ICE
INTELLIGENT COMMUNITY ENERGY

Interreg
France (Channel Manche) England
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ICE REPORT 2.8

GLOBAL ACTIVITY REPORT

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Pôle Mer Bretagne Atlantique

About ICE

Supported by Interreg VA France (Channel) England, the Intelligent Community Energy (ICE) project, aims to design and implement innovative smart energy solutions for isolated territories in the Channel area. Islands and isolated communities face unique energy challenges. Many islands have no connection to wider electricity distribution systems and are dependent on imported energy supplies, typically fossil fuel driven. The energy systems that isolated communities depend on tend to be less reliable, more expensive and have more associated greenhouse gas (GHG) emissions than mainland grid systems. In response to these problems, the ICE project considers the entire energy cycle, from production to consumption, and integrates new and established technologies in order to deliver innovative energy system solutions. These solutions will be implemented and tested at our unique pilot demonstration sites (Ushant island and the University of East Anglia's campus), to demonstrate their feasibility and to develop a general model for isolated smart energy systems elsewhere. The ICE consortium brings together researcher and business support organisations in France and the UK, and engagement with SMEs will support project rollout and promote European cooperation.

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1. Introduction

Intelligent Community Energy (ICE) is an Interreg VA France (Channel) England Project. It aims to design and implement innovative smart energy solutions for isolated territories in the Channel area. The ICE project considers the challenges islands and isolated territories are facing in terms of energy, as many of them depend on imported energy supplies and have no connection to wider electricity distribution. It also considers the entire energy cycle, from production to consumption and aims to deliver innovative energy solutions by integrating new and established technologies.

These solutions will be implemented and tested at our unique pilot demonstration sites (Ushant island and the University of East Anglia's campus), to demonstrate their feasibility and to develop a general model for isolated smart energy systems elsewhere.

The ICE consortium brings together researcher and business support organizations in France and the UK, and engagement with SMEs will support project rollout and promote European cooperation.

This global activity report summarizes the work carried out by the project partners during the six years of the project and highlights the main achievements that made it possible to reach the objectives of the project.

2. Assessing current and future community energy conditions

For a better understanding of the pilot sites (Ushant Island and the Campus of the University of East Anglia), a complete synthesis work was necessary.

As a first step, ICE Partners carried out an overview of renewable energy supply potential, by outlining appropriate methodologies for a full assessment of the available resources and their key constraints.

Table 1: Key constraints by renewable technology type.

Constraints/ Energy types	Resource constraints	Technical constraints	Environmental and heritage constraints	Social and political constraints
Solar	-Solar radiation; -PV temperature; -Cloud cover level (for optimal resource); -Air temperature; -Wind speed;	-dedicated electrical connection; -Accessibility for ongoing maintenance; -Grids type and capacity;	-Visual impact; -Impact of chemical substances on wildlife during the installation; -potential impact on agriculture if co-located with agricultural land use.	-permission required depending on installation capacity; -Vary by country and region; -Access to network market or subsidy.
Tidal	-Flow velocity and its variation over a tidal cycle; -Flow periods sustainability; - Flow direction; -Tidal range; -Local geographical features	-Energetic flow; -Geological constitution of the seabed; - Accessibility; -Individual Turbine specifications (cut-in and cut out velocities); -Technological immaturity.	-potential impact on marine ecosystem (the installation activities, movement of the turbine blades, turbulence, noise…) -potential impact on fishing, navigation and other sea uses;	-dependent on jurisdiction; -involvement of stakeholders (marine management agencies, electrical network operators, local communities and national governments); -Dealing with the islands suggest any negative prior experience can have long-term impacts on revisiting acceptability; -Fishing and other marine navigation rights.
Wave	-wind; -swell.	-Access to appropriate port facilities for installation and maintenance activities; -bathymetry; -seabed slope;	-Potential impacts on marine life, fishing and shipping; -Potential impact of noise, electromagnetic radiation and moving parts.	

		-onshore grid connection; -Technological immaturity.		
Wind	-Wind speed and its consistency (the ideal site will have a consistent wind speed close to the rated velocity of the proposed turbine).	-Proximity to electrical grid access; -Site access and appropriate road infrastructure/ jack-up for installation and maintenance; -Safe distance installation from infrastructure can further limit potential; -Geographically suitable installation area (avoid forests, marshlands, areas prone to flooding…) -Site's geology.	-Noise from the turbines; -the "flicker" effect from rotating blades; -Potential hydrological impacts on local water courses due to installation; -Risk and perceived risk to birds from wind turbine developments; -The presence of endangered species; -Visual impact on areas of aesthetic, cultural or historical significance, and designated sites; -Noise/perception of noise.	-Variable potential by locality; -Planning consent usually required for permanent structures; -Access to network, market or subsidy.
Waste and biomass	-Availability of biomass or waste resource in sufficient capacity. -Cost of biomass resource (depends on production site);	-Collection and diversion; -Process plant's location, -Bunkering service for fuel distribution	-Issues around combustion and 'incineration'.	-Issues around odor and aesthetic; -Issues around combustion and 'inceniration'.

The project also focused on renewable energy policy and regulatory considerations in Ushant and the UEA campus. Both sites were part of the European Union at initiation of the project, and EU policy is a fundamental driver of national policy even at local scales. Both France and UK promote renewable energy as part of their obligations under EU law. The UK continues to do so under UK legislated climate change goals.

In France, the national electricity utility (EDF) is predominant. This made the creation of a smart energy grid on Ushant is a challenge but also an opportunity for creating a smart energy island within constraints that varied significantly from island communities in the UK and in other regulatory regimes. EDF's scope to act on energy generation and supply, as well as demand side innovation is significant. **Developing smart energy grid on Ushant may require many small actions by a wider range of actors which represents a management and a collaboration challenges for EDF as well as the relevant public institutions.**

On the other side, the UK's highly liberalized energy markets are being challenged by the demands of moving towards a smart, flexible and low carbon system. The UEA campus is already experimenting innovative technologies to better manage demand. **In the framework of ICE project, our goal was to increase likelihood of deployment of innovations that target the energy behavior of the staff and students that work and live on campus.**

This work has helped identifying a range of potential options whose applicability was subsequently analysed for each site of interest.

