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Smart integRation Of local energy sources and innovative storage for flexiBle, secure and cost-efficIent eNergy Supply ON industrialized islands

D 6.3 – Business models for energy communities

Lead partner: STRATAGEM

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Executive summary

This document constitutes deliverable 6.3 “Business planning for local communities”. The deliverable provides information on the main research results relevant to the decentralised energy systems and energy management systems. Also includes information regarding energy communities, the identified business models for energy communities; addressing the OBJECTIVE 8: DEVELOPMENT OF BUSINESS MODELS in GA. In addition, five selected Business Models developed and implemented for Eigeroy, one for the Western Islands and Crete.

Table of content

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List of figures

List of tables

List of abbreviations

DES	Decentralized energy systems
EMS	Energy management systems
DERs	Distributed Energy Resources
AD	Anaerobic Digestion
RES	Renewable Energy Sources
CHP	Combined Heat and Power
CO2	Carbon Dioxide
HRES	Hybrid renewable energy
AD-BES	Anaerobic digestion with a Bioelectrochemical System
PV	PhotoVoltaics
EC	European Commission
RE	Renewable Energy
GHG	Greenhouse Gas

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1. Introduction

Deliverable 6.3 is related to Task 6.3: “Business models for energy communities” and is being led by STRATAGEM.

This report is composed of the following parts:

- **Chapter 1** Introduction
- **Chapter 2** Decentralized energy systems and energy management systems (an initial literature review with the main research results relevant to the decentralized energy systems and energy management systems and the identified costs and non-monetised externalities of the technologies in the demonstration case)
- **Chapter 3** Islands particularities
- **Chapter 4** Energy communities (definition, types, benefits, etc.)
- **Chapter 5** Business Models (literature review to investigate business models adequate for the local energy communities)
- **Chapter 6** Business Models for Eigeroy, Western Islands and Crete
- **Chapter 7** Application of Business Model Canvas (BMC)
- **Chapter 8** Deviations from DoA
- **Chapter 9** Conclusions

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2. Decentralized energy systems and energy management systems

2.2 Decentralized energy systems

Decentralized energy systems have become increasingly important in the ongoing energy transition. These systems involve smaller power generation facilities that are distributed throughout regions and communities, rather than relying on a centralized power grid[2]. This approach shifts the traditional energy model towards a more flexible, resilient, and sustainable energy landscape.

Empowering Sustainable Energy

The implementation of a decentralized energy system represents a radical shift in the production and consumption of energy, relying on distributed generation, energy storage, and demand response to establish a more localized and sustainable approach. The outcomes of the search results reveal important findings that shed light on the significance and advantages of decentralized energy systems.

A crucial aspect of decentralized energy systems is their versatility in a variety of settings. They encompass off-grid electricity solutions tailored for rural and island communities, providing reliable power to remote off-grid industries, and serving as peaker plants to ensure grid stability[3]. Decentralized energy systems can also provide reliable power in emergency and disaster situations, where centralized grid infrastructure may be disrupted or unavailable[4]. These systems' foundation lies in distributed energy resources (DERs), which consist of on-site generation integrated with advanced energy storage systems (ESS)[5]. The integration enhances the system's ability to optimize energy resources efficiently.

The resilience and flexibility of decentralized energy systems arise from their unique structure, wherein many small-scale production units replace the conventional reliance on a few large ones. Such a configuration not only strengthens the energy grid's ability to withstand disruptions but also allows for dynamic adjustments to meet evolving energy demands.

In terms of economic benefits, decentralized energy systems offer cost savings by reducing the need for extensive long-distance transmission and distribution infrastructure. By streamlining the energy supply chain, these systems minimize energy losses and associated expenses, contributing to overall cost-efficiency.

Furthermore, decentralized energy systems exhibit significant potential for promoting local economic development. Through the creation of employment opportunities and the encouragement of community participation and ownership, these systems empower local stakeholders to take an active role in shaping their energy landscape.

Beyond economic benefits, the adoption of decentralized energy systems serves as a significant step towards addressing environmental concerns. By emphasizing the promotion of renewable energy

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[3] https://www.man-es.com/discover/decentralized-power-generation-is-a-critical-transition-technology

[4] https://www.iiiee.lu.se/article/decentralized-energy-systems-give-advantages

[5] https://youmatter.world/en/decentralised-renewable-energy-systems/

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sources and the mitigation of transmission losses, these systems contribute to the reduction of carbon emissions, making strides towards a greener and more sustainable future.

The following is a brief summary of the main features and benefits of decentralized energy systems:

Characteristics:

- **Locally Generated Energy**: In a decentralized energy system, energy generation sources are situated closer to the point of consumption, often within or near the communities they serve. These sources can be diverse, ranging from solar photovoltaic panels, wind turbines, small-scale hydroelectric generators to biomass facilities[6].
- **Distributed Energy Resources**: The implementation of distributed energy resources (DERs) in decentralized energy systems is frequently utilized, which comprises on-site generation and advanced energy storage systems (ESS). DERs are designed to complement decentralized systems by storing excess energy and releasing it during peak demand periods, enhancing grid stability. The use of renewable energy sources like solar, wind, and biomass in DERs can be highly beneficial.
- **Resilience and Reliability**: Decentralized energy systems can enhance the resilience and reliability of the energy supply. Research efforts have focused on optimal sizing and pre-positioning problems of distributed energy resources for networked microgrids, capturing both optimal sizing and pre-positioning in the presence of multiple microgrids operating in a networked fashion[7]. This approach is particularly important in the face of natural disasters or grid disruptions.
- **Optimal Use of Renewable Energy**: Decentralization aims to bridge the physical gap between electricity producers and consumers, allowing for more optimal use of renewable energy sources. Microgrids and local energy markets enable consumers to directly access and trade renewable energy[8].
- **Reduced Transmission Losses**: With decentralized energy systems, energy is generated closer to end-users, reducing the need for long-distance transmission and distribution infrastructure minimizing transmission losses[9]. This can lead to cost savings for both energy providers and consumers.
- **Demand - Side Management**: Decentralized energy systems promote demand-side management strategies, enabling consumers to actively manage and optimize their energy usage. Smart grid technologies and real-time data facilitate demand response and energy conservation efforts[10].

Community Engagement and Empowerment: Decentralized energy systems that involve community participation and ownership can foster a sense of empowerment and local economic development. Studies have shown that these systems can provide social value, such as energy independence, local

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[8] Nikita, Tomin., Vladislav, Shakirov., Aleksander, N., Kozlov., Denis, Sidorov., Victor, Kurbatsky., Christian, Rehtanz., Electo, Eduardo, Silva, Lora. (2022). Design and optimal energy management of community microgrids with flexible renewable energy sources. Renewable Energy, 183:903-921. doi: 10.1016/J.RENENE.2021.11.024

[9] Xingyue, Jiang., Chuan, Sun., Lingling, Cao., Ngai-Fong, Law., Ka, Hong, Loo. (2022). Semi-decentralized energy routing algorithm for minimum-loss transmission in community energy internet. International Journal of Electrical Power & Energy Systems, 135:107547-. doi: 10.1016/J.IJEPES.2021.107547

[10] Muhammad, Majid, Hussain., Rizwan, Akram., Zulfiqar, Ali, Memon., Mian, Hammad, Nazir., Waqas, Javed., Muhammad, Siddique. (2021). Demand Side Management Techniques for Home Energy Management Systems for Smart Cities. Sustainability, 13(21):11740-. doi: 10.3390/SU132111740

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benefits, social relationships, and environmental responsibility, as well as economic value through self-consumption of renewable electricity and reduced electricity import costs[11].

