ERNACT SMARCTIC

Business Model Analysis

September 2022

Contents

1. Introduction

The “capitalisation and sustainability” workpackage of the SMARCTIC project builds on the previous experiences, outputs and deliverables developed in the project to ensure sustainability of project outputs after the project’s lifetime and achieve long-term effects. The project’s ambition is to be a kick-starter for other NPA communities to adopt the smart energy management model, develop innovative energy solutions, become more energy efficient, and address current energy challenges.

A business model including the specifications and scenarios for NPA territories to join up and make use of the smart energy management model will serve as a reference to target new NPA communities to join, apply, and sustain the Smart Energy Management Model. The capitalisation strategy will be carried out at 2 geographical levels. Regionally, all partners will target their stakeholders to obtain buy-in, on one hand to sustain the new smart energy solutions piloted in the project, and on the other hand to extend them to new users, and to develop new smart energy solutions after the project has finished. Transnationally, the goal will be influencing those responsible in other NPA regions to adopt the smart energy management model, thus expanding and enriching it with their participation and contributions.

The project will target the relevant decision makers such as energy managers, responsible of city/town planning or other public infrastructure owners to demonstrate to them the advantages of applying the model based on real results coming from the pilots. The general public will be also approached to demonstrate to them the benefits of the smart energy solutions implemented. The business model analysis directly contributes to Objective 3 (Increase NPA's communities innovation capacity to deliver energy solutions). The analysis is conducted on a transboundary basis and provides recommendations for new ways to deliver energy solutions that are adapted to the specific needs and challenges of NPA regions.

2. Project Overview

The SMARCTIC or “Smart Energy Management in Remote Northern, Peripheral and Arctic regions” an interregional project funded under the Northern Periphery and Arctic Programme 2014-2020. Commencing in July 2019, six partners from Ireland, Northern Ireland, Sweden, Finland, and Iceland are working together with the goal of increasing the use of energy efficiency and renewable energy solutions in housing and public infrastructures in remote, sparsely populated areas.

The partners are working together on a transnational basis to:

1. Provide a Smart Energy Management Model (SEMM) suitable for NPA communities
2. Build & test the effectiveness of new smart energy solutions
3. Increase NPA's communities’ innovation capacity to deliver energy solutions
4. Disseminate findings outside of the partnership

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Affordable, reliable and efficient supply and usage of energy is a major challenge for Northern Periphery and Arctic communities. The SMARCTIC approach is to focus, not on individual buildings or public infrastructure, but on the entire stock of buildings and public infrastructure within the community to minimise overall energy usage within the geographic boundary.

The main output in implementing the above approach, is an ICT technology based "Smart Energy Management Model" adaptable for deployment in a typical NPA community.

SMARCTIC is facilitating innovative energy pilots with companies and researchers; enabling communication between energy stakeholders to build awareness; trialling new solutions and changing energy behaviour; collecting and sharing energy data from multiple sources (buildings and houses, public lighting, foot traffic, etc.) This will drive achievement of the project's main result: 5 NPA regions with enhanced capacity to deliver high-quality energy efficiency and renewable energy solutions in their communities.

3. Pilot Descriptions

The six pilot actions are described in this section:

- Smart Energy Grid (Derry/Strabane) – Virtual Power Plant/Smart Grid Demonstrator
- Intelligent Energy Management of Public Indoor Environments (Donegal)
- Off-grid Solar PV and Smart Energy Storage Management (Donegal)
- ICT-based Energy Management (Västernorrlands)
- Adaptive Energy Management System (Lapland)
- Indoor Air Quality (Iceland)

Below is a description of each pilot, its regional context, stakeholders, main components and objectives.

3.1. Virtual Power Plant/Smart Grid Demonstrator (DCSDC, N. Ireland)

3.1.1. Derry and Strabane's regional context

Derry City and Strabane District Council (DCSDC) have decided to act locally while thinking globally and have recognised the need to tackle climate change by reducing greenhouse gas emissions to minimise future global warming and being ready for the unavoidable impacts of climate change in the City and District through adaptation planning. DCSDC recently declared a Climate Emergency, launched its Climate Change Adaptation Plan, established an All-Party Working Group and developed a Climate Change Pledge committing the council to climate action.

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DCSDC has competence in delivering initiatives to enhance the region for all citizens. They have a significant track record applying Smart City solutions in the region, which has been recognised at EU level, including implementing measures to reduce energy consumption in council buildings and the installation of IT systems to collect data and monitor energy usage.

The main stakeholders for this pilot are Derry City and Strabane District Council, the building managers and ultimately the general public. With the new pilot in place, the council will be better able to measure and manage energy consumption and costs across a set of council buildings, understand the possibilities for solar and wind energy generation in the region and identify energy storage options and their effects on energy efficiency.

3.1.2. DCSDC pilot overview

The pilot action is the creation of a Virtual Power Plant/Smart Grid Demonstrator that integrates renewable energy, battery storage and smart energy management, in the form of sensors and smart meters, to monitor consumption and learn from user behaviour. The pilot project will consist of an electricity and heating network that will power and heat a number of public buildings within a specific geographic boundary. Artificial Intelligence technology will record consumption data in conjunction with external weather conditions, energy performance of equipment, and learned user profiles, to maximise energy efficiency and optimise the consumption of renewable energy produced.

The main objective is to create the virtual power plant so that the impact of energy consumption and costs can be identified and analysed across the council buildings. Research into wind and solar energy generation in the northwest region will also be conducted, as will energy storage options and their effect on energy efficiency within the virtual power plant. Data modelling will be conducted to strengthen the outcomes of the research. The existing council building management system will be upgraded as part of this pilot also, to ensure a higher degree of visibility into building operational settings and controls that directly affect energy usage in these high-consuming buildings. Optimisation of the operational controls and settings will identify where improvements can be made to reduce energy usage and energy costs. Training in the use of the upgraded system will ensure building managers and other relevant users can modify and make corrections to settings as needed.