This analysis was carried out, in addition to the analysis mentioned, through a detailed look at the particularities of the pilot sites.

and allowed to conclude appropriate solutions for each of them:

- ✓ For the UEA campus: **solar and biomass technologies** seem to be the most effective;
- ✓ For Ushant Island: **solar and wind** energies, with some storage capacity are likely to be the most appropriate options.

To take the analysis further, an energy demand assessment was carried out for Ushant, and the annual, seasonal and intra-day variability were examined and compared to the production of each technology. for EUA, total annual production was presented for 2015-2016 and a breakdown of energy consumption was presented. Based on these elements, a full assessment for the identified technologies was carried out.

Table 2: summary of the advantages and limits to the development of renewable energy technologies on the pilot sites

	Ushant		UEA campus	
	Advantages	**limits**	**Advantages**	**Limits**
Solar	Great potential	solar radiation is much greater in summer, when the island's energy demand is strongest in winter	Great potential	-great seasonal disparity in production; - likely that demand will also be higher in winter (no data available)
Wind	wind energy production is enough to meet the objectives of 70%	Development consent and environmental and/or social issues will need to be	-	considerable obstacles to consent to the construction of wind turbines, and no

	(2020) and 100% renewable energy **if combined with battery storage and solar energy generation facilities and /or additional tidal power.**	overcome before a wind energy project can be implemented.		appetite for such development.
Tidal	Existence of well-suited sites to the exploitation of tidal energy.	-	-	-

Regarding the intermittent characteristic of all the selected resources (except biomass), particular attention has been paid to **energy storage solutions** in order to ensure resilience.

ICE partners highlighted in this first phase that **a combination of generation technologies can play a key role in creating a low-carbon energy system**. They also pointed, in order to maximize the amount of low-carbon energy and make full use of renewable technologies, the necessity of combining three additional features:

- ✓ An energy storage solution;
- ✓ Energy reduction measures;
- ✓ A correlation between consumption behavior and time of generation.

3. Designing business and future community energy conditions

The second phase provides for **the development of a business model for the energy transition in isolated territories**. In this context, a methodological approach has been developed by ICE partners.

The goal of the ICE methodological approach is to provide a blueprint for smart energy transitions in isolated and peripheral territories to allow transferability of the methodology. The challenge was **to ensure that the specificities related to issues featuring isolated territories are all covered by a generic approach.**

In order to develop a business model, ICE partners reviewed the current status of smart island energy transitions and several real-world smart energy programs by highlighting the lessons learned and best practices observed from past and ongoing smart energy transitions in isolated territories.

This helped a better understanding of the technical, financial, and operational aspects of the transition to smart energy solutions.

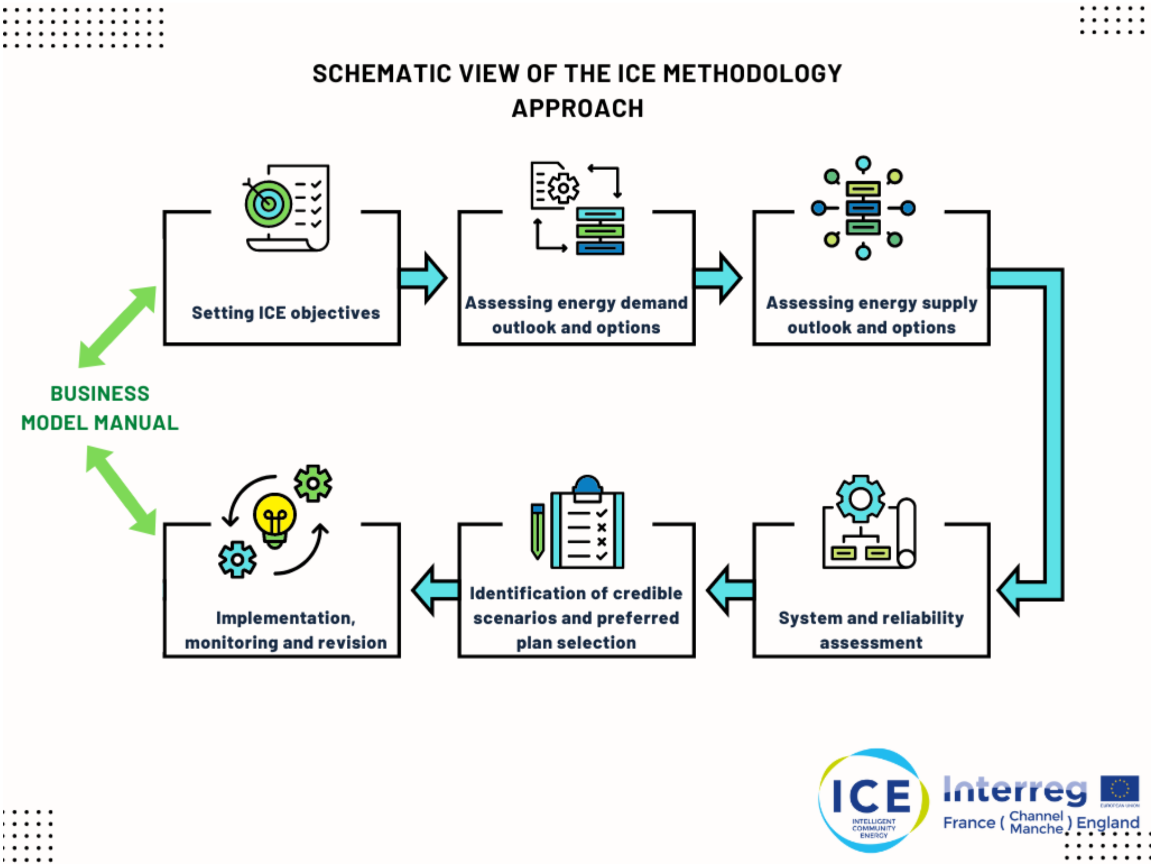

Figure 1: Schematic view of the ICE methodology approach

The suggested ICE methodological approach counts seven interrelated stages. All are intended to be hybrid and are based on the most appropriate elements of the IRP and AOP approaches. Except the business model manual, which will be adapted to the specific characteristics of the isolated territory in question.

The methodology also aims to be transferrable and comes with a set of guidelines **designed to be applicable in a wide range of isolated or islanded contexts**. The methodology is detailed in the publicly available deliverable "General methodology".

The General Methodology was applied to a series of French and UK islands to test its flexibility, with the results used to feedback into the method.