Benefits:

- **Increased Energy Security**: The diversification of energy sources and local generation play a pivotal role in enhancing energy security and mitigating the vulnerability to external supply disruptions[12].
- **Reduced Carbon Emissions**: By prioritizing renewable energy sources and minimizing transmission losses, decentralized systems contribute to reduced carbon emissions and a cleaner environment.
- **Improved Resilience**: Decentralized energy systems can improve resilience by reducing the risk of power outages and ensuring a more reliable energy supply.
- **Local Economic Development**: Decentralized energy systems can promote local economic development by creating jobs and fostering community participation and ownership[13].
- **Flexibility and Adaptability**: Decentralized systems can easily accommodate new technologies and changing energy demands, offering flexibility and adaptability to evolving energy markets[14].

2.2.1 Challenges of Integrating Decentralized Energy Systems

Integrating decentralized energy systems into existing power grids poses a series of noteworthy challenges that necessitate careful consideration. As evidenced by the search results, these challenges can have a significant impact on the successful implementation and operation of decentralized energy solutions.

Grid Stability

One of the most prominent challenges stems from the variability and unpredictability of renewable energy sources, such as solar and wind. The intermittent nature of these sources makes it difficult to maintain a stable balance between energy supply and demand on the grid, requiring innovative strategies to ensure reliable power delivery[15].

Grid Infrastructure

The integration of decentralized energy systems may necessitate the establishment of new grid infrastructure and seamless integration with existing centralized grid infrastructure. This integration complexity can demand significant investment and careful planning to achieve a harmonious coexistence of decentralized and centralized systems.

Regulatory Barriers

[11] Sophie, Adams., Donal, Brown., Juan, Pablo, Cárdenas, Álvarez., Ruzanna, Chitchyan., Michael, J., Fell., Ulf, J.J., Hahnel., Kristina, Hojckova., Charlotte, Johnson., Lurian, Pires, Klein., Mehdi, Montakhabi., Kelvin, Say., Abhigyan, Singh., Nicole, E., Watson. (2021). Social and Economic Value in Emerging Decentralized Energy Business Models: A Critical Review. Energies, 14(23):7864-. doi: 10.3390/EN14237864

[12] Marie Claire Brisbois, Decentralised energy, decentralised accountability? Lessons on how to govern decentralised electricity transitions from multi-level natural resource governance,Global Transitions,Volume 2, 2020,Pages 16-25,ISSN 2589-7918, https://doi.org/10.1016/j.glt.2020.01.001

[13] https://www.myntsystems.com/post/what-is-decentralized-energy

[14] Claudia, Antal., Tudor, Cioara., Marcel, Antal., Vlad, T., Mihailescu., Dan, Mitrea., Ionut, Anghel., Ioan, Salomie., Giuseppe, Raveduto., Massimo, Bertoncini., Vincenzo, Croce., Tommaso, Bragatto., Federico, Carere., Francesco, Bellesini. (2021). Blockchain based decentralized local energy flexibility market. Energy Reports, 7:5269-5288. doi: 10.1016/J.EGYR.2021.08.118

[15] https://ratedpower.com/blog/challenges-integrating-renewables-ower-grid/

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To fully realize the potential of decentralized energy systems, regulatory barriers must be addressed. Limitations on the sale of excess energy to the grid and constraints on the size of distributed energy resources (DERs) can impede the full potential of these systems. Overcoming regulatory hurdles may require collaborative efforts between policymakers and stakeholders to foster an enabling environment for decentralized energy integration.

Coordination and Control

Coordination challenges arise when it comes to microgrids and local energy markets. The increased number of smaller energy production units in decentralized systems demands effective coordination and management to ensure seamless operation and grid stability[18]. Operational challenges also emerge, as decentralized energy systems may require new capabilities for real-time monitoring and control to ensure grid stability and reliability. Advanced monitoring tools and efficient control mechanisms are vital to effectively address these challenges[16].

Cybersecurity

Security and privacy concerns related to the use of digital technologies and the risk of cyberattacks should not be overlooked. To safeguard the integrity and reliability of decentralized energy systems, robust cybersecurity measures and privacy protocols must be in place[17].

Transaction costs

The economic challenge for successful integration of decentralized energy systems lies in the transaction costs associated with energy exchange and grid services in decentralized markets [2][8]. Identifying strategies to optimize transactional efficiency and minimize associated costs is crucial for encouraging the adoption of decentralized solutions[18] .

2.2.2 A Growing Pathway Towards Sustainability in Europe

Decentralized energy systems are experiencing significant growth in Europe, with a distinct trend towards increased adoption and recognition of their prospective benefits. While specific projections for the forthcoming years are not available, the escalating demand for decentralized energy systems has propelled their prominence in the global market. This has emphasized the importance of renewable energy sources and decentralization in the ongoing energy transition. The European Parliament acknowledges the dynamic nature of the market for decentralized energy systems, which registered a twofold increase in size between 2007 and 2008, thus, indicating a robust inclination towards these systems[19]. A report by Roland Berger has underscored the inevitable transformation towards decentralized energy systems in Europe, and its success is contingent upon critical political reforms and regulatory changes[20].

Decentralized energy management systems are gaining momentum in Europe, owing to their technical and economic benefits, which provide local power players and consumers with greater control. These systems bridge the gap between energy producers and consumers, enabling the optimal utilization of

[16] https://utilityanalytics.com/2021/09/utilities-assess-benefits-and-challenges-of-decentralizing-the-power-grid-through-blockchain-technology/

[17] Idries, A., Krogstie, J. & Rajasekharan, J. Challenges in platforming and digitizing decentralized energy services. Energy Inform 5, 8 (2022). https://doi.org/10.1186/s42162-022-00193-9

[18] https://www.thecgo.org/research/innovations-and-decentralized-energy-markets/

[19] https://www.europarl.europa.eu/document/activities/cont/201106/20110629ATT22897/20110629ATT22897EN.pdf

[20] https://www.rolandberger.com/publications/publication_pdf/roland_berger_the_future_of_europes_decentralized_energy_market_1.pdf

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renewable energy sources through micro-grids[21]. The shift towards decentralized energy systems is consistent with the EU's vision of a more sustainable energy landscape, which emphasizes the use of distributed generation, energy storage, and renewable energy sources. This transformation aims to improve energy resilience, promote the adoption of clean energy, and empower consumers by giving them greater control over their energy consumption. The increasing focus on decentralized energy systems represents a significant step towards creating a more sustainable and efficient energy future for Europe.

2.3 Energy management systems

An Energy Management System (EMS) is an integrated system that oversees and regulates the operation of multiple energy sources to optimize energy efficiency and guarantee a reliable power supply[22]. It was developed to manage energy flow and resources in a synchronized and adept approach. The EMS is capable of controlling multiple power sources, including PV panels, wind turbines, diesel generators, and more, and determining when and how to operate them based on power accessibility and load demand[23]. To mitigate operational expenses and advance self-consumption of renewable energy sources (RES), it may additionally combine energy storage technologies, such as battery energy storage systems (BESS). In summary, an EMS is fundamental in upholding the reliable and sustainable functioning of energy systems, especially microgrids and smart grids[24].

The significance of an Energy Management System (EMS) in preserving power grid stability and incorporating distributed power generation sources can be highlighted as follows. To begin with, an EMS plays a critical role in determining the most economical configuration of power production, transmission, and distribution within the network, while taking into account factors such as system stability, safety, and reliability. It facilitates efficient and optimized power flow, particularly when distributed power generation sources are integrated, by coordinating their operation with the grid to maintain stability and balance supply and demand[25].

