# Approaching Near Zero Energy In Historic Buildings

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Deliverable Type: R

R = Document, report
DEM = Demonstrator, pilot, prototype, plan designs
DEC = Websites, patent filing, press & media actions, videos, etc.

Dissemination Level: PU

PU = Public
CO = Confidential, only for members of the consortium, including the Commission Services




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# Introduction

Energy Pathfinder project aims to contribute in reducing the energy use in historical buildings in northern periphery and arctic region. The project duration was from 01.06.2019 till 31.12.2022. The project has seven partners from 4 countries; Ireland, Faroe Islands, Finland and Sweden. The project, among other things, carried out a detailed literature review on challenges and possibilities for energy efficient renovation, co-design approach in one of the "demonstration" projects, energy surveys in seven "demonstration" projects, implementation of energy efficient retrofitting in two "demonstration" projects, developed an online toolkit and communicated the project results through various channels and also conducted seven webinars. The project in addition to management has five work packages such as Baseline and evaluation, Co-design methodology and process, Energy Management and Monitoring, Tool kit and demonstrators and Communication. In the below sections a brief overview of the main aspects of the five work packages is provided.

**Results**

Progress summary (deliverables)

| | WP1 | Status | WP2 | Status | WP3 | Status | WP4 | Status | WP5 | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| Deliverable number | T1.1.1 | Done | T2.1.1 | Done | T3.1. | Done | T4.2.1 | Done | C.1.1 | Done |
| | T1.2.1 | Done | T2.1.2 | Done | T3.2.1 | Done | T4.3.1 | Done | C.2.1 | Done |
| | T1.3.1 | Done | T2.2.1 | Done | T3.3.1 | Done | T4.4.1 | Done* | C.2.2 | Done |
| | T1.5.1 | Done | T2.3.1 | Done | T3.4.1 | Done | | | C.2.3 | Done |
| | T1.6.1 | Done | T2.4.1 | Done | | | | | C.2.4 | Done |
| | | | T2.6.1 | Done | | | | | C.3.1 | Done |
| | | | | | | | | | C4.1 | Done |

**Work Package 1: Baseline and evaluation**

In this work package baseline information of all the demonstration buildings were gathered using a template. Further, an extensive literature review on challenges and opportunities for energy efficient retrofitting was carried out. An open access article "A Review on Technical Challenges and Possibilities on Energy Efficient Retrofit Measures in Heritage Buildings" was published in the scientific journal "Energies". As this publication can be freely downloaded, it is expected to contribute to enhance the knowledge on the topic among interested groups across the world. A report that compiled the existing online tools, which facilitate renovation of historical buildings, available in the partner regions was prepared.

**Work Package 2: Co-design methodology and process**

A thematic and genealogical inquiry into the evolving and intersecting fields of co-design and participatory design was carried out. The study has highlighted implications for participation that orginate from a diversity of contextual matter, and traced how the concept of participation within different forms of organisation unfolds according to a variety of trans-border, political and paradigmatic motivations, uses and applications.

Further, a document was prepared that formalize a rationale and methodology for user-centered post-occupancy evaluation (POE).

As part of this work package, open space workshops were held in Myross Wood House. During the first workshop, which was held in September 2021, energy use reduction through building envelope improvement was presented. This was followed by second workshop in October 2021 and held as two-part session. The second workshop include session to know the participants' knowledge on different parts of the building and types of remedial work being carried out. This was followed by a questionnaire survey among participants to gain knowledge on their connection with the place.

**Open Space Workshop 1**
**CECAS, Sept. 26th 2021 -11 am – 1.30 pm**
The first co-design workshop was held as part of the launch of the Centre for Excellence in Climate Action and Sustainability at Myross Wood House. This was attended by around 30 people including users of the building and Green Skibbereen board members. The co-design workshop was chaired by Caitriona Courtney from NCE Energy Hub.

**Fig 1**: Open Space Workshop 1

The first presentation was given by Jose Ospina who introduced the Energy Pathfinder Project and gave an overview of the diverse demonstrator sites that are being used across the Northern Periphery & Arctic region of Europe.

**Fig. 2** Jose Ospina, *Project Manager for Energy Pathfinder*

**Fig. 3** *Caroline Akiboye & Simon Conolly on retrofitting proposal for Myross Wood*

This was followed by a detailed presentation from Caroline Akiboye & Simon Conolly of the energy baseline and retrofitting proposal for Myross Wood House that has been developed through the energy pathfinder project. The third presentation in this seminar was from Kevin Busby from Munster Technical University, coordinator of third year Architecture students in Cork Center for Architectural Education in UCC. The students used Myross Wood House for one of their projects. The seminar was ended with a Q & A session followed by closing remarks by Ana Ospina, Director of Green Skibbereen.