The business model based on the methodology above **aims to promote employment, support labour mobility and enhance competitiveness of SMEs in the channel area and in other island or peripheral communities.** It is against that background that ICE partners launched a Call for Expression of Interest (CEI) lead by PMBA, which identified **26 companies** capable of providing innovative solutions for the energy transition of isolated territories. They were therefore labelled “ICE companies” **(find out the list of ICE compagnies)**.

This was a key phase of the ICE approach, as it helped identify and/or develop the local capacity for skills needed.

A call for projects was launched on the French side, thus allowing SME’s to get a financial opportunity to develop their innovative projects.

Eligibility conditions were predefined as follows:

- ✓ Capacity to provide solutions or services within the framework of low carbon energy models for isolated territories;
- ✓ Eligible types projects: feasibility studies, market surveys, Proof-of-concept, prototypes, and territorial acceptance surveys;
- ✓ To complete an application form explaining the targeted energy isolation problem;
- ✓ To Specify the innovative nature of the solution and its implementation in Non-interconnected area (energy production, storage and distribution);
- ✓ To demonstrate how the more difficult access conditions of island territories are considered;
- ✓ To describe the technological usage and technical-economic barriers;
- ✓ To list the positive long-term socio-economic impacts.
- ✓ The cost necessary for the realization of the project must be between **15K and 25K €,** with a project **duration of up to 4 months.**

Figure 2: Communication design of the call for projects

After the CFP period (≈ one month), a selection committee has been set up to select the winning projects. The committee was made up of two partners: **PMBA and BDI**, **SMILO (Small Islands Organization) and an expert in energy transition at SDEF.**

the committee assigned scores ranging from 1 to 5 according to the following criteria:

1. Suitability of the solution to the energy needs of isolated territories;
2. Contribution to reducing the territory's CO2 emissions;
3. Innovative nature of the solution;
4. Level of benefit and added value of the service;
5. Potential economic impact;
6. Viability and growth potential of the project;
7. Respect of the maximum duration of 4 months and the budget;
8. Involvement of an isolated territory.

Following this scoring system**, four compagnies with four innovative projects** were awarded:

Table 3: List of the winning projects

Compagnie	Short project description
ENAG company	Development of an algorithm for the optimization of the battery storage of the Saint Nicolas des Glénan island power plant.
FARWIND Energy company	Feasibility study for the exploitation of mobile offshore wind energy in Marie-Galante in Guadeloupe (French overseas territory).
Guinard Energies Nouvelles company.	Site characterization, implementation and technical-economic study on the island of Molène
Swanbarton company	A study to identifying potential benefits from adding battery storage and commodity renewable generation to existing diesel electricity generation on Alderney with the goals of reducing costs for all residents and reducing emissions.

There is a diversity in the awarded projects. In fact, were selected: **a feasibility study, a site characterization study via modeling and two storage optimization related projects, based on existing technologies.**

Also, the four projects **address urgent energy independence issues** in isolated territories. They make it possible to **respond to actual needs** reported by the territories in question.

The Call for Projects also made it possible for these SME's to **benefit from European funding in a more simplified** way than usually possible, since they all have been funded through ICE project.

In order to evaluate the relevance of this call for projects in favor of SMEs, a survey was launched among the 3 awarded French SMEs.

All SMEs considered the initiative "very interesting". 2 out of the 3 SMEs estimated that their projects could not have been implemented without the ICE funding since it allowed them to finance their projects entirely.

To support growth and innovation, **access to finance is crucial,** especially considering the high level of risk attached to the sector of earlier stage renewables, renewables and its smart technology enablers.

In parallel with the call for projects on the French side, the ICE partners carried out an **inventory of possible funds** on both sides of the Channel in order to help SME's overcome the barrier of access to finance.

To sum up, the ICE business model is based on **three key pillars** : (1) good knowledge of the local companies and what they have to offer (especially SME's), (2) the best possible understanding of the needs of the territories and (3) a knowledge of the mechanisms for starting the energy transition in the territory.

4. Pilot sites demonstration

After a full assessment of the current and possible future conditions in isolated territories, this section provides essential material for the operational phase.

ICE partners have established a standard methodology, which can be applied to any isolated territory.

The following chart describes the methodology of reflection, which was afterwards applied in the pilot sites:
Based on this methodology, ICE partners described two specific energy systems on Ushant Island and the UEA Campus. The characteristics of the first pilot site were considered, as well as the current energy consumption on the Island.

BRETAGNE DÉVELOPPEMENT INNOVATION EXETER PLYMOUTH UNIVERSITY UEA marine

In terms of energy production, only electricity is exclusively produced in Ushant Island, all the island's fuel needs are imported.