3.2. Intelligent Community Energy Management - (DCC, Ireland)

3.2.1. Donegal's regional context

Donegal County Council (DCC) has committed, through its Energy Policy, to achieving energy performance improvements throughout all its premises, plant and equipment. DCC is committed to continual improvement in energy performance and has provided a framework for setting and reviewing energy objectives and targets as part of an Energy Management

System that conforms to ISO 50001. Energy management is a systematic approach to managing energy and continuously improving energy performance. It concentrates on reducing usage in the first place through improving behaviour and implementing simple controls, followed by projects to reduce usage. This can be complimented by the use of renewable energy, but priority is given to conservation. The purpose is also to minimise energy use without negatively affecting service levels for citizens or staff.

3.2.2. DCC's "Intelligent Community Energy Management of Public Buildings" pilot overview

Donegal County Council's goal with this project is to create a smart pilot that monitors and optimises the indoor environment in public buildings within a local authority geographic area. This consists of low power, long range, and secure connected Internet of Thing (IoT) devices, with geolocation features, that can penetrate dense building material to monitor municipal operations and energy consumption. Visualisation tools, GIS technology, and Artificial Intelligence (AI) facilitate building managers in ascertaining when thresholds are exceeded so they can optimise indoor environments to improve working conditions and increase energy efficiency. Primary stakeholders of this pilot action are the public infrastructure owners, building managers and the general public.

3.2.3. DCC's "Off-grid Solar PV and Smart Energy Storage" pilot overview

Donegal County Council's goal with this component of the project is to analyse data collected through energy audits and the use of connected Internet of Thing (IoT) to determine the best locations for solar panel installation to increase energy efficiency. Solar panels and insulation are being installed in three sites based on the results. Two of the solar panel installations include batteries. Primary stakeholders of this pilot action are the public infrastructure owners, building managers and the general public.

3.3. ICT-based energy management system for densely populated communities - (RCV, Sweden)

3.3.1. Västernorrland's regional context

Regional Council of Västernorrland (RCV) is working systematically to improve the environment at all places of work in Västernorrland county. Personnel have been given environmental training, and there is an environmental representative at every workplace, who is the driving force in these environmental efforts. In addition to the internal environmental work, RCV is working to actively participate in progressing the status of sustainable development in the areas of environment and energy, in partnership with other stakeholders in society. RCV collaborates on a regional level with the other county councils in northern Sweden, and on an international level in this and other EU networks.

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Furthermore, the Regional Energy Agency is part of RCV and is one of the 15 energy agencies in Sweden. Its main objectives are to increase the use of renewable energy and to promote an efficient use of it.

RCV is working with the regional strategy for ICT and regional growth. The Regional Council is participating in a number of regional and national projects to increase energy efficiency and to switch households to more environmentally friendly behaviour.

3.3.2. RCV pilot overview

The aim of the RCV pilot is to use smart technologies to measure, monitor and improve energy efficiency in public buildings in Kramfors municipality.

In this pilot RCV is planning to measure energy consumption for the whole vocational-training area (vehicle program workshop), including separately for different types of infrastructure (HVAC, lighting) and machines that are used there (gates, compressors, lifts etc.). Data from other sensors such as temperature sensors, CO2, CO-air quality sensors will be also collected. IoT based system with energy and indoor/outdoor data will be built and fed with the sensors data in order to propose solutions for improvements regarding energy-efficiency (other type of smart sensors can be also suggested by the supplier).

During the pilot we will test possibilities to save energy e.g., by using data to assess when it is optimal to open gates to warm up the room, instead of using heating system. We already have in mind some potential solutions, but some others can emerge during the pilot. The intention is to use sensors data (e.g., indoor/outdoor temperature) to try to optimize energy use in the workshop: to adjust the lighting, ventilation, and heating requirements according to data from the sensors.

The core element of the pilot is, however, education and awareness rising. Data is being used to influence behaviour change among students in the program. The idea is that these students already have an interest in technology/mechanics, and they can use their knowledge and experience from the pilot in their future work (e.g., when they have their own car workshop and want to save energy).

Students will have access to smart screens that will show them how energy is used and give tips for improvement (e.g., when they should open/close gates or switch off machines). Energy experts and teachers are working together with students to:

- Better utilise the existing data and propose new solutions (better explore their needs and ideas)
- Build new habits among program participants that promote more energy-conscious behaviours

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At the end of the pilot, relevant data on the energy use in the workshop will be gathered and analysed to determine how it changed during the pilot as the result of students' initiatives and smart solutions tested.

Recommendations on how to use different types of data in school environment will be created, in order to both ensure better energy efficiency, but also to work with students on awareness raising regarding sustainability issues.

Testing of smart energy screens in the pre-school (Skarpåkerskolan) is also part of the pilot, where children will have access to screens showing real-time electricity consumption that stimulate the children and the staff at the pre-school to become electricity smart.

The outcomes from the pre-school will complement those obtained in the vocational-training environment by adding another group of youth and showing the importance of working with the youngest groups towards more sustainable behaviours.

3.4. Adaptive Energy Management System - (LUAS, Finland)

3.4.1. Lapland's regional context

Located in north of Finland, the regional size of Lapland is of 100,370 km² (92,667 km² land and 7,699 km², water). The population is of 177,000 people, while the population of reindeers is about double that! The biggest city of the region is **Rovaniemi**, with 63,000 inhabitants. The main sources of energy for light, heat and other essential public/domestic services in the region are hydropower, as well as local wood fuels, peat, and forest industry effluents.

Fuel poverty is not an issue in Lapland. However, this region also has policies, strategies, and targets for improved energy efficiency. The objective is to reduce CO_2 emissions and increase the use of renewable energy. Lapland's energy vision is to utilize Lapland's large energy resources so that its know-how and livelihoods develop, and energy solutions support Lapland's vitality. Investments are being made in competitive energy solutions that support industries and the regional economy, utilising northern know-how and innovation capacity. There is a desire to diversify energy production, based on a variety of production technologies and fuels, so that the full potential of the region is exploited, albeit in an environmentally friendly and sustainable manner, respecting Lapland's unique nature.

3.4.2. Lapland University of Applied Sciences (LUAS) pilot overview

LUAS has developed a pilot initiative to increase energy efficiency and the use of renewable energy solutions in the Finnish Lapland public buildings.

The LUAS pilots include an ice hockey hall and football hall which are next to each other. Both buildings have high energy consumption and Ounashalli (football hall) has minor problems with

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heating as the indoor temperature drops a little too low sometimes. The aim is to improve energy efficiency in these large buildings that contain areas of high energy consumption.