Preserving power grid stability is of utmost importance, and the EMS contributes by continuously monitoring and controlling various parameters such as frequency, voltage, and reactive power. It ensures that the grid operates within safe limits and can respond to fluctuations in power generation and demand. By actively managing the grid, an EMS helps prevent blackouts, voltage sags, and other disruptions, thereby ensuring a dependable power supply[26].

The successful integration of distributed energy resources (DERs), such as wind turbines and solar panels, into the power grid is made possible through the use of an EMS. The EMS accelerates the

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[21] https://www.hivepower.tech/blog/decentralized-energy-systems-a-necessity-in-europe

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[23] Espín-Sarzosa D, Palma-Behnke R, Núñez-Mata O. Energy Management Systems for Microgrids: Main Existing Trends in Centralized Control Architectures. Energies. 2020; 13(3):547. https://doi.org/10.3390/en13030547

[24] Meliani M, Barkany AE, Abbassi IE, Darcherif AM, Mahmoudi M. Energy management in the smart grid: State-of-the-art and future trends. International Journal of Engineering Business Management. 2021;13. doi:10.1177/18479790211032920

[25] Zahraoui Y, Alhamrouni I, Mekhilef S, Basir Khan MR, Seyedmahmoudian M, Stojcevski A, Horan B. Energy Management System in Microgrids: A Comprehensive Review. Sustainability. 2021; 13(19):10492. https://doi.org/10.3390/su131910492

[26] H. Lee et al., "An Energy Management System With Optimum Reserve Power Procurement Function for Microgrid Resilience Improvement," in IEEE Access, vol. 7, pp. 42577-42585, 2019, doi:10.1109/ACCESS.2019.2907120.

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optimization of the use of these distributed generation sources by considering factors such as their output power, availability, and grid constraints. As a result, this integration leads to increased utilization of renewable energy sources, reduced dependence on centralized power plants, and improved overall grid resilience[27].

Through the use of an EMS, energy savings and efficiency can be achieved by gaining insights into energy consumption patterns and identifying optimization opportunities. The real-time monitoring and analysis of energy usage enables the identification of areas with high consumption, inefficiencies, and potential energy-saving measures. The adoption of energy efficiency strategies and the informed decision-making process can result in a reduction in energy expenses and a reduction in environmental impact.

Moreover, the EMS also engages customers in energy management by providing them with access to their energy consumption data and personalized recommendations for energy-saving actions. This encourages customers to take an active role in energy conservation efforts and make informed choices about their energy usage. Additionally, the EMS prioritizes customer privacy by ensuring secure handling and protection of energy data[28].

Key functions and objectives of EMS

An Energy Management System (EMS) encompasses a variety of functions and objectives that are designed to enhance energy utilization, improve efficiency, and ensure the reliable operation of energy systems. In this regard, the following is a summary of the primary functions and objectives of EMS:

- **Data Collection**: EMSs acquire real-time energy measurement data from a range of sources, such as sensors and meters. This data includes energy consumption, production, and other relevant parameters, which allow for comprehensive monitoring.
- **Data Visualization and Analysis**: EMSs analyze and present energy data through graphical representations and visualizations, which facilitate users' comprehension of energy usage patterns, trends, and anomalies. These insights illuminate energy consumption, identify inefficiencies, and support informed decision-making[29].
- **Monitoring and Control**: EMSs provide continuous monitoring of energy consumption, production, and system parameters. Users can implement control strategies, adjust setpoints, and automate energy-consuming devices and systems, thereby optimizing energy usage and maintaining system stability[30].
- **Optimization and Planning**: EMSs employ advanced algorithms and optimization techniques to optimize energy usage, taking into account factors such as cost, reliability, and environmental impact. They support energy planning, load forecasting, and demand response strategies.

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- **Reporting and Performance Analysis**: EMSs generate comprehensive reports and analytics that provide detailed information on energy performance, savings, and efficiency improvements. These reports facilitate performance evaluation, benchmarking, and compliance with energy management standards.

Objectives of EMS:

- **Energy Efficiency**: The primary objective of EMS is to minimize energy consumption while maintaining or improving system performance.
- **Cost Reduction**: An EMS can provide valuable insights into energy usage patterns and support cost-effective decision-making, thus aiding in the reduction of overall energy costs.
- **System Stability and Reliability**: EMSs ensure a dependable power supply and mitigate the risk of disruptions[31].
- **Integration of Renewable Energy Sources**: EMSs facilitate the seamless integration of renewable energy sources, such as solar and wind, into the energy system.
- **Environmental Sustainability**: EMSs promote environmental sustainability by supporting energy conservation, reducing greenhouse gas emissions, and facilitating the adoption of renewable energy sources. They enable organizations to track and minimize their carbon footprint[4].

The field of energy management can be classified into three primary categories: smart transmission system, smart distribution system, and demand-side management. Recent academic literature highlights the significance of these areas in optimizing energy management.

Smart Transmission System focuses on maintaining energy management ability and enhancing international competitiveness through the utilization of smart grid topology. It is crucial for ensuring stability between energy supply and demand in the smart grid. This intelligent transmission system plays a central role in energy management, employing highly efficient computing systems and secure network communication within a centralized structure[32].

Smart Distribution System aims to improve system efficiency and ensure smooth energy load through flexible supply planning and dynamic pricing. The integration of distributed energy resources (DERs) and energy storage systems with smart distribution networks using demand-side management is essential in energy management. This approach involves implementing demand reduction bidding during peak hours, incentive DSM, and demand response (DR) programs to optimize energy consumption[33].

Demand Side Management involves managing power utilization loads in various areas to ensure stability, work efficiency, and prevent situations of insufficient or excessive power distribution. It

[31] https://www.frontiersin.org/articles/10.3389/fenrg.2022.1097858/full

[32] Bakare, M.S., Abdulkarim, A., Zeeshan, M. et al. A comprehensive overview on demand side energy management towards smart grids: challenges, solutions, and future direction. Energy Inform 6, 4 (2023). https://doi.org/10.1186/s42162-023-00262-7

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enables communication between energy suppliers and consumers, reducing energy acquisition costs and associated penalties through continuous monitoring of energy use and appliance scheduling.

Furthermore, incorporating distributed energy systems involving residential, commercial, and industrial users, along with blockchain technologies, facilitates peer-to-peer exchange of information and energy, leading to economic savings, peak load reduction, and increased market efficiency[34]. These various aspects of energy management contribute collectively to the optimization and effective utilization of energy resources.

EMS exhibits a broad spectrum of applications encompassing electric utility grids, small-scale systems, industrial groups, tertiary sector actors, local authorities, space management, and scheduling. In a more specific way:

- **Electric Utility Grids**: EMS is used by operators of electric utility grids to monitor, control, and optimize the performance of the generation or transmission system.
- **Small Scale Systems**: EMS is equally significant in small-scale systems, such as microgrids. The growing demand for residential devices that can manage EV charging based on the total load versus the total capacity of an electrical service has made EMS highly relevant in this context.
- **Industrial Groups, Tertiary Sector Actors, and Local Authorities**: Energy Management Systems (EMS) have been extensively adopted by various industries, including industrial groups, tertiary sector actors, and local authorities. By utilizing the Energy Management System (EMS), stakeholders are provided with a comprehensive overview of energy consumption for each site, categorized by energy type, enabling them to identify and address issues while also granting access to necessary reports[35,36].
- **Space Management and Scheduling**: Through web interfaces, mobile devices, digital kiosks, room signs, and more, EMS software components empower users to access space management and scheduling features[37].