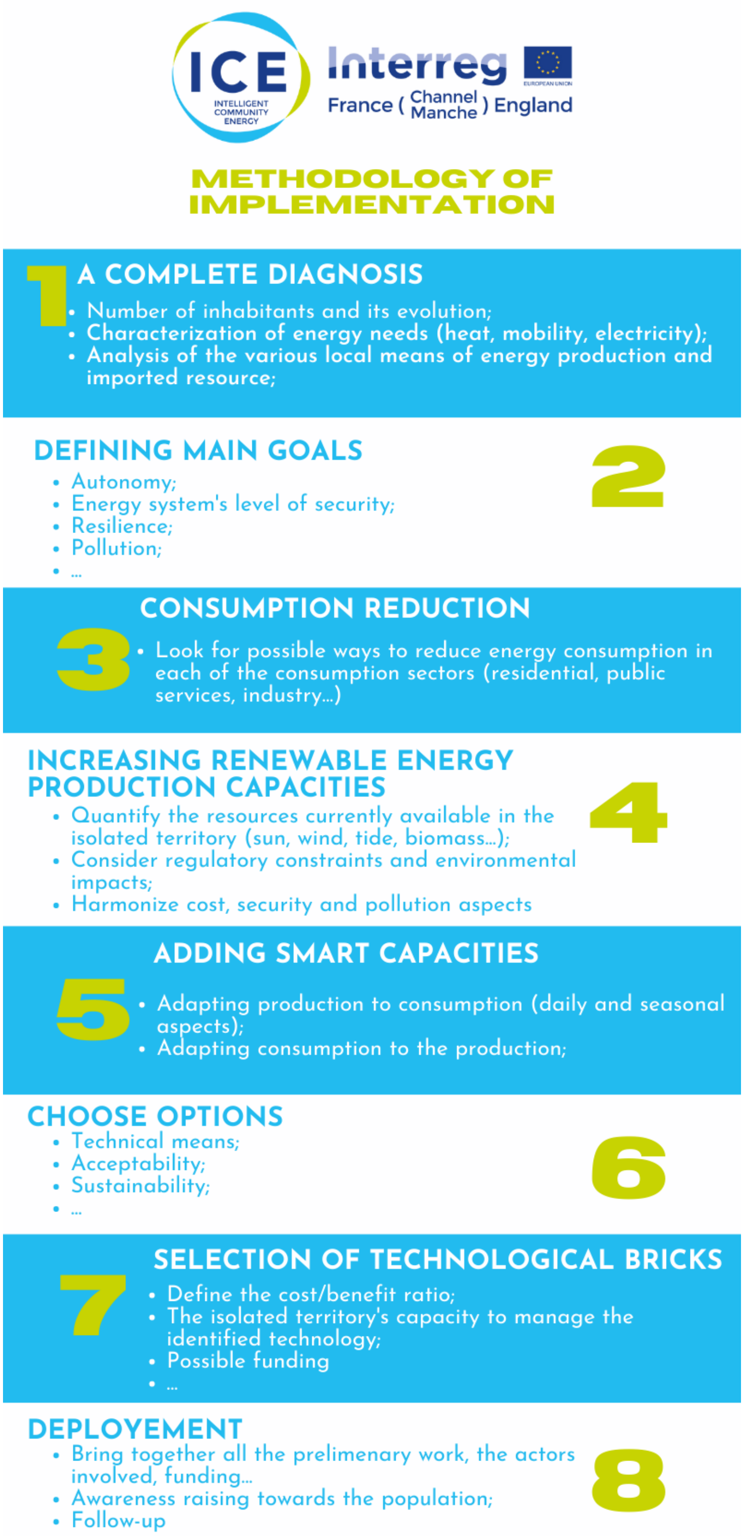

Figure 3: summary of the implementation stages according to the ICE method

On the UEA campus however, energy sources are mostly provided by natural gas through localized combined heat and power (CHP) plants, electricity imports form power grid as well as localized renewable energy production.

Regarding the ratio between energy production, loss and the potential for new renewable energy technologies, it was estimated that the Ushant Island should be able to reach a renewable electricity rate of 65% in 2023.

However, achieving 100% renewable energy by 2030 remains possible if some additional smart measures are taken.

In the UEA campus, 63% of electricity is consumed by the academic activity of the campus, residential needs of electricity represent 23%.

Both heat and electricity consumption have fallen significantly since the improvement in energy efficiency and the introduction of new technologies (≈10%).

Variability is a very important aspect to consider for future adaptation (production/consumption). In fact, energy consumption variability on Ushant Island is intra-day and seasonal (high peaks during winter and at the end of the day). Therefore, the development of renewable energy technologies**, reducing energy consumption** (high potential of reduction by encouraging **house insulation)**, as well as **storage solutions** can help reduce the magnitude of the variations in consumption.

like the variability of consumption in Ushant, the UEA campus is also experiencing a peak in gas consumption during winter. In this period of the year 70% of the total annual heating is consumed. Electricity consumption on the other hand, does not vary significantly along the seasons (52% during winter vs 48%).

On the other hand, electricity consumption in the UEA campus has daily variations, particularly for renewable energy. Demand peaks between 4 and 8 pm, a noticeable increase also occurs between 1 and 2 pm. Variabilities were also observed during the week, demand is 20% lower during the weekends. These disparities can be explained by the pace of academic activity on campus. Based on this diagnosis, ICE partners have identified 3 categories of actions to prioritize for the implementation of smart energy solutions in isolated territories. they are listed below in order of importance:

It was also highlighted that consultation of the local population is a major step, regarding the direct effect of the actions that will be carried out.

In a further work, ICE partners have **selected relevant solutions for Ushant Island**.

Table 3: Recap of the selected actions to deploy in Ushant Island

Technical category	Deployed solutions	Description	Purpose
Energy production	An Energy Management System (EMS); (deployed by EDF SEI, outside of the project in 2017)	The EMS contains an information exchange and control with: -The various renewable producers and the thermal power station; -The lithium-ion-battery-based storage system; -Future flexibilities	- Continuous supply-demand balance in terms of electricity; -Maintenance of system services; -Maximize the share of renewable energy share; -Arbitration of renewable energy producers in case of overproduction of non-controllable renewable energy, and low demand; -Possibility of adjustment (adding new producers, new flexibilities, improving optimization)
Energy consumption	A communication system and sensors	The system contains several technological building blocks: -**A data center** for storage and data processing (Rennes); -**loRa antennas:** installed in 4 high buildings for optimal coverage (Ouessant); -**Sensors:** installed in the targeted public services buildings.	The data connection is translated into information about energy consumption and environmental measurements (temperature, humidity, CO2…). It allows the users (10 public services buildings) to quantify potential energy savings and therefore establish action plans such as rationalization of radiator's operation, buildings renovation…
Consumption-Production interactions	Technical solution for automated control of **the electric heating** in 4 public services buildings	The system consists of: -a web management platform; **-Local supervision:** allowing to adjust the operating mode, provides information (temperature, electricity consumption…), plans the use according to occupation time slots; **-a LoRaWan** gateway allowing the information from the sensors and the local calendar to be fed back to the software platform, as well as to go down from the platform to the buildings; **- A PLC comprising** the program for regulating and controlling the heating equipment; -**Actuators** for heating equipment's control; -**Sensors** for heating regulation data transmission.	The heating is regulated locally by the controller, based on the local temperature measurement, by controlling the heating power of the radiators in each zone: -if the temperature is below the upper threshold of the setpoint, the radiators operate; -once the upper threshold is reached, the radiators are switched off.

4.1 Results

These devices allowed to measure the electricity consumed by the targeted buildings, but also to measure consumption by categories: heat, lighting, outlets… this specific option makes it possible to identify energy-intensive equipment. It was therefore concluded that during winter, electricity consumption increases considerably, and that this increase is associated with heating (as other consumption remains the same between winter and summer, ex fridge, TV, etc.)

These types of sensors allowed to analyze the coupling energy data and the use of a building. For example, the library was heated continuously while the building was occupied occasionally over the observation period.

In fact, the sensor allows to collect a large amount of data but doesn't have an impact on consumption.