For example, consumption at the Ice Hockey arena (Lappi Areena) is difficult to manage because it has spaces that require heating and spaces that require cooling at the same time. Some of the heat generated in the cooling process is directed out of the building. So, through this pilot Lapland University of Applied Sciences is trying to find new solutions to reuse that excess heat, either in the same building or in the building next to it.

The pilot is based on smart city technologies that bring together data and services from multiple public sources to improve a community's capability to facilitate changing user needs and increased energy performance. They will use predictive analysis to promote proactive building maintenance and performance optimisation.

Heating optimization
Most of the energy used is for heating, and especially in the winter the public buildings have a common problem of either over heating or under heating. One cause of the problem in Finland is the temperature variation from -30 to +30 degrees and another cause of the problem in these kinds of spaces is the variety in the number of people in the space simultaneously. Real-time outdoor and indoor temperature measurement shows the reaction of the room temperature to the prevailing outdoors conditions.

Reusage of excess heat
New sensor configuration has been completed and the system is in use. With the new configuration LUAS are getting a lot more and better data than previously. E.g., much more accurate energy consumption readings and amounts of excess heat and how much of it is reused during the days.

It seems that the amount of excess heat is even more than anticipated and the next step will be to calculate the most efficient ways to reuse it, potentially in Lappi Areena or in Ounashalli, which is located right next to Lappi Areena.

Solar energy
LUAS are also working on calculations on several different sized solar panel plants based on the actual amounts of energy produced by solar panels in Rovaniemi, the costs of panels installed and payback times.

Energy consumption is so high even in summertime, that no matter how big a solar plant they build all the energy will go straight into use.

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3.5. Smart solution for indoor air quality in Arctic/Sub-Arctic buildings - (OS, Iceland)

3.5.1. Iceland's regional context

Even though temperatures in Iceland can be low throughout the year, it really starts feeling like winter properly in late October or early November, when the darkness creeps in. The average number of daylight hours during winter months deeply influences the Icelandic people's habits and routines and, as a consequence, the time spent indoors and their energy consumption.

In the northern part of Iceland, close to 66°N, the sun stays below the horizon in mid-winter all day, although there is 'grey sky' for a number of hours. At night, temperature in winter can drop to -20°C. This situation means that Icelandic people stay indoors for longer periods of time and, consequently, their energy consumption increases considerably. A standard family may only go outside for work and shopping during the winter, and therefore, most people spend a lot on their houses, making them as comfortable as possible. The energy consumption is high. However, they use either geothermal water directly or hydro-powered electricity for heating. Therefore, the heating is 100% sustainable and does not involve the use of fossil fuel.

Many households take advantage of this luxury and have their own small spa or hot pot outside. Youngsters in Iceland do not experience cold anymore. Household temperatures are stable year-round, regulated with water radiators that receive ca. 70°C hot water, either geothermal water directly or via a district heating centre, which regulates the temperature with heat exchangers. However, the time spent indoors may be a health concern, and this SMARCTIC pilot addresses the air quality issues in combination with heating energy consumption.

Indoor temperatures range between 18-23°C, depending on the house owner's level of comfort. However, the average house owner is usually not concerned about air quality, and they just open the windows if the air quality is not sufficient. This 'manual regulation' can waste energy by decreasing the temperature indoors, which is then reheated, and the pilot's sensors and devices help to address both issues: preserving air quality without wasting too much energy.

3.5.2. Orkusetur (OS) pilot overview

The SMARCTIC pilot in Iceland focuses on implementing smart city tested IoT sensors and automated technology in small town and village settings. The project is utilising integrated sensors and devices to improve indoor and outdoor air conditions for children, primarily the youngest generations in their school environment, while maintaining sensible energy use and savings.

These sometimes-conflicting goals are managed with 'smart' technology, such as the 'Fresh-r' air heat exchanger, which guarantees indoor air quality while also extracting heat from outgoing air. Fresh-r units are being installed in Borgarfjordur eystri (East Iceland), in a small local school in the town with approx. 100 inhabitants and on the island of Grimsey (North Iceland).

Outdoor sensors are connected to municipality control systems, allowing joint operation and procedures or algorithms to react to unhealthy conditions, such as road traffic or natural changes (e.g., volcanic gasses). The integrated outdoor sensor system is designed to connect to Akureyri municipality data centre.

4. SMARCTIC Smart Energy Management Model

A SMART energy management model (SEMM) was created by the SMARTIC team earlier in this project. This model has the unique characteristics required to be adapted for use in various NPA regions, addressing the issues of extreme climates and sparsely populated areas. This knowledge-based model considers both energy and building management profiles and could be effectively utilised in managing the energy demand response process within all NPA regions. Overall, the model provides a good reference for designing energy consumption optimisation strategies in NPA environments.

The SMARCTIC SEMM adopts a modular approach and depicts the various stages and categories of technologies required for use in energy management and optimisation. This framework allows for the unique requirements of NPA regions to be met whilst emulating the structure of examples from SMART city implementations.

4.1. SEMM Modules

The modules depicted in Figure 1 demonstrate the framework of technology, data and flow on which custom SMART energy management models can be based. Each module's role and function are outlined in the sections to follow.

Sensors

The energy sector is closely interconnected with the building sector and integrated Information and Communication Technologies (ICT) solutions for effective energy management supporting decision-making at building, district and city/regional level are key fundamental elements for making a city/region Smart. Sensors operating via an IoT-based system enhance the interactivity of a building's energy management systems.

Sensors monitor operating conditions of buildings and building equipment and allow for cross-domain data to be harvested for processing by implemented control systems. Sensor networks are seen as the first layer operation in the emerging fields of energy management and are used to detect environment conditions and energy consumption, such as lighting, temperature, humility, electricity, etc.

Generally, most sensors are categorized as:

- Thermometer
- Humidity meter
- Ambient light sensor
- Door & Window sensor (detecting whether the door/window is open or not)
- motion detection sensors (detecting movement in a particular area)
- Energy meter (allowing power monitoring)

The data derived from the sensors will form the basis of information used for analysis and optimization; over time the data will also serve as historical data which can be used in comparison with data produced following implementation of solutions.