**Fig. 4***. Plans for the redevelopment of Myross Wood House.*

**Open Space Workshop 2: 30th October 2021**
This event was organized by CCAE and advertised through social media and to Myross Wood House stakeholders. Green Skibbereen Members and Directors supported the event. A link to Event Brite was provided and 22 persons registered and were interested. In the event, 11 people actually attended. The event was the first face-to-face event held by the project since the COVID lockdown began. Health precautions, (masks, hand sanitizer and social distancing) were observed as well as checking of COVID certificates was implemented at the event.

The attendees were interested stakeholders who were familiar with the project and some who had not visited the building before, as well as Green Skibbereen Board members responsible for the building management and maintenance. The event kicked off at 11 AM with a short introduction to the Pathfinder project and welcome from Jose Ospina, Energy Pathfinder Project Manager.

**Part 1 assessment of building with stakeholders ACA**
Simon Conolly and Caroline Akiboye (CCAE Architects) gave a presentation outside the house and explained the history of the building and its various construction and architectural features. This was followed by a walk around the perimeter of the building to look at some of the key aspects of the building. The courtyard was then visited, followed by a short viewing of the boiler room showing its historic oil boiler that provider heat for the 60 of rooms,

A viewing of rooms in one of the wings of the building was also carried out, noting the communal washrooms on each floor.

The attendants then adjourned to the front room of the building, where Prof, Kevin McCartney led the co-design workshop. This was based on a simple step by step questionnaire that went through all key aspects of the building: fabric, roof, walls, doors, windows, floors and the n sources of heat, giving different recommended insulation and renewables integration options.

Attendees were then asked to choose options within the questionnaire, identifying which would be their preferred options and specifying what priority they believed work on these specific items should have. There was some final general discussion of options and selections made, before the workshop closed at 1 PM. Discussion took place around different elements of the questionnaire with those attending expressing their views about the different options. The questionnaires were then completed and collected for analysis. The session was recorded and the recording was uploaded on the project drive.

A report was produced by Prof. McCartney based on the results of the questionnaires and the ensuing discussion.