2.3.1 Energy Management Systems: Market Overview and Growth Projections

The Energy Management Systems (EMS) market is characterized by a high level of competitiveness. In Europe, the EMS market displays moderate fragmentation, with several prominent players dominating the industry. Notable companies such as Schneider Electric SE, Eaton Corporation plc, Siemens AG, Johnson Controls International Plc, Fuuse, ABB Group, General Electric, Honeywell International, Fibar Group SA (Nice SPA), Panasonic Corporation, and Enel X (Enel SpA) offer diverse energy management solutions catering to various industries and sectors, as evidenced by available search results[38].

Forecasts reveal promising growth prospects for the global EMS market, with a projected expansion from USD 504.22 billion in 2022 to USD 797.94 billion by 2029, exhibiting a Compound Annual Growth

[34] Saleem MU, Shakir M, Usman MR, Bajwa MHT, Shabbir N, Shams Ghahfarokhi P, Daniel K. Integrating Smart Energy Management System with Internet of Things and Cloud Computing for Efficient Demand Side Management in Smart Grids. Energies. 2023; 16(12):4835. https://doi.org/10.3390/en16124835
[35] https://www.metron.energy/blog/ems-energy-management-system-definition/
[36] https://www.capterra.com/p/268192/Energy-Monitoring-System-EMS/
[37] https://www.inovisenergy.com/what-is-an-energy-management-system-ems/
[38] https://www.mordorintelligence.com/industry-reports/europe-energy-management-systems-market-industry

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Rate (CAGR) of 6.8% during the forecast period[39]. Further, the Europe energy management systems market is predicted to progress with a CAGR of 15.49% over the forecast period of 2022 to 2030, acquiring a revenue share of $11448.17 million by 2030[40]. These predictions underscore the sustained upward trajectory of the EMS market, emphasizing its significance in the context of global energy management trends.

Summary

In conclusion, Energy Management Systems (EMS) play an integral role in transforming energy resource management and utilization. As the world moves towards a more sustainable and efficient energy future, EMS is a key tool in achieving these goals.

With the increasing adoption of renewable energy sources and the proliferation of distributed energy systems, the importance of EMS has been elevated. It becomes crucial in maintaining power grid stability, optimizing energy flow, and seamlessly integrating clean energy sources. By using advanced algorithms and real-time data analytics, EMS facilitates intelligent decision-making, resulting in reduced energy costs, enhanced energy efficiency, and minimized environmental impact.

The competitive landscape of the EMS market is indicative of its growing significance across industries and sectors. As global and European players continue to invest in EMS technologies and solutions, the market is poised for substantial growth in the coming years.

In the pursuit of sustainable energy practices and a greener future, organizations and stakeholders must recognize and embrace the potential of EMS and leverage its capabilities to maximize energy efficiency and ensure reliable energy supply. By utilizing EMS to its fullest extent, we can pave the way towards a more sustainable and resilient energy landscape for future generations.

[39] https://www.giiresearch.com/report/qyr1280772-global-electronics-manufacturing-services-ems.html
[40] https://inkwoodresearch.com/reports/europe-energy-management-systems-market/

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2.4 Costs and non-monetised externalities of the technologies in the demonstration case

The costs and non-monetised externalities of the technologies in the demonstration case of ROBINSON were identified and quantified with a survey with technology developers/providers and case study operators.

2.4.1 Non-monetised externalities of the technologies in the demonstration case of ROBINSON

Renewable power facilities may induce non-monetized externalities related to social, environmental and technical aspects. In the following table we present the identified non-monetized externalities.

Table 1: Non-monetised externalities

	Non-monetized externalities
Environmental	• Visual impairments in the case of solar and wind power • Odor nuisance in the case of biomass plants • (Methane, waste water) emissions (from biomass digestion) • Reduction/valorization of process waste (fish waste, olive waste, wood waste, …) • Air pollution (better air quality) • Noise levels • Impact on flora (shadowing effect of solar panels) and fauna (bird strike for wind turbines) • Water consumption (for electrolysis) • Consumption of resources (precious metals, biomass/wood)
Social	• User participation • Innovation • Employment • Inclusiveness • Community building • Energy independence/Autonomy • Behavior change (Awareness) • Cooperation (More cooperation and knowledge sharing) • Fair distribution of costs (Cost reflectiveness) • Coordination with current planning and policy processes • Democratization of the energy market

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	Non-monetized externalities
	• Direct participation from citizens
Technical	• Improved energy efficiency (energetic use of waste streams, integrated heat & power solutions) • (local) Heating networks (waste heat recovery) • Grid stability, continuity and reliability • Energy storage options • Safety • Security • Replicability • Maintenance • Flexibility

2.4.2 Costs of the technologies

In order to provide some estimations regarding the cost of the technologies in the demonstration case, we based on the deliverable D5.1" Technology specifications".

- CHP unit (mixed fuel): 1000 [euro/kWe capacity]
- Steam boiler: 420 [euro/kWth]
- Wind turbine: 1500 [euro/kWp]
- Electrolyzer: (PEM): 385-2068, (AE): 571-1268, (SOEC): 1400-3500 [euro/kWe]
- Gasifier: 700 €/kWth
- Photovoltaics (PV) systems: 1100 [euro/kWp]
- Energy storage (for battery electricity storage): 180 (per kWh energy capacity) and 143 (per kW power capacity) [euro/x]
- AD-BES, Fuel mixer: will be defined during project implementation.

Cost and environmental data of energy carriers

Below the prices for different feedstock and energy carriers, specified for Eigerøy.

	Feedstock	Value	Unit
1.	Waste Wood	0 – 10	€/t
2.	White Wood	20	€/t
3.	Lower heating value	3.50	kWh/kg
4.	Energy prices at Prima Protein		
5.	LNG Cost (2020)	43.19	€/MWh
6.	CO2 tax (2020)	14.35	€/MWh
7.	Electricity Nordpool (av. 2020)	33	€/MWh

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3. Islands particularities

During the implementation of Task 6.3: " Business planning for local communities", the particularities of each island were identified with the aim to support in the selection of business model that could be applied to each island based on their special characteristics and needs (infrastructures, technical, geographical, etc). In the following tables information from the submitted D6.2 "Market Assessment report" was used.

3.1 Eigerøy

In Eigerøy, - or in Norway in general, there are no thermal power plants located close to the island. Almost 100 % of the electricity is provided through cables from the main land, and this power is generated mainly from hydropower (89,2 %), with 8,6 % onshore wind power with and 2,2 % Thermal power1. There are some few photovoltaic (PV) panels installed on household rooftops on Eigerøy, however, - additionally about 28 000 m2 is identified as being available on rooftops of industrial buildings. When fully developed, this large area could contribute to energy production with currently estimated 5 200 MWh/year. Thermal energy in households is 78 % based on electricity, 16,7 % via wood, coal, and coke, and 5,3 % with liquid fossil fuel. In the industrial sector at Eigerøy is electricity used as well as fossil fuel. Detailed data for the energy split is missing as electricity for heating in industries is not separately measured. Fossil fuel-based were about 6 950 MWh liquid fuel used (based on available 2017 number), and about 26 500 MWh/year are based on LNG.

Additional local electrification (e.g., transport on land and sea) and additional local businesses are expected to result in a significant increase in electricity consumption by about a factor of two.

Table 2: Eigeroy status and particularities

Status & Constraints	Energy particularities/challenges of Eigeroy
• A very small share is fed into the grid. • Power is generated mainly from hydropower, onshore wind power, thermal power. There are some few photovoltaic (PV) panels installed on household rooftops on Eigerøy. • The island itself is connected to the mainland via a sea cable with a peak capacity of 20 MWh.	• New industries are to be established on the island in the coming years, specifically around the harbor area of Kaupanes with an additional need of up to 8 - 16 MW power capacity. The industry in the harbor handles about 30 % of the turnover of all industrial fish processing in Norway (according to data from 2019). The new industries will increase the island's energy demand and require an upgrade of the existing energy system.