Networks

Networks are a key element of SMART energy management as they provide the medium by which data can be transferred and communicated. This communication may be between the point of gathering and the system on which analysis and control will occur or between the sensors themselves. Networks also provide for communication back to devices with control system commands. Specific protocols have been developed for utilisation with IoT devices. For

In application, network technology must allow for wireless sensors, controllers and energy-aware devices to reach through multiple walls, floors and other structural elements. The supporting infrastructure must also have the capability to transfer data over large areas. This is typically achieved through periodic updates although advanced ICT solutions have made real-time updates a reality.

NPA regions the network technology utilised is particularly important as in remote and sparsely populated regions the data may need to be transferred long range, across very wide areas. There are a number of technologies available that are developed for this purpose outlined in section 3.

Data

SMART buildings produce a massive amount of data from a wide spectrum of energy-related sources, such as smart meters, sensors and other IoT devices. With this resource, a data-driven management solution can be developed. There are many technologies and off-the-shelf solutions that can aid the processing of this data.

This multi-disciplinary big data environment enables the integration of cross-domain data, combined with emerging artificial intelligence algorithms and distributed ledgers technology. Semantically enhanced, interlinked and multilingual repositories of heterogeneous types of data are coupled with a set of visualization, querying and exploration tools, suitable application programming interfaces (APIs) for data exchange, as well as a suite of configurable and ready-to-use analytical components that implement a series of advanced machine learning and deep learning algorithms.

The data-driven architecture enables reliable and effective policymaking that adheres to current standards, as well as supports the creation and exploitation of innovative energy efficiency services through the utilization of a wide variety of data, for the effective operation of buildings.

This is achieved through analysis of cross-domain data including the building's data (e.g., energy management systems), energy production, energy prices, weather data and end-users' behaviour, in order to produce daily and weekly action plans for the energy end-users with actionable personalised information. Device controllers that process these metrics, and actuators that perform the appropriate actions (e.g., adjust temperature, air flow, light) to maintain desired settings.

Collectively, sensors and controls (S&C) serve as the operational backbone of cyber-physical systems for building energy management, enabling an organisation's overall energy savings goals through the minimization of preventable energy losses and additional optimization of environmental and equipment parameters.

Mapping

Energy Mapping depicts the consumption of energy over defined geographic areas and can take many forms. This determines energy demand geographically and allows for optimisation with a city/region's baseline energy requirements identified. There are many different innovative approaches to using Geographic Information Systems (GIS) to inform energy planning at a strategic level. By structuring energy issues of an energy strategy thematically and spatially, a matrix approach can help to improve analysis and facilitate discussions about challenges, possible solutions and their effects.

The GIS layers not only make it possible to spatially analyse and visualise current and projected energy demand, but also allow for many more applications. By combining these new map layers with other layers such as spatial representation of areas of deprivation using data from economic and social indices, GIS can be a powerful tool used to combat fuel poverty.

Heat mapping can also be an extremely useful tool in understanding energy usage in a city/region. Heating and cooling make up nearly half of all the energy that cities and regions use. Heat mapping is a method of assessing energy demand in a city, with layers of analysis allowing for informed decision making when planning energy use and infrastructure investment. Thermographic imaging also clearly shows where heat is wasted.

Energy consumption mapping of stocks of buildings combined with an assessment of the state of the buildings also allows for an estimation of the potential energy savings. Where a city/region has mapped the energy consumption and effects of sustainable energy solutions of the residential/business sector, these findings can be visualised and presented to communities in a bid to change energy behaviour.

Mapping is an extremely important element of SMART energy management in NPA regions as it allows for data to be visualised and compared by citizens, communities and consumers. Through this, end users can act on real-time information and make informed decisions relating to energy usage, thus changing energy behaviours.

Community Engagement

This module operates to inform and influence and act as incentive for NPA communities to adopt SMART energy behaviours, encourage organisations and local authorities to implement innovative energy solutions, and allow regions to become more energy efficient and address current energy challenges. Access to and visualisation of the data gathered, and analysis conducted will empower all regional stakeholders to engage in the improvement of energy efficiency. This can be achieved by application of solutions, messaging, workshops, advisory services and other engagement activities.

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Figure 1: SMARCTIC SMART Energy Management Model

4.2. SEMM NPA Adaptability

The SMART Energy Management Model was developed by the SMARCTIC Project Partnership for the specific purpose of addressing the unique challenges of NPA regions' energy consumption. This model presents a modular approach that allows the model to be adapted through the application of the various technologies that are described, resulting in a model that can be adapted for use by all NPA regions.

5. SMARCTIC Pilot Business Model Development Methodology

This section describes the approach to the development of the SMARCTIC business model. The development approach was executed carefully to anticipate and guarantee the longevity of the project's outputs and their impact and to share how they can be replicated by other regions and expanded upon to generate new smart energy solutions.

The business model aims to summarise the value propositions of the project results, the project partners, resources and actions, the design and practical implementation of the SMARCTIC pilot implementations. This document is not only for use by the project partners but aspires to set a methodology for the exploitation of project results and actions in other initiatives and other regions. It is hoped that it will motivate other NPA communities to adopt the smart energy management model, develop innovative energy solutions, become more energy efficient, and address current energy challenges. The deliverable was designed in the last months of the SMARCTIC project after most of the partners had the opportunity to measure the impacts of the pilots.

The content and context for this deliverable were fed through the training, demo sessions and pilot assessments conducted during the project. In addition, activities such as desk research conducted by the deliverable leader and consultations with partners on the best approaches to sustain the impact of the project were deemed useful.

This analysis component of the project targets the relevant decision makers such as energy managers, those responsible for city/town planning and other public infrastructure owners to demonstrate to them the advantages of applying the SEMM model, based on the real results of the pilots.

The project tailored the Business Model Canvas (Figure 2) and applied it in the development of the SMARCTIC Energy Pilot Business Models. Therefore, each service brief is outlined through the value proposition and co-creation journey for durability and scalability of the service.