The experiment took place from march to April 2021, while a lock down has been established in France. Which had an impact on the occupation of public services buildings.

by looking at energy consumption data of the townhall and the library of Ushant island, a marked decrease in electricity consumption was observed in the library (38%). The townhall on the other hand has increased its consumption by 12% during the experimentation. Townhall data were therefore analyzed more precisely and it was concluded that, compared to the current situation with the manual control, the solution can in fact increase consumption for intermediate periods (spring & autumn) as in cold days, the solution seems to significantly reduce electricity consumption.

A longer period of experimentation is recommended (the whole winter period) before validating this statement.

In addition to the deployed technical actions, ICE partners experimented devices that allow the distribution of information intended for users/consumers/inhabitants. This type of action was deployed both in Ushant island and the UEA campus.

In this section, a summary of the experimentation of **Smart Heating Technologies** (SHT) deployed in the UEA campus will be presented.

The experimentation of the SHT lasted 26 weeks, it was deployed both in dormitories and two living labs. This technology allows:

- ✓ a cost-effective way of attaining the optimal control of heating as it is designed to be easily connected to existing systems wirelessly;
- ✓ control of heating in each zone (room) following specific user needs and habits;
- ✓ a real-time optimization depending on outdoor conditions, the occupant's presence…;
- ✓ an effective and simple way of managing while being aware of the effect that occupant actions cause to the system performance:
- ✓ a comparison of a single user profile with that of other similar users and, thus, offer an opportunity to develop an understanding of energy-related needs and practices.

In the case of UEA campus, the implementation of the SHT led to savings in gas consumption over the period of experimentation. **Up to 40% energy savings** were observed at one of the Labs comparing to the control group at the same location between week 4 and week 14. However, **there was bounce back in energy consumption after week 14 at both Living Labs**, when higher energy consumption than the control groups were observed.

A survey was carried out among the residents of the campus for a for a more complete evaluation of the technology.

The survey showed that the use of the SHT gradually reduced, it went from several times a week at the start of the experimentation to less than once a week over the mid-term of the project.

Consequently, the frequency of using the automatic control features dropped significantly towards the end of the experimentation.

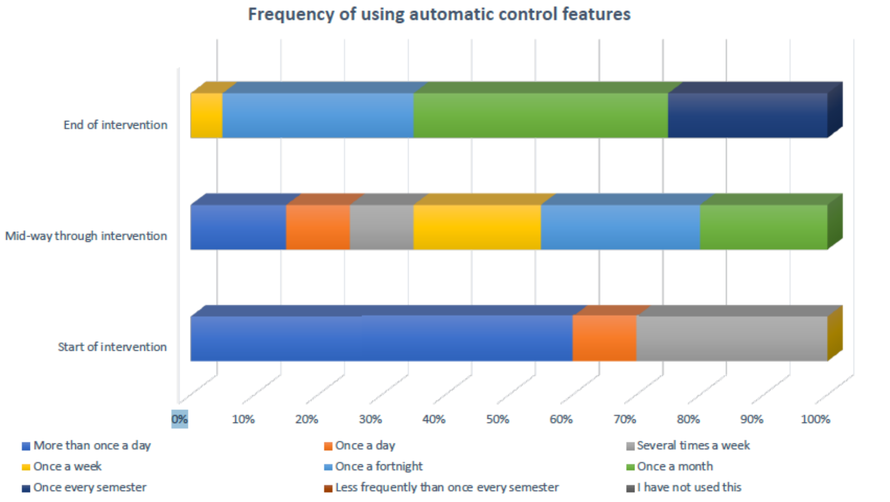

Figure 4: Reported frequency of using automatic control features

Overall, adopting SHT represents few challenges. Some are technology related and others are linked to the user's experiences in adopting new technologies. In the specific case of the UEA campus, the challenge was likely behavioural for two reasons:

- ✓ students are used to have centralized heating system with no precise control over room temperature and did not need to pay for the service;
- ✓ students might not feel the required level of ownership over the infrastructure changes happening on campus.

5. Proof of concept and transferability

The ICE methodology approach presented in Figure 1: Schematic view of the ICE methodology approachFigure 2 is mainly destinated to public authorities or utility compagnies. Because the technology, expertise and implementation schemes will often be designed by private compagnies, it is essential to include a wide range of suppliers capable of implementing a community energy scheme.

At this stage of the project, ICE partners led the reflection around an approach allowing companies to be part of this ecosystem of suppliers.

To do so, they first identified the breadth of skills that a community energy scheme requires then they described the value potential of compagnies likely to offer relevant skills.

Breadth of capabilities likely to be involved in planning, implementation and operation of a community energy scheme:

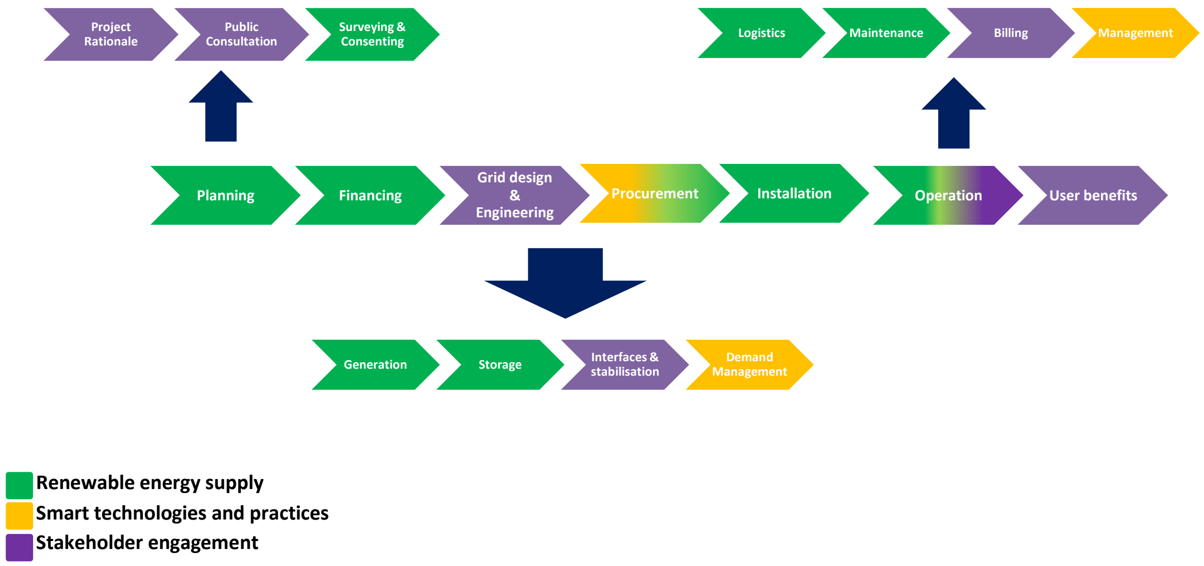

Figure 5: Value chain highlighting supplier opportunities as the project advances

The value chain outlines the main activities and challenges from the initial planning stages, through project implementation, and leading to planned users benefits. This map highlights as well the breadth of expertise likely to be required.