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Status & Constraints	Energy particularities/challenges of Eigeroy
• In 2020, about 88 % of the electricity was consumed by local industry, mainly by appliances on the 400 V level. • One industry converting fish waste into protein consumes considerable amounts of liquified natural gas (LNG) as an energy source to produce process steam.	• Seasonal impact in energy consumption on the island results from the use of the traditional cabins (used for recreation) during weekends and vacation and, even more important from the seasonal business of the fish de-loading and processing businesses. • Fish food production process requires a large amount of high-temperature steam, which is currently supplied by an LNG fired boiler. The process also generates low-temperature waste heat, which other local industries could use for heating. Such integration has the potential to convert their current fossil-based heating systems to fossil-free, and thus achieve 100 % decarbonization. • Different profiles of demand and availability of energy will be balanced via the ROBINSON Energy Management System (EMS).

3.2. West Islands

Comhairle nan Eilean Siar (Western Isles Council) is the local authority for the Western Isles (or Outer Hebrides) of Scotland and delivers a wide range of statutory and non-statutory services for the benefits of residents and communities in the islands. The Outer Hebrides are a chain of islands off the west coast of Scotland with a population of around 26.000. Most of the population being situated in and around the main town of Stornoway.

The Outer Hebrides is a Follower Island in the ROBINSON Project and will develop a Replication Plan for implementation of the energy management system (EMS) in our islands. The Outer Hebrides are home to abundant renewable energy resources, particularly wind, wave, and tidal energy. To date, exploitation of these resources has been restricted due to low levels of indigenous demand and a constrained capacity for the export of electricity off the island network via interconnectors to the mainland. The drivers for exploiting these resources, not least in an attempt to address the energy supply challenges that impact the local economy and quality of life on the Western Isles, has gained significant traction among the island community.

The project aims to address challenges faced by many island and rural locations – weak electricity grid, underutilised bio-waste resources, high on-island oxygen prices and an unreliable energy supply.

Solutions provided by OHLEH include the diversion of fish waste from landfill, the integration of fish waste with domestic waste (which is believed to be a first), the production of hydrogen for power and transport, and the production of oxygen at lower-than-market price. Effectively, the islands receive two independent electricity supplies – one to Lewis and Harris (the North Island Group) and one to North Uist, Benbecula, South Uist and Barra (the South Island Group).

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Table 3: Western Isles status and particularities

Status & Constraints	Energy particularities/challenges of Western Isles
• Limited grid capacity and interconnection with the mainland grid, leading to potential grid instability and blackouts. • High energy costs due to reliance on imported fossil fuels.	• High potential for wind power generation due to the island's strong and consistent winds. • Organic waste used as feed to AD plant (esp. organic, grass, fish processing waste) can be sent to CHP for cogeneration.
• Extreme weather conditions and energy efficiency issues. • Exposure to supply interruptions.	• Carbon reduction from use of RES and energy storage, along with the production of green hydrogen. • Strong government support for RES exploitation
• Dependence on diesel generators for electricity generation in many areas, leading to high emissions and air pollution. • High energy consumption and emissions per capita	• Potential for energy storage solutions, such as TES to shift energy usage from high-demand periods to low-demand periods, which can help reduce strain on the energy grid and lower energy costs.
• Poor energy efficiency standards in the private housing stock, these factors drive up the levels of consumption and therefore the total cost of energy.	• Installation of a proposed HVSC subsea interconnector would unlock delivery of a substantial capacity of recently consented wind farms and change this picture. • Energy management system to control and optimize energy usage, RES production, energy storage, etc.

3.3. Crete

Crete is the biggest island in Greece and the fifth in size in the Mediterranean basin, with regard to both its area (8.336 km^2) and population (634.930 inhabitants). Crete is located between the geographical longitudes from 23° 30′E to 26° 22′ E and latitudes from 34° 53′ N to 35° 42′ N. The Crete’s length from the eastern to the western coast is approximately 260 km, while its width from the northern to the southern coast ranges from 12 km to 60 km. The island’s coastline has a total length of approximately 1.000 km. Regarding the Cretan economy, tourism, commerce and agriculture correspond to the 46% of the overall economic activity in the island. The most emissive activities in the island with regard to the greenhouse gases are the electricity production, which is heavily based on imported fossil fuels, the transportations on the island and from and to the island.

Electricity production in Crete is based on three thermal power plants, equipped with steam turbines, diesel generators, gas turbines and a combined cycle. The power production system is integrated with wind parks, photovoltaic stations installed either in the countryside or on the buildings roofs, and a small hydro power plant.

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The annual RES contribution on the electricity demand coverage was 21% in 2019. The steam turbines and the diesel generators consume heavy fuel, while the combined cycle and the gas turbines consume diesel oil.

Table 4: Crete status and particularities

Status & Constraints	Energy particularities/challenges of Crete
• Due to the heavy reliance on imported fossil fuels, the island has high energy production costs for electric, heat, and cooling loads. • Transportation from and to the island, based also on imported fossil fuels (heavy fuel, diesel oil and kerosene).	• High potential for solar and wind power generation due to the island's climate. • Various biomass resources (e.g. agricultural organic wastes, animal manure, pruning, olive kernel wood, etc.), exploitable through AD and decentralised CHP cogeneration.
• Limited grid capacity and interconnection with the mainland grid. • Environmental and cultural concerns limit large scale RES projects on the island.	• Heating/Cooling demand from RE, because of the gradual transfer of the heating demand coverage from diesel oil to heat pumps. • Seasonal storage (TES, Batteries, Hydrogen) to ensure a stable and reliable supply of RES energy.
• Energy losses due to ageing of the equipment. • Tourism leads to a significant rise in electricity consumption (for cooling loads, cooking, etc.). • Limited availability of RES due to the island's weak interconnection with the mainland.	• Innovative business models like community-based initiatives and energy cooperatives to stimulate • local RES investment.
• Biomass burnt locally without any control. • Crete's energy system lacks integrated storage systems to support a transition towards a high RES and flexible energy system. No additional energy networks, such as natural gas networks or decentralized CHP plants, are currently installed in Crete.	• DSM techniques like load shifting and direct load curtailment can optimize power consumption and decrease the requirement for high installed power capacity.

The development of ROBINSON innovations will ultimately assist in creating new opportunities and business models for different areas, such as the renewable energy sector (RES) and low-carbon economy and industries, renewable energies, biofuels and encourage business opportunities for local communities and, by creating new value chains, open up markets for the developed technologies having a positive impact on EU's competitiveness in low carbon economy. The main customer segments identified by the holistic approach of the ROBINSON project are islands' public authorities aiming to accelerate their decarbonisation actions; various industries operating in islands; sustainable renewable energy communities operating in remote areas and closed grids and willing to reduce energy costs, minimise the environmental effects, improve the energy availability and increase independence and stability.

According to the findings in the submitted D6.2 "Market Assessment report", the ROBINSON project is a modular system designed to provide sustainable and resilient energy solutions for European islands. The customer segments for the ROBINSON project could be broadly categorized into two

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groups: local communities and businesses, and energy service providers. Local communities and businesses on the islands could benefit from the ROBINSON project's sustainable and reliable energy supply, which can help reduce energy costs and improve energy security.