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<table>
<tr>
<td rowspan="2">Key Partners
Identify the key partners/suppliers/ stakeholders in providing your service</td>
<td>Key Activities
The most important activities necessary to deliver the value proposition
…</td>
<td rowspan="2">Value Propositions
Identify the core value being provided by this pilot. What exactly is your organisation trying to give to stakeholders? What problem are you solving/what need are you satisfying. How is what you offer different from what is currently available?
…</td>
<td>Customer Relationships
What type of relationship do you have with your end users/stakeholders? How do you engage new stakeholders? How do you keep stakeholders engaged?
…</td>
<td rowspan="2">Customer Segments
Who are your target stakeholders? What do they like/need/benefit from? Is it a small niche community or mass market?</td>
</tr>
<tr>
<td>Key Resources
The resources or assets necessary to deliver the value proposition
…</td>
<td>Channels
What channels will be used to deliver the pilot products and services? Supply/distribution/marketing /communications channels
…</td>
</tr>
<tr>
<td colspan="2">Cost Structure
Identify the key costs. How do key activities and key resources contribute to the cost structure? How do costs relate to revenue/benefit streams? What proportion of costs are fixed and variable?
…</td>
<td colspan="3">Revenue Streams
How is income or value generated? And how will that income or value be reported (using what channels)?
…</td>
</tr>
</table>

Figure 2. Business Model Canvas adapted by the SMARCTIC partners

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6. Pilot Business Models Development and Analysis

The partners have shared below three tables providing details of each of their SMARCTIC pilots, in relation to the value they provide, the stakeholders, resources and actions involved in the design and practical implementation of the pilot, and the long-term feasibility and sustainability of the pilot.

6.1. Virtual Power Plant/Smart Grid Demonstrator Business Model (DCSDC)

6.1.1. DCSDC Business Model Analysis

Business Model Elements	**Virtual Power Plant/Smart Grid Demonstrator Business Model** Derry City & Strabane District Council (DCSDC)
Key Partners	Everun trading as Izon Ltd. Building Managers and council staff at Power Generating sites: Alley Theatre / Strahans Road / Irish Street CC / Derg Valley Leisure Centre /Melvin Arena.
Key Activities	• Installation of smart metering in power generation sites • Data modelling of energy consumption in power demand sites • Data modelling of wind power, ISEM market, anaerobic digester plant • Creation of a VPP dashboard showing battery storage capacity, power generation, power demand, grid conditions and power flows between the various grid elements.
Value Propositions	The VPP represents how the council could become less reliant of the national grid and generate renewable energy using council owned assets. The VPP data modelling allows the council to create investment plans for owning or partially operating large scale renewable systems such as a solar farm or its own wind turbine. The modelling emphasises the need for battery storage within a VPP. The software and data modelling/dashboard creation were developed specifically for DCSDC. This information wasn't available before in such a user-friendly manner. The visualisation of energy flows between buildings, the grid and a battery storage communicate what a future energy system would look like.
Customer Relationships	Energy project staff held bi-weekly meeting with the software development company Izon Ltd. The relationship between DSCDC and Izon representatives developed into a very positive one with frequent communications via email and online meetings. Held a series of stakeholder update meetings. Liaised with building managers for access and communication for the install of sub metering in power generation sites.
Customer Segments	Up to date information with regards to how their renewable power systems are performing. The nature of the system dashboard enables the building manager to understand the power demands of their sites. The pilot also identifies areas for future innovative projects. The data from the VPP assisted in the identification of a battery storage installation at the Alley Theatre PV site.

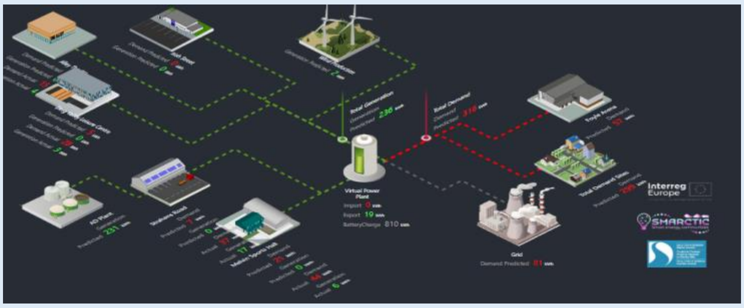
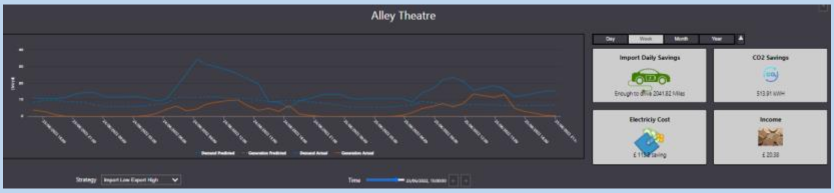
Key Resources	VPP dashboard is available to view on http://dcsdcvpp.izon.live/ 
Channels	The VPP dashboard shows the various power related icons and the flow of energy between assets/buildings and battery storage. Individual data for the power generating buildings is available by clicking on the building icon. A graphical representation of power generation and building energy demand is shown along the bottom of the screen. Information relating to cost/CO2 savings is shown on the right. Data files showing power generation and energy usage in the building can be downloaded for daily / weekly / monthly and yearly information in an excel spreadsheet by clicking on small icons to the top right. 
Cost Structure	The software maintenance of the dashboard software and associated sub metering subscriptions will be maintained by Derry City and Strabane District Council. It is envisaged that the service will be run on an ongoing basis.
Revenue Streams	The dashboard displays the potential energy and CO2 savings within council owned assets.

Table 1: DCSDC Pilot Business Model

6.1.2. Feasibility of the DCSDC pilot action

Indicators	Long Term Feasibility - Virtual Power Plant/Smart Grid Demonstrator
Key Issues	• Funding streams for investing in future renewable projects and battery storage. • Ability for council to buy / sell energy or trade energy within ISEM. • Network operator approval for micro grid and battery storage • Communicating the benefits of a VPP to stakeholders and investors
Key Factors (Internal)	• Change in internal management structures with the Environment and Regeneration Department. • Human resources and funding for progressing the project
Key Factors (External)	• Brexit impact on future participation in EU Interreg Projects and EU Partnerships. • Northern Ireland future energy policy implementation and funding streams to progress future investment. • Network Operator approval to integrate renewables and battery storage onto the grid. Grid capacity issues.

