty.
Energy & businesses	Same as above but for businesses	Potential	Grants (currently available)	Sustaining vital businesses and the services they provide, sustaining employment, low carbon energy generation, CO_2 reductions, learning, influencing attitudes, creating conversations.
Renewables on community buildings	PV, energy storage, low carbon heat, smart energy solutions, insulation, and other energy efficiency	Potential through savings for community	Grants (very available)	Sustaining community buildings, taking pressure off community volunteers, low carbon energy generation, CO_2 reductions, learning, influencing attitudes, creating conversations, combating fuel poverty.
Community renewable energy enterprises	Medium scale Wind, Community PV on multiple houses, Field scale PV,	Potential to Good	Grants and loans (currently available)	Potential benefits of the order seen in mind map in appendix.

Conclusions

This feasibility study encapsulates the opportunities for community energy in Llanrhian Community Parish as well as introducing it to the growing community energy sector. Not only through technical resource scoping and fiscal appraisal but also through information on the socio-economic context of community energy, the key organisations in Wales, and where sources of funding may be available. It has remained as broad as possible, despite the short timeframe, in order to provide sufficient information to act as a springboard and strong foundation for Llanrhian Community Parish, Trefin Energy, and the residents of the community to make informed choices in the near future.

The rationale behind embarking on a community energy project is compelling. There are few actions individuals can take that are as far-reaching in terms of benefits or as mentally empowering as being involved in a local community energy organisation. It provides agency to rural communities and is an antidote to the apathy of "I'm just one person, I can't make a difference". As shown in the inspirational case studies cited, numerous projects across Wales prove that with a core of dedicated volunteers great things can begin. Most groups or organisations begin with asking the question "What can we do?". This feasibility report hopes to have provided sufficient detail for that question to be answered. Community energy can take action on many levels; it can create local change through small acts such providing advice, education, signposting to services, and information through to owning and operating generation assets as wealth generators and investment vehicles. Crucially they are not mutually exclusive and often a mixed approach creates the most wide reaching results.

The same applies to generation projects that a community organisation wishes to embark on. While one project may be the most sensible option as a starting point, it does not mean that other projects that maybe have slightly more risk, financial or technical, cannot be pursued in future. In fact once a community energy organisation has it's first project operational under its belt the possibilities for what is achievable seem to expand. The energy industry and market is constantly evolving to create new opportunities or re-opening old ones. The technical and financial appraisal of the most feasible generation projects for Llanrhian Community Parish indicates that, as with many community energy groups, a medium scale wind turbine would be the optimum project to look into in greater depth at this time. The summary points of medium scale wind are:

- It is one of the cheapest forms of renewable energy.
- Llanrhian Parish has an excellent wind resource.
- It provides the highest modelled Internal Rate of Return.
- Wind power has an established community energy blueprint to follow.
- There are many supporting organisations to aid in it's development.
- Wind power at this scale has planning permission precedent in the area.
- A wind power project is able to provide investment opportunities through a community shareoffer as well as household bill reduction opportunities through Energy Local.
- It can create community benefit across the whole Parish.
- Is most likely to create a sustainable organisation cashflow to support future endeavours and their business case to attract grant funding or development/capital loans.

This conclusion does not suggest that other project options, such as micro-hydro, micro-wind, or EV charging

should not be discussed periodically in future to determine if more favourable financial conditions can be found. Depending on the capacity of the community energy organisation and their skillsets, or negotiations with landowners/landlords, a different project may come to the fore as the leading opportunity. However, it must be noted that development of a community renewable energy generator takes resources, time, focus, and tenacity. A medium scale wind turbine could take 2-6 years to reach the point of operating and commissioning for instance. It is key to ensure that resources are continually direct towards the main goal/purpose of the organisation to achieve success.

Recommendations

Recommendations are provided below, separated into categories for clarity. They do not necessarily need completing in sequential order as in reality many things may happen simultaneously or it may be more appropriate to take one step before another depending on the circumstance.

Community Engagement

- Distribute the feasibility study to the community electronically and in hard copies located at various community hubs.
- Hold multiple further community meetings at these hubs at various times across the Parish to engage with as wide an audience as possible. Provide summary information from the feasibility study and answer queries.
- Provide news and updates to mailing lists as and when project milestones are reached.
- Use the community energy project as a focal point for other community events, such as gardening days, walks, or community meals.

Organisational

- Establish a community energy entity that will take forward any projects, i.e. charity, CIC, co-operative.
- Attract multiple volunteer Directors with varying skillsets from across the Parish or county who have a vested interest in the success of the project. A high number ensures continuity and contingency for the organisation. Assign clear organisational roles to all.
- Seek & apply for grant funding for establishment costs or membership body costs.
- Create an organisation charter and vision to act as a guide in future decision-making.
- Create or curate a dedicated website for the organisation that is easily updatable with news on progress.
- To aid in long term stability, consider organisation training course in:
    - Non-violent communication (NVC)
    - Empathy training
    - Project Management
- Join membership bodies such as Community Energy Wales, Renewable UK, REGEN. Through these bodies attend free workshops and events to network and curate connections in the sector.

Project Development

- Establish a clear project development priority through a democratic process informed by this feasibility study.
- Reach out to the community to engage with the landowners that are key to developing the project. Secure agreements in principle to continue feasibility work.
- Engage with established community energy organisations operating the same type of project for advice. Visit these projects.
- Utilise those that can offer development services such as CARE, Ynni Teg, or Transition Bro Gwaun.
- Determine the extent to which these services can progress the chosen project under the funding they may have already secured. i.e. establishing grid connection possibilities and finalising site location.
- Determine what consultancy services, and at what cost, are required to move beyond that extent i.e.:
    - Ecology reports
    - Detailed Design
    - Planning documentation and application
    - Legal costs
- Apply for preparatory grant funding from WGES or other body to fund these additional costs as well as development officer staff time for the community energy organisation itself.
- Apply for grid connection permission and secure capacity with preliminary deposit.
- Undertake a tender exercise for detailed design and planning application consultancy services to ensure value for money. Appoint chosen consultant.
- Submit planning application.
- Secure Option & Lease agreements with landowners.
- Secure Power Purchase Agreements for any on-site consumption via a private wire.
- Undertake a tender exercise for installation & construction services. Appoint chosen contractor.
- Apply and secure capital grant funding and bridging loan if required.
- Pay balance for grid connection works.
- Contractor begins construction...
- Develop project shareoffer to replace bridging loan. Including method of administration and promotional documentation.
- Launch shareoffer and publicise to local community as much as possible to ensure local investment and wealth distribution.
- Arrange any export based power purchase agreement such as Energy Local, licence exempt PPA, or standard grid export PPA.
- Commission generator and move to operational phase.
- Close shareoffer when target reached.

These recommendations are not exhaustive but provide a course roadmap. Development of a community energy organisation and associated generator takes many small steps which can vary in sequence depending on the circumstances. Rest assured that the community energy sector is incredibly supportive, willing to provide informal advice often without charge. Should the way feel tricky or slipping backwards there will always be someone with experience to talk to. We wish Llanrhian Community Parish & Trefin Energy, as well as the members of it's community the best of luck in any future endeavour.

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