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4. Energy Communities

4.1. Definitions of energy communities

European Energy Communities specifically refer to the communities within the European Union working towards the European Green Deal and Climate goals. The EU's energy transition aims to secure sustainable, competitive, affordable energy, where at least 32% of energy comes from renewable sources by 2030, a target set by the European Commission.[41]

According to the European Commission Energy communities organise collective and citizen-driven energy actions that help pave the way for a clean energy transition while moving citizens to the fore. They contribute to increasing public acceptance of renewable energy projects and make it easier to attract private investments in the clean energy transition. At the same time, they have the potential to provide direct benefits to citizens by increasing energy efficiency, lowering their electricity bills and creating local job opportunities. By supporting citizen participation, energy communities can help provide flexibility to the electricity system through demand response and storage.

Energy communities offer a means to re-structure our energy systems by harnessing the energy and allowing citizens to participate actively in the energy transition and thereby enjoy greater benefits.

Energy communities can take any form of a legal entity, for instance, that of an association, a cooperative, a partnership, a non-profit organisation or a small/medium-sized enterprise. It makes it easier for its citizens, together with other market players, to team up and jointly invest in energy assets. This, in turn, helps contribute to a more decarbonised and flexible energy system, as the energy communities can act as one entity and access all suitable energy markets, on a level-playing field with other market actors.[42]

Different Types of Energy Communities

Energy communities can take many forms and include various stakeholders, including households, small and medium-sized enterprises, local authorities, and research institutions. Some examples of energy communities include:

- **Community-owned renewable energy projects**, such as solar or wind farms, where the local community comes together to invest in and operate a renewable energy facility.
- **Energy cooperatives,** where households come together to purchase renewable energy collectively, with the goal of reducing their energy costs.

[41] https://eucalls.net/blog/european-energy-communities
[42] https://energy.ec.europa.eu/topics/markets-and-consumers/energy-communities_en

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- **Virtual power plants** use smart grid technologies to aggregate distributed energy resources and allow multiple energy generators to be controlled as a single entity.

Benefits of Energy Communities

Some of the main benefits of European energy communities are the following:

- ✓ Increased access to funding and resources: Energy communities allow individuals and organizations to pool their resources and expertise. This can lead to greater economies of scale and increased access to funding and other resources. This is particularly important for small and medium-sized enterprises, which often have limited access to funding and other resources.
- ✓ Promotion of renewable energy and energy efficiency: Energy communities can play a key role in the deployment of new energy technologies, such as renewable energy sources and energy storage systems. By spreading the costs of these technologies across multiple individuals or organizations, energy communities can make it more financially feasible for small and medium-sized enterprises to invest in these technologies, which can help to drive innovation and growth in the sector.
- ✓ Enhanced community engagement: European Energy Communities encourage active participation of citizens, local authorities, and businesses in the energy transition. By involving local communities in energy-related projects, the energy transition becomes more inclusive and fosters the citizens' feeling of ownership and commitment to the energy transition.
- ✓ Reducing energy costs: Energy communities can help households and small businesses to reduce their energy costs by purchasing renewable energy collectively, and through collective bargaining, they can also access better energy tariffs and deals.
- ✓ Promoting local economic development: Energy communities can promote local economic development by creating jobs, providing training and education opportunities, and attracting new businesses and investment. This can help to revitalize local communities and support the EU's efforts to achieve sustainable and inclusive growth.

4.2. Citizens and renewable energy communities

Through the Clean energy for all Europeans package, adopted in 2019, the EU introduced the concept of energy communities in its legislation, notably as *citizen energy communities* and *renewable energy communities*. More specifically, the Directive on common rules for the internal electricity market ((EU) 2019/944) includes new rules that enable active consumer participation, individually or through citizen energy communities, in all markets, either by generating, consuming, sharing or selling

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electricity, or by providing flexibility services through demand-response and storage. The directive aims to improve the uptake of energy communities and make it easier for citizens to integrate efficiently in the electricity system, as active participants.
The formal definitions of energy communities: ‘citizen energy communities’ is included in the revised Internal Electricity Market Directive (EU) 2019/944 (European Parliament & Council of the European Union, 2019), and ‘renewable energy communities’ is included in the revised Renewable Energy Directive (EU) 2018/2001 (European Parliament & Council of the European Union, 2018).

In addition, the revised Renewable energy directive (2018/2001/EU) aims to strengthen the role of renewables self-consumers and renewable energy communities. EU countries should therefore ensure that they can participate in available support schemes, on equal footing with large participants.

Table 5: The differences between the two communities

DIFFERENCE	CITIZEN ENERGY COMMUNITIES	RENEWABLE ENERGY COMMUNITIES
Geographical scope	Electricity directive does not bind energy communities to immediate vicinity.	Local communities ‘must be in the vicinity’ of renewable energy projects owned/developed by that community.
Activities	Operate in electricity sector and are technology-neutral (fossil fuel source or renewable)	Broad range of activities related to all forms of renewable energy
Participants	Any actor can participate, but stakeholders involved in large-scalecommercial activity where energy is the primary economic activity cannot make decisions.	Restricted Membership – Natural persons, local authorities, MSMEs, who’s membership/ participation is not their primary economic activity.
Autonomy	‘Decision-making powers should be limited to those members or shareholders that are not engaged in large-scale commercial activity in the energy sector.’	‘Capable of remaining autonomous from individual members or other traditional market actors that participate in the community as members or shareholders.’
Effective control	Exclude Medium-sized and large enterprises from being able to exercise effective control.	Can be controlled MSMEs that are ‘located in the proximity’ of the renewable energy project.

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Based on the report of JRC[43] Community energy reflects a growing desire to find alternative ways of organising and governing energy systems (Van Der Schoor et al., 2016). It is a new form of social movement that allows for more participative and democratic energy processes. Until recently, community energy lacked a clear status in EU and national legislation, taking different forms of legal arrangements.

The Clean Energy Package recognises certain categories of community energy initiatives as '*energy communities'* in European legislation. Energy communities can be understood as a way to 'organise' collective energy actions around open, democratic participation and governance and the provision of benefits for the members or the local community (Roberts et al., 2019).

[43] Energy communities: an overview of energy and social innovation,2020

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4.3. Local Energy Communities

Local Energy Communities (LECs) are legal entities that effectively control their members, are locally rooted and whose goals must be to provide environmental, economic, social and financial benefits.

Role of communities in the Energy Transition: Within the context of an energy transition to a low carbon economy, new roles for local communities are emerging, whereby they are transitioned from being passive consumers to active prosumers with the possibility of local generation, demand response and energy efficiency measures. The energy transition will require significant mainstreaming of niche social and technical innovations to succeed at the community level, for example electric vehicles, heat pumps, smart meters, sustainable energy communities, domestic PV, and battery storage.

Barriers to community energy

The Local Energy Communities Project (LECo) policy paper has identified common barriers to community energy projects:

Societal, cultural, political and/or organizational:

- Lack of historic experience with cooperatives and civic activism
- Low trust in the cooperative model as a viable alternative
- Lack of political support from local representatives
- No experience with setting up cooperatives
- Organisational challenges – pre-planning stage barriers

Legal, administrative, bureaucratic:

- Complicated legal framework, high levels of bureaucracy to acquire licenses
- Lack of national community energy strategy; lack of national targets for community energy projects, which then are broken down in Local Energy Action Plans by local authorities
- Bureaucratic barriers to grid connection (complicated application procedures, uncertainty of approval, costs, time consuming)
- Not allowed to operate micro-grids - producing, own-use, selling within community, selling to third-parties – as compared to only: sell it to the grid and buy it back (often with low financial returns to the community – profits are again made by companies outside the community, which defeats the idea to keep revenue within the community)

• Lack of supportive local authorities and/or local energy agencies

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• Generally no support schemes for Renewable Energy Sources (RES) projects

Technical:

- Technical challenges – lack of expert knowledge to design, plan, procure, implement, commission a project
- Lack of expert knowledge for operation and maintenance
- Size of energy project

Financial:

- Financial challenges in the initial stages of project development; access to finance, grants, etc.
- Fair and secure payments for energy generated (insufficient Feed-in-tariffs (FIT), FIT only for wind, but not for Solar PV, no standardized PPAs, third-party-offtake not possible).
- Insufficient incentives for renewable heat projects: replacing fossil fuel heating with biomass boilers or solar thermal, heat pumps.
- Complicated tax rules.