Indicators	Long Term Feasibility - Virtual Power Plant/Smart Grid Demonstrator
	• Energy trading policy for prosumers within N Ireland.
Uncertainties	• Future energy policy both at a national and council level.
Success indicators	• Data from the project has been used to identify another Smart pilot in Alley Theatre. The 12Kw solar PV system will be optimised using 15 Kw of smart battery storage. • The potential to share the VPP outcomes with project partners, councils and energy groups linking in with council networks.

Table 2: DCSDC Pilot Feasibility

6.1.3. Sustainability of the DCSDC pilot action

Sustainability levels	Sustainability - Virtual Power Plant/Smart Grid Demonstrator
	Indicators
Scale up	Identification of future pilots using the data collected and modelled within the VPP
Scale out	Adaptation of the software and dashboard could be implemented within other organisations / councils to develop their own VPP
Scale deep	Understanding has been expanded across council stakeholders. More interest within council participants to incorporate energy actions / renewable integration into daily operations.

Table 3: DCSDC Pilot Sustainability

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6.2. Intelligent Community Energy Management – Donegal County Council, Ireland (DCC)

6.2.1. DCC business model analysis

Business Model Elements	Intelligent Community Energy Management Business Model Donegal County Council
Key Partners	Revere Smart Energy Managers, Barry Sharkey Solar Installations, Gallen Insulation Facilities Management Donegal County Council Stakeholders in the Theatre, Regional Cultural Centre and Libraries
Key Activities	Choice of sites for participation in pilot Installation of smart metering in several Community Sites Setting up of an Energy Management System showing modelling of energy consumed, budget costs and carbon savings Analysis of energy consumption patterns based on bills, EMS output and User behaviour Energy Ratings applied to each site Installation of solar farms, insulation upgrades and thermal glazing at a number of sites
Value Propositions	A sustainable community energy system is an integrated approach to supplying a local community with its energy requirements from renewable energy or co-generation energy sources. The core value of the pilot was to enable Users in a Community to collectively analyse their own energy consumption and then make decisions together to target renewable alternatives for the Community. There is a lack of basic knowledge among stakeholders about how energy works in general and how it can be measured and managed. Stakeholders feel isolated and intimidated in trying to move towards alternative energy resources. Giving them the basic tools to operate as a community and helping to develop a Community Energy plan is crucial and this pilot can demonstrate this. Any attempts in doing this approach currently are generally managed by a national or local body. We are enabling the Community to build the understanding and make their own decisions.
Customer Relationships	We hold regular meetings with the stakeholders in the Community buildings. We also work closely with the facilities management team in Donegal County Council. We keep stakeholders engaged by keeping in regular contact via the Energy Management System e.g., they get alerts.
Customer Segments	Building owners or managers. They like the Energy Management System and the fact that they are not operating alone. A lot of these managers have little knowledge of energy other than paying the bills. They love the fact they are part of an energy Community. They benefit from discussing common

Business Model Elements	Intelligent Community Energy Management Business Model Donegal County Council
	problems e.g., none of the buildings had an energy rating prior to the project, access to the Energy Management System, renewable energy installations, insulation upgrades.
Key Resources	Some investment in sensors and an Energy Management System. Commitment to running and attending regular meetings. Access to external energy advice which the Community group can use
Channels	The Energy Management System is available to purchase along with the Sensors. Information is being communicated via social media channels.
Cost Structure	Key costs are in the sensors and Energy Management System. Key activities consume the majority of the cost whereas the key resources are less but are ongoing costs. There is little cost involved in the actual meetings or distribution of the information. Variable costs will be licenses to access the Energy Management System. The Community owns the sensors when they are purchased. The Solar Panel Installations, insulation and thermal glazing are fixed costs.
Revenue Streams	There is a budget tracker facility within the Energy Management System. As time passes, it will become apparent that the solar installations have had an impact on electricity costs, and these will be reported via the Energy Management System. Behaviour changes have also been implemented since site owners have had access to the Energy Management System. These are more difficult to measure but reduction in energy usage will be reported via the Energy Management System also.

Table 4: DCC Pilot Business Model

6.2.2. Feasibility of the DCC business model

Indicators	Long Term Feasibility - Intelligent Indoor Energy Management & Solar PV/Storage System
Key Issues	Members of the Stakeholder/Community group may change and choose to disengage from the group. Funding streams for any renewable energy alternatives identified for implementation by the group Competition within the group for funding
Key Factors (Internal)	When project is finished it may lose momentum Change in personnel Funding sources

Indicators	Long Term Feasibility - Intelligent Indoor Energy Management & Solar PV/Storage System
Key Factors (External)	This is a small pilot and may be superseded by better external alternatives
Uncertainties	Funding Internal and external policies
Success indicators	Three solar farms have been installed with measurable impact on energy consumption Insulation upgrades have taken place in three sites with measurable impact

Table 5: DCC Pilot Feasibility

6.2.3. Sustainability of the DCC business model

Sustainability levels	Sustainability - Intelligent Indoor Energy Management & Solar PV/Storage System
	Indicators
Scale up	Other sites within Donegal County Council building portfolio can join the pilot
Scale out	Adaptation of the software and dashboard could be implemented within other organisations / councils for use by their own Community Energy groups
Scale deep	This has had a major impact on site owners' attitude and understanding of how their buildings work in relation to energy

Table 6: DCC Pilot Sustainability

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6.3. ICT-based Energy Management – Region Västernorrland, Sweden (RCV)