Relevant opportunities to specialist suppliers were therefore identified for each link of the value chain.

- ✓ Planning for example, includes multiple outsourced services such as surveying, public consultation, and assessment of options;
- ✓ Grid design and engineering: There is, a diverse requirement for expertise, services and equipment supply. Such suppliers will be involved in the design and optimization process, and subsequently may be involved in the procurement of equipment;
- ✓ Operation, including maintenance: the operational phase requires inspection, maintenance, repair, upgrading and expansion, along with associated management of the complete system operation.

- **Value Propositions for Participants in Value Chain:**

in order to mobilize the entities involved in this value chain to commit to a project, ICE partners highlight **the identification and validation of the motivations** as a key stage of the methodology.

The aim of this methodology is to achieve a fit between: Customer priorities that could be satisfied by the company, and the product/service to be provided by the company.

Although the starting points for this supply chain structure were offshore wind projects, a simple renaming of some components has created a structure with applies equally to marine current and tidal projects.

A database of businesses was created, based on the ICE labeled companies and the breath of capabilities identified and census work carried out by the partners. The identified companies are those likely to become suppliers into the growing marine renewable energy system market. Not only for isolated territories, but also ports, campuses …

This allowed to build a **skills portal** including a categorization method of the capabilities of companies thus enabling organizations to seek specific capabilities.

The skills portal was built withing the framework of ICE project and around experiences from other programs (Rampion Offshore Windfarm supplier portal, TIGER project which focuses on the tidal energy market, Offshore Wind Growth Partnership). The aim of this coordination is to optimize inter-operability between different portals and avoid unnecessary duplication.

The registered companies are classified following 5 categories and 12 subcategories:

Table 4: a summary of capability categories listed in the skills portal

Tier 1 Categories	Description	Tier 2 categories
Project Development and consenting	Development and consenting services, environmental, resource, metocean, geo/geophysical surveys, engineering/consultancy	Consenting studies (surveys etc)
		Development / engineering studies
Turbines	Supply/manufacture of turbine components and sub-assemblies including the nacelle, rotor and support	Generators (turbines etc)
		Structure
Balance of plant	Supply/manufacture of CAPEX components such as foundations,	Foundations
		Cabling

	structures, anchors, moorings, onshore works and operations bases	Offshore sub-station
Electrical Infrastructure	Supply/manufacture of electrical infrastructure such as cables and on/offshore substation	Onshore sub-station Energy storage Micro-grid systems
Installation, Commissioning and Decommissioning	Assembly, installation and commissioning of complete system. Decommissioning, removal and disposal.	Installation & commissioning Decommissioning
Ports and Logistics	Ports, harbors and provision of port/quayside services and onshore logistics	Ports & logistics
Operations and Maintenance	Asset management including scheduled and unscheduled inspection and maintenance tasks, electricity sales, admin, marine operations (including vessels).	Inspection, maintenance & repair Vessels & marine ops
Supporting Functions	Supporting functions such as specialist professional services, training, accommodation and enablers	Training & support services
Innovation	Research centres, R&D focussed technology business and academia	Innovation

Companies operating in fields listed above, are invited to register to the portal in order to identify and be identified by potential customers and collaborators.

In parallel and in order to develop the transferability aspect of the ICE methodology, ICE partners identified territories, other than the pilot sites, likely to benefit from methodology. In addition to island territories with challenging energy supply, further types of territories were included: University campuses and ports.

Thus, 24 NIZ (Non-Interconnected Zones) were identified according to 4 main criteria:

1- System is isolated from surrounding systems;
2- System can generate between 10 KW and 10 MW;
3- The population living in the territory served by the system represents a small proportion of population politically affiliated with the territory;
4- The distribution system capacity covers the needs of the demand, but the transmission network is not necessarily isolated from the national grid.

Figure 6: Mapping of the 24 identified NIZ

It was observed that each territory has its unique characteristics (geography, technology and energy, politics, socioeconomics…). Also, some difficulties have been encountered such as lack of complete data for some territories. Therefore, and to conclude the transferability aspect of the ICE methodology, ICE partners agreed that this work has allowed:

- ✓ The development of a blueprint for communities to use in decarbonization energy system plan;
- ✓ Highlighting a very substantial supply chain, which justifies the economic value of the ICE project;
- ✓ Concluding that territories have specific characteristics, and therefore specific needs. Which means that each territory may benefit from the ICE methodology, but in its own specific way.

6. Consumer engagement

The social or community acceptance of sustainable energy innovations is more than just a welcome feature that helps project development. Energy projects will not be successful unless people adopt and use the necessary infrastructure and technology, modify their behaviour to accommodate the (renewable) energy supply, lower total energy consumption, and accept regulations relating to a sustainable energy transition.

6.1 Consumer engagement at the UEA

A study was carried out at the UEA in order to provide a critical overview of the role of UEA's community (staff and students) in sustainable energy transitions. To do so, ICE partners addressed two main research questions:

- ✓ **In what ways are members of staff and students across UEA willing to support a sustainable energy transition?**

This question was addressed through a questionnaire survey that was distributed among the UEA community. The questionnaire included basic information questions, energy, behaviours and practices-related questions, energy experiences related questions…

- ✓ **How can members of the UEA community engage effectively with innovative smart grid technologies to make their everyday practices and behavior more sustainable**?

ICE partners have recruited 40 students residing on UEA's campus in order to design a living laboratory. The aim of this living lab is to explore the way student residents engaged with SHTs (Smart Heating Technologies) that was developed within residential buildings on the UEA.

-the answer to the first question came positive. In fact, individual members of the UEA community overwhelmingly share a concern about environmental problems and overconsumption of energy and engage in several sustainable energy practices.