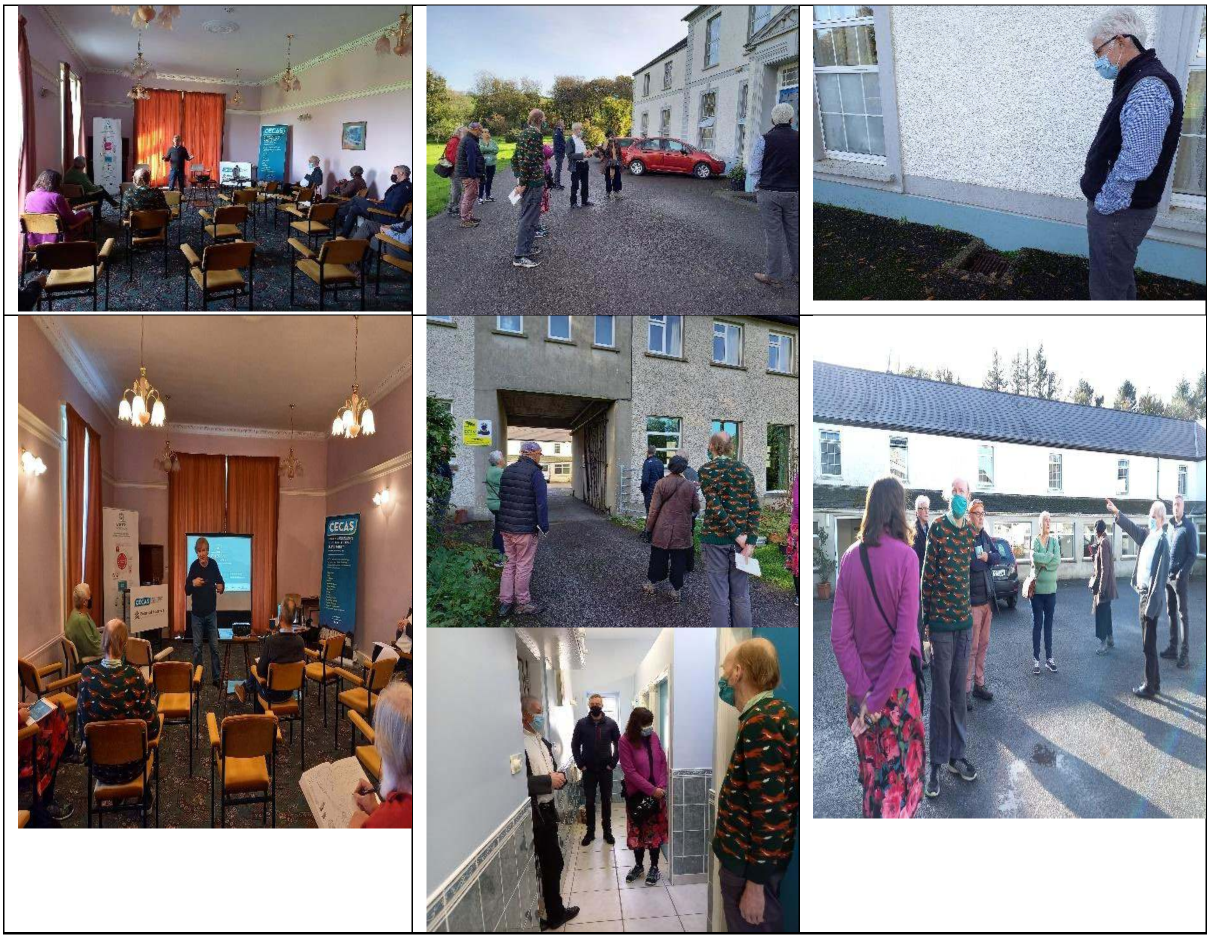


**Fig 5:** A few photos from the open space workshop 2

**Users' experiences; shortcomings due to internal climatic conditions/ thermal comfort encountered within the building**

Since January 2021 Myross Wood House has been used for a variety of community, social and environmental events and activities. The house has also been available for continued survey, investigation and proposed projects of various types. Green Skibbereen has not been able to carry out any significant retrofit of the building, due to the limitations explained above, and works have been limited to required maintenance to the building at present. The main reasons for this shortcoming are explained above

The issue for Green Skibbereen in the current use of the building has been the rent set by MSH, mainly intended to cover costs of operating the building, primarily the oil-fired boiler which is the sole source of heating for water and space. This heating system is very expensive both in terms of oil consumption (around € 50,000 per year) but also in terms of maintenance as the boiler is old (which is over 14 years old) and needs constant maintenance. Green Skibbereen has had to meet innumerable repair requirements to the system and to the various water cylinders, shower units and oil tanks.

Maintenance costs are in addition to the progressively escalating rental paid by GS to the MSH. Between these two costs, and other running costs of the building, the enterprise operating income made by use of the building is absorbed, leaving no surpluses for other activities (e.g match funding of projects) or for creating reserves. Significant repair needs have been identified by the various surveys undertaken. A recent fabric condition survey identified laten repair needs of approximately € 3,000,000. This is without 9icnouding the substitution of the current oil-based heating system for one based on heat pumps or some other renewable energy technology, which cost and additional € 3090,000

The limitation on the existing licences from the MSH has prevented Green Skibbereen from applying for and securing the required level of funding for retrofitting. However, a small grant of € 25,000 towards the installation of thermal solar panels and new short water storage tanks in the building, to reduce the use of oil for water heating, has been secured by Green Skibbereen. Installation is due to take place by January 2023.

**Work package 3: Energy Management and Monitoring**

An energy assessment of retrofitting made in demonstration projects is prepared and a main summary of the results are provided

| Building | Major renovation measures installed/planned/suggested | Comments |
|---|---|---|
| Bayview, Scotland | Addition of insulation in floors, walls, ceilings, comb ceilings, apex loft, replacement of windows and doors with modern uPVC double-glazed units. Also, subdivision of the building into four dwellings and reconstruction of the rear portion to form a new common stairwell. | It is projected that as a result of the renovation and subdivision of the building the RdSAP indicator will improve from E43 (whole building) to a range of values ranging from D68 to C75 (worst and best performing new flats respectively) |