6.3.1. RCV pilot action business model analysis

Business Model Elements	**ICT-based Energy Management Business Model** Region Västernorrland
Key Partners	Supplier: Schneider Electrics Stakeholder (steering group)/ partners: Krambo (property owner), Charlotte Sandelius Kommunförbundet (kfvn), RVN- Sofia Mackin, Ådalsskolan- Lars Hellström, Skarpåkersskolan-Christine Norgren Nordlöf.
Key Activities	Installations, Workshops, dialog and follow ups with schools and, suppliers and property owners.
Value Propositions	The goal of the project is to reduce energy consumption by: • Establish an integrated ecosystem of tools / data as a basis for the development of smart energy solutions. • Test these smart energy solutions in a public building. • Follow energy development and assess the solutions for continuous improvement (and opportunities for broader implementation). • Test interactive visualization tools for spreading the developed solutions. • Increase knowledge about energy efficient behaviour Provide recommendations for how to better improve energy efficiency in public buildings.
Customer Relationships	The role of our stakeholders is currently relatively passive. As we have had and still have major challenges with our supplier in the project, it is difficult for us to invite new stakeholders in a project that cannot really deliver. We have also had a large turnover of project managers, which makes cohesion somewhat dispersed.
Customer Segments	Today, our stakeholders consist of property owners, representatives from municipal associations, school staff and principals as well as the Head of Sustainability within RVN. If this project was successful, they could have used this as an example to other schools to change both teachers' and pupils' behaviours for the benefit of saving energy.
Key Resources	The key would have been a good collaboration with the supplier. Making sure what was asked for in the procurement was something they could deliver.
Channels	Since this project has not been working out the way we planned we are not highly promoting this project but instead trying to learn from it. Some core values would be just that, the things we learned from not working the way it was supposed to. The installation for this pilot is installed by a technical specialist, who has full responsibility for all energy equipment at the schools in this pilot.
Cost Structure	The NPA partner shares the cost with RVN, where NPA contribute with the greater part.
Revenue Streams	There are no revenues in this project. But for the property owners there can be long term energy saving and therefore also money savings. There is also a possibility that the pupils who change their behaviour also apply that in their homes. That would lead to a similar result; saving energy also affects the economy of the household.

Table 7: RCV Pilot Business Model

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6.3.2. Feasibility of the RCV pilot

Indicators	Long Term Feasibility - ICT-based Energy Management
Key Issues	Energy saving technology, professional supplier
Key Factors (Internal)	The right tool for the right need. From procurement to chosen supplier.
Key Factors (External)	Communication, ensure that the supplier can deliver.
Uncertainties	Changes in staff, changes in the supply chain.
Success indicators	Functioning installations/solutions, functioning collaborate with supplier, clear communication.

Table 8: RCV Pilot Feasibility

6.3.3. Sustainability of the RCV pilot

Sustainability levels	Sustainability - ICT-based Energy Management
	Indicators
Scale up	
Scale out	
Scale deep	

Table 9: RCV Pilot Sustainability

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6.4. Adaptive Energy Management – Lapland University of Applied Sciences, Finland (LUAS)

6.4.1. LUAS business model analysis

Business Model Elements	Adaptive Energy Management Business Model Lapland University of Applied Sciences
Key Partners	• City of Rovaniemi – Owner of the pilot premises • Santasport Oy – Operator of the pilot premises • Caverion Oy – Service provider of the building services system
Key Activities	• studying the current state of energy efficiency of pilot sites • assessment and measurement of found improvements • analyzing the gathered data • joint discussions about the findings with stakeholders • drawing up a plan for improvements • result sharing through the SEMM webpage
Value Propositions	Core value is to increase the energy efficiency and energy self-sufficiency of the pilot premises by: • decreasing the amount of wasted heat generated in the cooling process • making calculations and based on the calculations make recommendations for the introduction of solar energy Currently there are no renewable energy sources used and almost all of the excess heat generated in the cooling process is led straight out and up in the air.
Customer Relationships	In this case the end users are the building maintenance staff, our relationship with them is really good and they have been receptive to all new ideas we have come up with. Same applies also for the owners and operators. We have engaged with them by holding several stakeholder meetings with them and informing them by email of the progress of the project.
Customer Segments	The City of Rovaniemi is the main stakeholder as the owner of the premises. Their main concern has been the high energy consumption that with today’s energy prices means very large energy bills. They have really liked our ideas that aim at reducing the amount of energy acquired from the market for two main reasons. This, on the one hand, saves them money and, on the other hand, reduces the impact on the climate.
Key Resources	Knowledge of renewable energy and knowledge about the cooling processes in large premises. Also, ICT knowledge and skills so we are capable of producing a web based interactive information platform.
Channels	Pilot results will be distributed via a designated web-based information platform
Cost Structure	• Staff costs 166 000€ • External expertise and services 17 900€
Revenue Streams	No income generated in this pilot, value is in saving energy and saving the costs of energy.

Table 10: LUAS Pilot Business Model

6.4.2. Feasibility of the LUAS pilot

Indicators	Long Term Feasibility - Adaptive Energy Management
Key Issues	• Identify the key persons from the stakeholders • Baseline study on energy efficiency • Finding and acquiring suitable equipment and service updates • Further future use of the acquired services
Key Factors (Internal)	Finding suitable personnel for management who has the time and knowledge needed to further development
Key Factors (External)	• Finding other public premises that generate excess heat and spreading knowledge of excess heats reuse to them • Finding other public premises who would benefit using renewable energy in an efficient way
Uncertainties	• Do the owners see these subjects as so important that they will find the time and money to maintain and further develop these issues after the project? • In addition to time and money, because of the ownership, these also need the political will to keep working on these subjects
Success indicators	• Reusing excess heat that is currently released outside instead of paying for additional heating • Producing and using new renewable energy

Table 11: LUAS Pilot Feasibility

6.4.3. Sustainability of the LUAS pilot

Sustainability levels	Feasibility - Adaptive Energy Management
	Indicators
Scale up	Further development of energy efficiency in these pilot premises
Scale out	Finding other similar buildings in Lapland and spreading knowledge to them
Scale deep	City of Rovaniemi owns several similar buildings, they could scale these findings to the other buildings

Table 12: LUAS Pilot Sustainability

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6.5. Indoor Air Quality – Orkusetur, Iceland (OS)