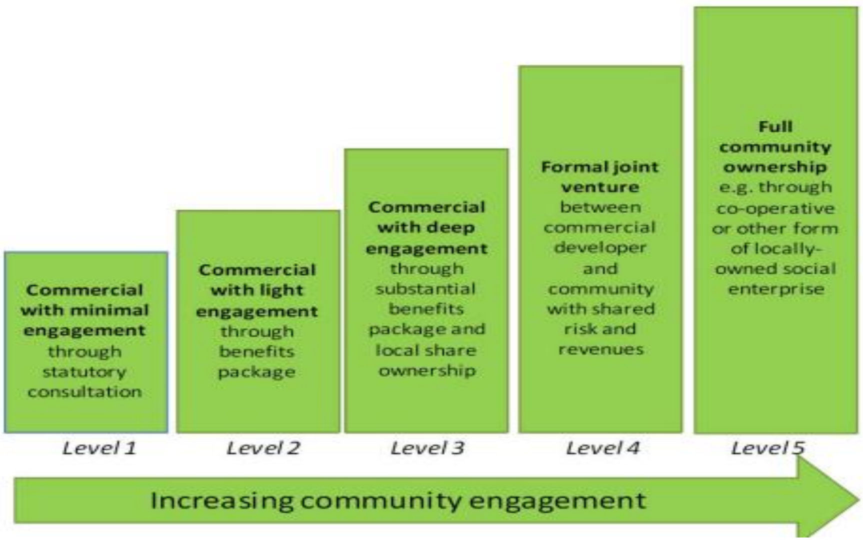

Figure 1: Levels of Community engagement

Energy communities can play a key role in facilitating the decentralisation of the energy system and the local operation of renewable energy. Energy communities can also facilitate the local optimisation of power flows and the reduction in energy losses. But their long-term success will depend on their ability to operate energy networks in a cost-efficient way ensuring benefits for all customers and the whole energy system.

When participating in an energy community, members may benefit from financial gains in relation to energy costs. These can include a reduction in their energy bill as the available renewable energy is

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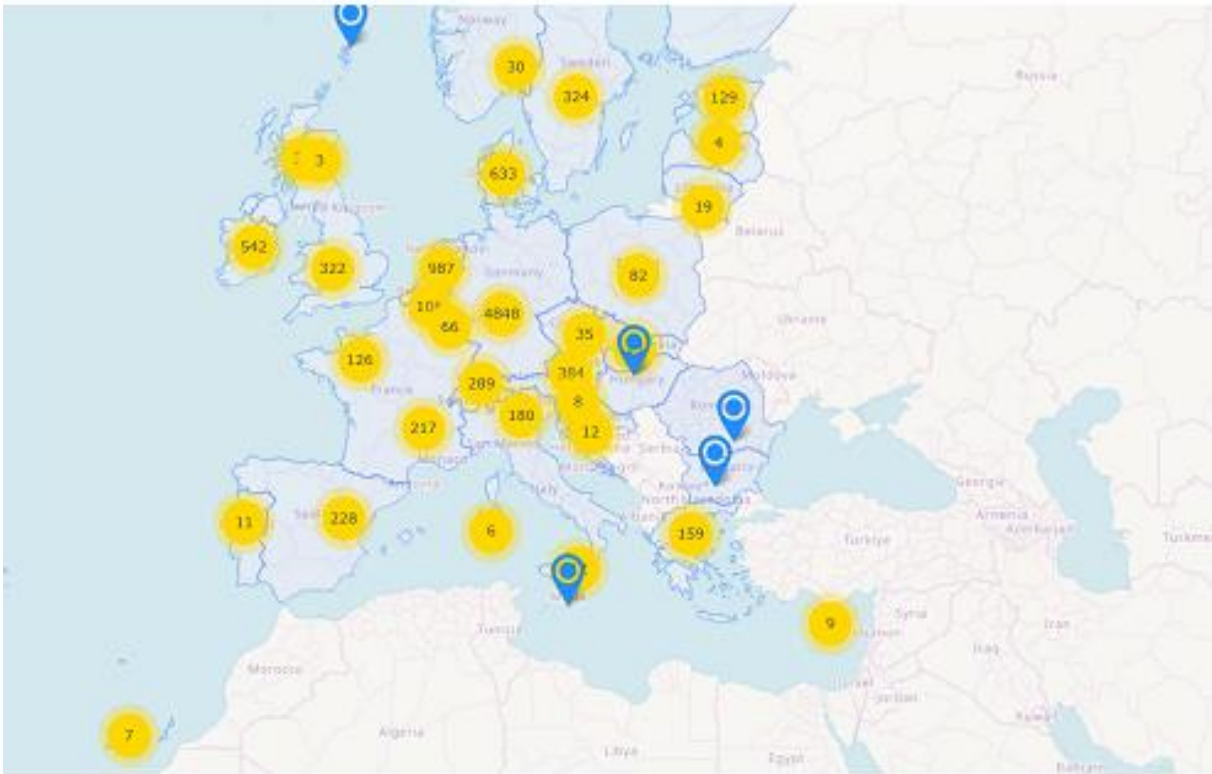
cheaper than the retail tariff and can be injected into the grid through feed-in-tariffs. Other benefits may include lower network tariffs due to aggregation effects (Abada, Ehrenmann, and Lambin, 2017). A community may also ensure better local supply security in case of power disturbances elsewhere in the grid (Pahkala, Uimonen, and Väre, 2018).

3.1.1 Review of energy communities in Europe

Based on an inventory created by the EU-funded COMETS project, this map provides an overview of Europe's energy communities and their specific data, such as the type of energy community, the number of members, their energy production, etc. [44]



[44] https://energy-communities-repository.ec.europa.eu/news-and-events/energy-communities-repository-news/launch-eu-energy-communities-map-2023-01-30_en

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5. Business Models

5.1. Energy Business Models

The motivation towards clean energy transition is boosted by the triggering of investments, aiming to provide a positive impact in society, environment, and economy. The adoption of suitable business models is able to financially support a project, effectively, by generating financial returns. Multiple factors should be taken into consideration when deciding of the most appropriate business model selection. Local conditions, financial situation, regulatory and institutional framework, and the support mechanisms of each territory are among the most critical. When designing and planning the project, its scale, potential risks, and barriers, expected revenues and social benefits are included in the list for sufficient business model definition and adoption. Ownership (assets owned by user) and Service Models (customer acquires the energy produced by a company/entity/body that owns the system) are types of business models adopted in cases of RES energy systems, depending on the ownership of assets from Public-Private Partnerships or Cooperative schemes, and the availability of upfront capital of feed-in-tariffs.

During the implementation of the Task 6.3 “Business planning for local communities”, STRATAGEM performed a literature review to further investigate additional business models adequate for the local energy communities. According to the research these are some of the most common *business models for energy communities,* and the choice of model depends on the specific needs and goals of the community.