| | | |
|---|---|---|
| Keepers Cottages, North Ronaldsay Lighthouse, Scotland | A package of EE measures including improvements to building fabric and airtightness, in addition to development of an HVAC solution which offers low running costs and operational carbon emissions and is technically and logistically feasible considering the challenging site. | RdSAP software indicated that the main indicator could potentially improve as below for three of the units on site:<br>Cottage 1: Class E50 to Class B84<br>Cottage 2: Class E53 to Class B85<br>Cottage 3: Class E43 to Class D62<br>This is a relatively crude estimate but gives a reasonable indication of the reduction in running costs that might reasonably be expected as a result of an in-depth retrofit project |
| Cathedral of Saint Mary and Saint Anne, Ireland | Adding insulation to the main pitched roof above the nave, using air-to-air heat pumps to reduce the need of more powerful warm air system | |
| Myross Wood House, Ireland | A package of measures to improve the overall fabric performance | Installation of the recommended measures would significantly reduce the energy use of the whole building from 436 KWh/$m^2$ year to 113 kWh/$m^2$ year. The annual energy use of building will reduce from 1263 MWh to 327 MWh (a reduction of approximately 75%) |
| Rector's House, Finland | A package of measures such as improvement of air tightness, heat recovery of the existing mechanical ventilation system | Implementation of the recommended measures could result in reduction of heating energy demand from 122135 kWh to 49319 kWh (a reduction of approximately 60%) |
| Tegskyrkan, Sweden | Replacement of windows to energy efficient windows and cyclic set-point temperature settings | Energy savings of upto 27% may be achieved by replacing existing windows with energy efficient windows.<br>Cyclic temperature set-point strategies may result in savings upto15.5%. However, it may take 1-3.4 Hours before the air temperature reach the target temperature. |
| Viðareiði Vicarage, Faroe Islands | Major renovation of the whole building | Significant improvement on the quality of life of its occupants due to improved thermal comfort and daylighting of the interior |

From a social perspective the Bayview project represents an interesting model wherein a community development trust acquiring a derelict property, renovating it and converting it into a community owned asset which addresses a pressing housing need in the island by subdividing the renovated building for long term rental accommodation. The Westray Development Trust, which is owned and managed by local community is very active in community development projects, is the developer for Bayview housing project. The project received funding from Scottish Land Fund funding and in 2020 the project received a support of £ 380 000 from Scottish Government's Islands Housing fund. The financial support from government is a major factor in the project realization.  In more isolated parts of Scotland, some charitable organisations, such as Communities Housing Trust, are also bridging the resource gap by undertaking development projects on behalf of local communities.

A vicarage was renovated in Faroe Islands and the vicar and family who live in that building are highly satisfied with the renovation. The vicar has explained to the project partners, during their site visits in August 2022, the benefits of the renovation.

**Work package 4: Toolkit and Demonstrators**

In this work package an online toolkit was developed that could provide generic advice in practical building conservation and retrofit and would act as an aid for learning and planning retrofits. The activity and deliverable that dealt with demonstration projects (DT4.2.1) was moved to work package 3 as that deliverable fits better with the activities in WP3. Accordingly, this work package primarily dealt with the online Toolkit.

The development of online toolkit has been complicated by several factors, including the Covid 19 pandemic which limited face-to-face meetings. site visits, measurements and changes in employment at Oulu University of Applied science (OUAS). Two prototypes of the Toolkit were developed during 2020. One of these was posted on-line as a Demonstration at that stage: https://pathfinder-toolkit.herokuapp.com/.

Oulu University of Applied Sciences decided to invest EPToolkit 2.0 even though the funds allocated for this task was exhausted. A "Toolkit development subgroup" was formed to ensure appropriate contribution from partners. The subgroup met regularly met. Historic Environment Scotland, who had experience of using a usable programming platform and a valid license, made a strong contribution in the process. The working group focused again on developing the content and structure of the Toolkit. Accordingly, version 3.0 of the Toolkit was developed.

The Toolkit is currently a beta version, and the latest version of the Toolkit can be accessed via link https://www.eptoolkit.eu/#/. The online toolkit will help one to understand how to retrofit historic buildings in northern Europe in order to make them more energy efficient and sustainable - without compromising the aspects that makes them important such as cultural heritage. The toolkit does not require technical knowledge to use it. It can be used by anyone interested in learning about historic building retrofit. For example, a house owner, can use it together with an expert in the field, for example with an architect. This toolkit can also facilitate the co-design process. Toolkit provides generic advice on practical building conservation and retrofit and is an aid for learning and planning retrofits in general. The toolkit consists of three parts: (i) Retrofit Library: Is Selection of retrofit measures to browse and learn from, including technical and heritage considerations, (ii) Project planner: It is an Interactive tool to explore, and tailor retrofit pathways for your specific historic building, and (iii) Case studies: Are Web links to selected resources with examples of relevant conservation projects and technical discussion.