The survey results highlighted that energy users on the UEA campus generally have:

- Enough knowledge and understanding about energy;
- Appropriate attitudes and values (the significance of personal decisions and actions);
- Appropriate intentions and behaviours;
- …

Although, simultaneously the research uncovered multiple evidence of persistent and widespread "value-action gap". This is explained by the inability of individuals to adopt additional sustainable practices considering multiple barriers to action, due to assertions that institutional and structural factors oftentimes undermine people's capacity and willingness to take action.

-The analyse of the second key research question highlighted that "domestication theory" is extremely valuable in identifying and distinguishing between the different types of work students perform when domesticating smart home technologies. However, this study pointed out the challenges of properly and fully domesticating new technologies.

In a context of claims that SHTs can result in significant energy gains whilst enhancing comfort, four core themes emerged from the engagement carried out with students residing on the UEA campus:

- Smart heating technologies are technically and socially disruptive;
- SHTs require forms of adaptation and familiarization from householders that can limit their use;
- Learning to use SHTs is a demanding and time-consuming task;
- There is little evidence that SHT will generate any energy savings and, indeed, there is a risk that they may generate forms of energy intensification in the longer-term;

6.2 Consumer engagement in Ushant

The consumer engagement was also analysed in the second pilot site, Ushant. Four surveys were carried out with the objectives of:

- ✓ Gain access to representations and practices linked to energy production and use;
- ✓ Understand the energy infrastructure of households and how they were used;
- ✓ Define the feelings of residents about various renewable energy sources and observe changes in acceptance of each technology;
- ✓ Promote initiatives about reducing energy use, more rational energy use, and optimizing energy production from renewable sources.

The surveys were operated by "Les îles du Ponant" via questionnaires about energy and energy practices.

These surveys allowed a solid measurement of how Ushant's population perceived energy transition. In fact, due to the insular nature of the island and the proximity with the fuel-powered power station, residents are well informed of the way electricity is produced.

Also, a large majority of the residents are aware of the polluting aspect of the fuel.

Overall, the perception of renewable energy in Ushant Island is very positive, with 100% of respondents stating they are in favour of solar energy projects on the island. Also, about 80%-90% stated they were in favour of tidal energy projects.

Meanwhile, only 50% are in favour of wind energy projects, versus 80% in 2018. This drop can be explained by the emergence of a project led by a private company in 2020-2021, which created a division of opinion about wind energy solutions.

It should be noted that there is not a direct match between the more economically feasible technologies and those which are popular. Wind and solar PV are the most commercially mature of the technologies, while wave and tidal are still moving from the pilot stage into the early stages of industrialisation. This may prevent some issues with conflict as to what can be commercially deployed and may limit adoption.

The resident's opinion about renewable energy is largely influenced by the high cost of electricity production on the island. Which makes it easier to launch pilot energy programs. Most residents expressed a clear interest in such energy pilots (savings, production, change in uses), and a willingness to be involved in the energy transition of the island.

6.3 Links and comparisons with external communities: the case of public participation

In order to compare the public participation in several communities, a comparative systematic literature review was carried out. It covers seventeen international case studies of public participation in island energy transitions.

The review explores the characteristic features of island communities relevant to energy projects and consultations, the successes and shortcomings of community engagement in island energy transitions, and the adaptation of 'best practice' engagement principles and practices to promote fair and constructive discussions on the development of marine and terrestrial energy sources.

Overall, the island communities reviewed appeared to share features with many mainland communities where engagement exercises have taken place on energy projects. Among the list were difficulties with the idea that islands possess obvious communities, when islands – like most geographically defined communities – are assemblages of groups and individuals with different forms of engagement with the local region that contribute distinctive experiences, knowledge, values and priorities.

The seventeen case-studies derived from peer-reviewed academic literature point to practical problems of engagement that are experienced in both island and mainland regions but are intensified in isolated territories. Qualitative differences between island and mainland areas may not be that major, and recognizable common themes exist around: building trust, capturing and respecting diversity of views, and a need for sensitivity towards each community's perceptions of the economic and social effects of energy projects on locally-significant industries, aesthetic values, and community cohesion.

By comparing public participation in the sustainable energy transitions in both Ushant and Tilos (Greece) scepticism about the practicality of public participation was highlighted. In fact, participation practices are, ultimately, a product of the complex interplays between rationales for participation, power imbalances, social structures, and institutional settings that tend to limit the emancipatory potential of public participation.

ICE partners suggest that meaningful public participation in (island) energy transitions should be prioritized rather than adopting an abolitionist stance towards the challenges of participatory practice.

According to ICE partners, particular attention should be given to public participation issues in order to:

- ✓ Develop a more nuanced and dynamic understanding of how different contexts (historical power, political relationships community characteristics…) shape participation practices;
- ✓ Uncover diverse forms and otherwise hidden case-studies of societal engagement with sustainable energy solutions pointing to the fact that the public is interested in energy-related issues and not just apathetic or a barrier to energy transition processes;
- ✓ Better understand additional forms of ongoing societal engagement around energy and climate change, such as everyday commitments to use smart or renewable home technologies;
- ✓ Critically explore whether energy justice and energy democracy principles that currently constitute the focus of energy policy at an international level are being adequately incorporated in energy transition processes on the ground;
- ✓ Cross-fertilize best-practice engagement ideas from across the multitude of different energy transition projects currently in development at an international level.

6.4 Consumer to prosumer transition

In order to understand the recent developments on policy and regulatory framework shaping the role of consumers in energy transition, ICE project focused on cases of the European Union, UK and France.

This provided a detailed review of the EU, UK and French policy and regulatory environment related to energy consumers and the facilitation of their transition to *prosumerism*. In fact, any individual using energy is essentially an energy consumer and it is safe to say that we all belong in this category. While we use energy differently and our engagement with energy use varies, there are certain broad steps that can describe the gradual progression of an energy consumer to an energy prosumer.

Recognizing that *prosumerism* is not achievable overnight but rather requires a gradual development calls for a closer look at the early stages of energy markets, when an individual would only be described as a **consumer** (and not a prosumer). That is the state where most energy users still are and probably all have been up until approximately 10 years ago. A typical example would be a household that is connected to the energy systems for electricity and gas and enjoy a regularly billed access to these commodities. The household does not have a choice of multiple energy suppliers, they can only use the services of a regional (or national) company.