6.5.1. OS business model analysis

Business Model Elements	**Indoor Air Quality Business Model** Orkusetur
Key Partners	• Municipality of Akureyri (stakeholder) • Austurbrú (Municipalities East Iceland) – (stakeholder) • Fresh-r (supplier) • Ethera (supplier)
Key Activities	• Establish goodwill and confidence • Select proven technology with exciting novelties • Professional installers • Collaboration on promotion when installation completed
Value Propositions	Arctic nation (in this case Iceland) inhabitants spend a lot of time indoors in winter months. Domestic energy use is renewable and affordable, leading to relatively high inhabitant consumption of geothermal heat and hydropower, compared to areas with similar climate elsewhere and relying on fossil fuel which is both expensive and being phased out. While heating is comfortably managed, air quality may suffer, in particular in older buildings and of concern in public places, such as schools. Our main task in this project is to use IoT technology to manage air quality in primary schools. Application of sensors that monitor relevant parameters allows users to react properly to the outdoor and indoor air content.
Customer Relationships	Orkusetur/Orkustofnun has the privilege of being housed in the same building as some of Akureyri Municipality sections, in particular the company Vistorka, which is owned by the municipality and has as its main goal to provide ‘clean’ lifestyles for town inhabitants; improve living conditions while participating in renewable cycles; energy, waste, cycling, plants, commuting etc.
Customer Segments	Other municipalities in Iceland may benefit from our work and also other participants in this project. Similar efforts have been carried out in other countries and we can share/communicate results.
Key Resources	Patience is key. Have a clear goal and push for it at the right moment over a long period of time… Financial resources need to be available.
Channels	Pilot is delivered in collaboration with key partners (see above) and trusted technical providers, installers and personnel.
Cost Structure	The NPA partner covers all cost and is reimbursed to some extent from the project funding. The remaining amount may or may not be reimbursed from stakeholders.
Revenue Streams	No revenue from this project, other than better air quality for children.

Table 13: OS Pilot Business Model

6.5.2. Feasibility of the OS pilot

Indicators	Long term Feasibility - Indoor Air Quality

Key Issues	Functionality of selected technology
Key Factors (Internal)	Communication and know-how
Key Factors (External)	Communication and willingness to participate
Uncertainties	Changes in policy/staff/funding etc.
Success indicators	Functioning solutions

Table 14: OS Pilot Feasibility

6.5.3. Sustainability of the OS pilot

Sustainability levels	Indicators
Scale up	Other municipalities
Scale out	?
Scale deep	?

Table 15: OS Pilot Sustainability

7. SMARCTIC's Smart Energy Business Model

The SMARCTIC Smart Energy Business Model is the result of the combined efforts of the SMARCTIC partners' in sharing their experiences, learning, assessment and analysis of the pilot actions they designed and implemented using the SMARCTIC Smart Energy Management Model. The development approach of this business model was executed carefully to anticipate and guarantee the longevity of the project's outputs and their impact and to share how they can be replicated by other regions and expanded upon to generate new smart energy solutions.

SMARCTIC's Smart Energy Management Business Model	
Vision	What is the ultimate goal of the Smart Energy Pilot? • Increasing energy efficiency in rural and remote areas • Increasing the use of renewable energy • Testing, validating and improving the Smart Energy Management Model Encouraging energy use awareness and behaviour change to reduce waste
Key Partners	• Identify a "champion" of the pilot/energy community, if possible, to ensure longevity • Local authority facilities management • Facility/Building Managers • Energy bill payers Technology suppliers/installers
Key Objectives/ Activities	• Defining an action plan with all components, resources and goals identified • Establishing baselines, i.e., current state in terms of energy use and efficiency • Identifying the amount and type of technical knowledge needed to set up, implement and maintain the pilot • Choosing the appropriate buildings/settings that will benefit from the pilot • Installing appropriate and relevant smart metering sensors & other technology • Setting up an Energy Management System, or other monitoring and data dashboard solution, with access for relevant stakeholders • Data analysis based on historical, sensor-provided and predictive data turned into actions or recommendations • Regular discussions, workshops, demos for stakeholders Educating and engaging the public
Value Propositions	• Creating an "energy community" from disparate buildings/organisations allows for increased awareness, knowledge sharing and economies of scale. • Establishing an integrated ecosystem of tools/data as a basis for development of smart energy solutions Educating those in decision-making positions about the benefits of the pilot and how it could be expanded upon to increase energy efficiency further
Customer Relationships	Engagement and regular meetings with stakeholders are essential to building the energy community and ensuring long-term engagement
Customer Segments	• Building owners and managers, who benefit from discussing common problems, learning from the experience of others, etc.
Key Resources	• Commitment from those responsible for the public buildings is essential • Some investments in sensors, energy management software and display technology are needed Access to energy and ICT expertise and advice
Messaging/ Channels	• Stakeholders should be identified and engaged right at the beginning of the project • Energy Management Systems transform data from sensors and other sources, into actionable information managers can use to manage their energy usage

	• Making some data available in a consumable format for the public increases support, engagement and learning, and helps encourage future investment
Cost Structure	• Key costs are in purchasing and maintaining sensors, other equipment and energy management systems • Costs of maintaining the system long-term must be considered in the early stages Cost/benefit analysis done over time will confirm the value of this short-term investment into long-term financial and environmental gain
Revenue Streams	• Savings in energy costs will accrue over time; energy management systems have budget tracking facilities • Explore public funding for pilot expansion or extension possibilities • Behavioural change "revenue" goes beyond the scope of the actual pilot, as participants bring their changed attitudes and habits to other areas of their lives
Growth Opportunity	Successful pilots can be expanded, e.g., to include additional buildings or energy producers, or can replicated elsewhere

Figure 2: SMARCTIC Smart Energy Management Business Model

8. Joining SMARCTIC's network

The SMARCTIC project is intended as a "kick-starter" for other NPA communities to adopt the smart energy management model and develop additional innovative energy solutions to become more energy efficient and address current energy challenges. In order to sustain and grow the SMARCTIC network, those responsible for energy, infrastructure and public building management in all NPA regions are invited to join the SMARCTIC network through its online platform, and to use the SEMM to help implement their energy solutions, thereby expanding the reach of the SMARTIC outputs and enriching the network with their participation and contributions.

8.1. SMARCTIC New Partner Open Agreement

Prospective NEW members of the SMARCTIC network will be asked to describe their planned energy solution implementation on the SMARCTIC website and indicate why they would like to join the SMARCTIC network. Once the SMARCTIC partners have agreed to add a new member to the platform, the new member agrees to provide the relevant information, including information relating to the type and objectives of their solution, the expected benefits, technical requirements, user supports, lessons learned and recommendations. The new member also

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agrees to maintain and update the energy solution details as necessary and to review them at least quarterly to ensure the information remains relevant.

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