Under the Project planner input button, one can find a survey, which is the basis of EPToolkit. The survey response aims to lead to solutions that are energy-efficient, while considering the historical aspects of the buildings, and make sense from a construction point of view, emphasizing the urgency of the repairs to be made.

However, the Toolkit requires further fine tuning and improvement. The partners have agreed to provide the coding of the Toolkit open access in the project website. This may help interested parties to improve the tool kit and thereby possibly have much wider impact on reducing energy use in historical buildings.

## Work Package: Communications

The project created a website https://www.energypathfinder.eu which formed the main front-end to communicate the project results, news, reports and other deliverables. Similarly, social media accounts were created in Facebook, Twitter, Linkedin to communicate project information regularly. Further, brochures and roll-up were used to spread the project information.

The following seven webinars were organized during the project

1. Achieving NZEB standards in historic buildings
2. Landsverk's approach for sustainability, retrofitting of the historical vicarage of Viðareiði
3. Energy Use & Thermal Comfort in a Large Single-Zone Building (Tegskyrkan) during Cold Season
4. Fabric Monitoring for Traditional Building
5. Retrofitting Monitoring & Measuring Systems, Cork City Council's Experience
6. EnerPHIT Refurbishment of Niddrie Road, Glasgow
7. Energy, Temperature and Humidity Monitoring of the Cathedral of St. Mary and St. Anne (North Cathedral).

Research publications that acknowledged the Energy Pathfinder project


1. Nair, G., Verde, L., Olofsson, T., 2022. A Review on Technical Challenges and Possibilities on Energy Efficient Retrofit Measures in Heritage Buildings. Energies 15 (20), 7472. https://www.mdpi.com/1996-1073/15/20/7472
2. Zhang, Y., Zhao, C., Olofsson, T., Nair, G., Yang, B., Li, A., 2022. Field measurements and numerical analysis on operating modes of a radiant floor heating aided by a warm air system in a large single-zone church. Energy and Buildings. https://www.sciencedirect.com/science/article/pii/S0378778821009300
3. Zhang, Y., Olofsson, T., Nair, G., Zhao, C., Yang, B., Li, A., 2020. Cold windows induced airflow effects on the thermal environment for a large single-zone building. Nordic Symposium on Building Physics, 6-9 Sep, Tallinn. https://www.e3s-conferences.org/articles/e3sconf/abs/2020/32/e3sconf_nsb2020_06003/e3sconf_nsb2020_06003.html


All the above publications are open access and can be downloaded free of cost.

## Transnational learning from the project

Transnational learning was possible through the field visits in partner regions which provided an opportunity for the participants to see the energy efficiency retrofits implemented in various historical buildings, approach taken under different circumstances and also the challenges and opportunities that exists. The project entailed close co-operation among partners in various activities, for example, sub task group for the toolkit has members from HES, NCE Insulation and OUAS. Such interaction has contributed in mutual learning by partners. Further, the project organized seven webinars which was also helpful in sharing the knowledge and transnational learning. The topic covered in the webinars include experiences from implementation of sustainable energy renovation of historical buildings to monitoring of retrofitting and simulation studies on energy use and thermal comfort in listed building. The webinars bring experiences and learnings on retrofitting of historical buildings from different northern periphery regions. All webinars were recorded and are uploaded in the project website https://www.energypathfinder.eu/resources/webinars/

### Covid-19 Impact

The Covid-19 has a significant impact on some of the activities such as co-design approach and also studying and data collection and monitoring of "demonstration buildings". This is because these activities required meeting people and also visits to the buildings which were restricted. Further, as the partners could not host physical meetings the communication of the project was affected. The partners could not meet in person for more than two years during the project. This situation might also have impacted the project as significant interaction and sharing of information among partners for execution of various tasks was required. Nevertheless, the project tried to reduce the impact by hosting monthly online partner meetings and also by hosting webinars.

### Conclusions

The project suggests significant energy savings potential in historical buildings in northern periphery region. There is no "one size fit all" solutions for energy efficient retrofitting in historical buildings. The buildings are unique and challenges and opportunities differ. Further, this project has pointed out unique challenges in energy performance improvement of historical buildings in sparsely populated region. For example, the electrical network in North Ronaldsay is highly constrained and limit potential solutions involving storage technologies and new microgeneration systems. Nevertheless, it is possible to learn from the experiences of energy retrofitting of historical buildings in partner regions.