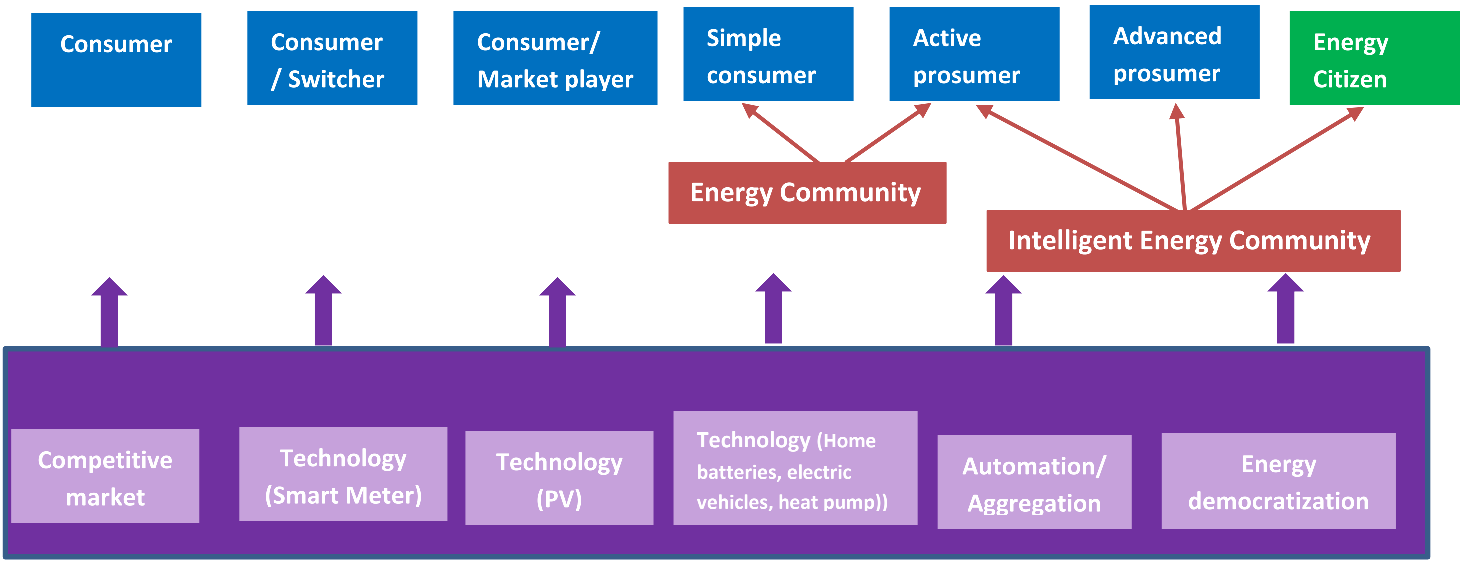

Figure 7: Energy consumer engagement pathway

The pathway analysis provides a heuristic approach to the journey energy consumers take while they navigate the new regulatory and technological landscape. It is not meant as a deterministic route and indeed within the analysis alternative pathways are demonstrated. This analysis led to the necessity for highlighting the steps and their enabling conditions, either in the market or in technology or in the broader regulatory environment.

7. Conclusion

There is considerable potential for islands to go over to having their electrical supply provided from low carbon renewable energy generation, either in total, or to some substantive fraction of their total consumption. In the European locations in which we were dealing the main key technologies are wind and solar energy, and this is likely to be truer now than it was when the assessment was carried out a few years ago. Storage is also likely to be fundamental to islands which do not have a physical connection to a mainland electricity provider. The use of storage tends to place additional stress on system cost, but this will be increasingly mitigated by falling storage costs. It is worthwhile to keep supporting wave and tidal technologies a part of national efforts in driving more renewable capacity, but it is unlikely that wave and tidal will become commercially viable for island use in the near future.

The study also highlighted the complexities that can be added by particular approaches to regulation and how regulatory systems created with mainland applications in mind can throw up unexpected consequences for islands. The French system of having similar electricity costs for all French citizens, regardless of location protects the island consumer from high local costs, but massively reduces the incentive for consumers to switch to renewable energy. It is not clear whether the French monopoly provider is incentivised to reduce costs by considering renewables. The UK situation means off grid islands are exposed to higher costs, which is an issue in itself, putting inhabitants at risk of fuel poverty and the attendant issues this throws up. However, this means they will look at alternatives that may save money. The issue then becomes whether they can access the capital to introduce the technology. The UK situation is different for off and on grid islands for this reason.

There is also a case for including more consideration of low carbon heating in the assessment of island renewable energy potential and consumption. The switch may put greater pressure on getting to 100%, since it may drive up overall electrical demand, but it may offer more options for system balancing and again reduce reliance on imports of fossil fuels. Including heating to a greater extent also puts more emphasis on improving the material of island buildings, supporting energy efficiency and driving down overall household costs and demand and making it more likely the inhabitants can live comfortably. The subsidised nature of French electricity supply should make it particularly of interest for a shift to heat pumps since it means many French island households already use electricity for heating, and a shift would reduce heat demand by 65-75% for each household moving to a ground or air source heat pump.

Technical solutions are realistic for isolated territories, even with an apparently lower market or impact. The current situation that involves mainly importation of fossil fuel, leads to high cost of energy production. The development of renewable energy, mainly intermittent, needs smart grid technologies (storage and intelligence), which also have a price.

However, technical solutions are relevant on isolated territories, especially testing them first on isolated territories. The ambition to convert energy production to 100% renewable seems to be quicker and easier achievable on small isolated territories first, and then replicate best solutions on connected area.

The ICE project also highlighted the importance of promoting SMEs specializing in renewable energies. In fact, within the framework of a survey carried out among companies having benefited from ICE financial support (ICE call for projects), 2 out of 3 projects could not have been implemented without this funding.

The surveyed SMEs also underlined that there are few initiatives such as the ICE call for projects to contribute to the advancement of sustainable energy projects for isolated territories. They also considered the call as a “simpler process to access European funding”.

The Intelligent Community Energy project has been an excellent example of how tailor-made solutions for low carbon energy can indeed deliver benefits to remote communities both as application testbeds and as owners and developers of these solutions. Both pilot sites have greatly by the experience of engaging on this project, both as demonstration sites and from the experiences of and collaboration between the project partners and stakeholders. The project’s legacy is one of regional innovation for low carbon energy and sustainability that can be best performed through the strong links that the consortium has developed with partners inside and outside the FCE area.

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