Table 6: Energy Business Models

Type of Business Model	Description
Self-consumption	Self-generation of clean energy, city/industry/municipality as the owner of the energy plant. The generator and consumer are the same entity (prosumer) and the installation is financed by the prosumer. The prosumer self-consumes the energy generated by their clean energy plant.
Power Purchase Agreement (PPA) • **On-site private wire PPA**	Customer can negotiate a direct power purchase agreement with renewable energy generators. The customer does not owe the power plant, but he purchases the clean energy. Many different types of PPA models are available.

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Type of Business Model	Description
• **Direct off-site PPA** • **Sleeved PPA** • **Synthetic (Virtual) PPA** • **Aggregated PPA** • **Wholesale PPA** • **Mini-utility PPA**	•*On-site private wire PPA:* Can be established when a third-party developer installs and operates a clean energy plant located on the same building or in a nearby location to the consumer. •*Direct off-site PPA:* Involves a customer establishing a PPA with an off-site clean energy generator directly. Generators can sell the energy via a PPA to customers located anywhere in their electricity service territory or in the country if regulations allow. •*Sleeved PPA:* A utility physically delivering power on behalf of the customer. In the sleeved PPA model, the generator sells the power to the customer under a PPA and a third party- supplier/utility is appointed by the customer to sleeve the power from the generator to the customer. •*Synthetic (Virtual) PPA:* Enables a clean energy generator to sell power 'virtually' without physical exchange of power to multiple assets of the customer. •*Aggregated PPA*: Customers with lower energy demand and/or less experience of entering into PPAs can set up multiple buyer structures with other customers to purchase power from a clean energy generator directly. •*Wholesale PPA:* The wholesale (or utility) PPA is used for selling power on the wholesale market where the generator establishes a PPA contract with a grid operator such as a licensed supplier or balancing party. The grid operator then sells the electricity on the wholesale market and to its customers. •*Mini-utility PPA:* the customer contracts directly with the generator (without the intermediary supplier), who does not provide balancing or sleeving services. Therefore, the customer is responsible for balancing, transmission and associated risks.
Public-Private Partnership (PPP)	PPP involves a contract between a public-sector authority and a private party for a clean energy project. The private partner provides the financial support, undertakes the installation activities, the technical operation and maintenance actions and costs and upon completion of the project.
Energy Services Company (ESCO)	ESCOs deliver a variety of energy services such as heating and cooling, energy efficiency upgrade or other, to a customer's premises or facility. ESCOs manage the level of financial risk through providing performance standards e.g. pre-determined energy savings.
Leasing model	The investor/owner of the clean energy installation leases the system to the occupant or owner of the site, who operates the system and either self-consumes the energy or exports it back to the grid via an export price or net metering mechanism.

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Type of Business Model	Description
Community energy	In the community model, the main target is the community ownership, leadership and benefits, meaning that the ownership and ventures are shared by the community, crowd-funded projects and community ownership models such as co-operatives, social enterprises.
Virtual power plant (VPP)	A virtual power plant (VPP) is a software platform that remotely controls a network of medium and small-scale generator units such as solar, micro combined heat and power plant (CHP), wind, biogas, small hydro, storage systems connected to flexible consumers that have the capacity to increase or decrease their demand. A city/community can apply this type of BM with households and businesses to become part as flexible customers. A VPP is a decentralized energy system that aggregates the energy generation and storage capabilities of multiple buildings or homes in a community. This can help communities optimize energy usage and reduce energy costs by sharing resources and balancing energy demand and supply.
Municipal aggregation	In this model, a municipality, city, or a group of municipalities can form an entity to procure electricity in bulk to meet the aggregated energy demand of interested residents and businesses.
Reverse Auction	In this type of BM, the roles of seller and buyer are reversed so the sellers bid in the auction procedure. Some reverse auction cases include a community that announced a call for tender for clean energy projects with specified technology and capacity as necessary requirement for the seller to join the auction process. Another case is the city/municipality to request for buying a clean energy product or service or technology, and the seller to bid for providing it.
Microgrids	Under this model, communities create their own local power grids, separate from the main grid. Microgrids can be powered by a variety of sources, including renewable energy, and can provide energy security and independence for the community.

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Type of Business Model	Description
Energy Cooperatives	Energy cooperatives are member-owned and operated organizations that provide energy services to their members. Members typically have a say in how the cooperative is run and can benefit from lower energy costs as a result of the cooperative's bulk purchasing power.
Energy Trading Platforms	Energy trading platforms allow communities to buy and sell energy directly with each other, bypassing traditional energy utilities. This model can promote energy independence and reduce costs for communities.

5.2. Innovative business models for energy communities

Following are some of the most innovative business models for energy communities, and the choice of model will depend on the specific needs and goals of the community. It's important to note that these models are still evolving and may not be available in all regions.

Table 7: Innovative Business Models for Energy Communities

Type of Business Model	Description
Energy-as-a-Service (EaaS):	EaaS is a business model where energy companies offer energy services, such as renewable energy installations and energy management services, as a subscription-based service. This model allows communities to access renewable energy and energy management services without the need for large upfront investments.
Community Renewable Energy Funds (CREFs):	CREFs are funds that allow communities to invest in renewable energy projects, such as solar or wind farms. This model can help communities access the benefits of renewable energy while also promoting local investment and ownership.
Tokenized Energy Trading:	This model allows communities to trade energy using blockchain technology and digital tokens. This can help promote energy independence, reduce energy costs, and increase transparency in energy trading.
Energy Democracy:	Energy democracy is a business model that aims to give communities more control over their energy supply and usage. This can include community-

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Type of Business Model	Description
	owned renewable energy projects, energy cooperatives, and democratic decision-making processes around energy usage and investments.

With the cooperation of the relevant partners (NORCE, ENH, EI, UNIGE, DALANE, REST, PRIMA, FUNDITEC, CNES, KRITI, UHI, TUC), STRATAGEM performed a series of workshops and discussions in order to evaluate which of the identified business models could be applied as the most suitable on the three different application cases (Eigeroy, Wester Islands and Crete). Based on the previously identified business models and considered the *CLEAN ENERGY BUSINESS MODEL MANUAL*, the following business models that support cities and their communities with their clean energy projects and policies are presented.

Table 8: Business Models (source: CLEAN ENERGY BUSINESS MODEL MANUAL)

Business Models	*Supports local generation*	*Independent from local resources*	*Easy implementation/ transaction / contractual structure*	*Low up-front investment*	*Suitable for regulated & deregulated markets*	*Public/ community involvement*	*Creates additionality*
Self-consumption	✓		✓		✓	✓	✓
On-site private wire PPA	✓			✓			✓
Direct off-site PPA		✓		✓			✓
Synthetic PPA		✓		✓	✓		✓
Sleeved PPA		✓		✓			✓
Aggregated PPA		✓		✓			✓
Wholesale PPA		✓	✓		✓		✓
Mini-utility PPA		✓					✓
PPP		✓			✓		✓
ESCO	✓			✓	✓		✓
Leasing	✓			✓	✓		✓
Community energy	✓	✓				✓	✓
VPP	✓					✓	

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Business Models	*Supports local generation*	*Independent from local resources*	*Easy implementation/ transaction / contractual structure*	*Low up-front investment*	*Suitable for regulated & deregulated markets*	*Public/ community involvement*	*Creates additionality*
Reverse auction	✓				✓	✓	✓
Municipal aggregation		✓		✓		✓	

5.3. E-LAND's Business Model Innovation Tool for Energy Communities

As part of the ROBINSON project, we are involved in the BRIDGE Initiative Business Model Working Group where Horizon projects participate to exchange knowledge and conduct research on business models. Because of ROBINSON participation in BRINGE Initiative we had the chance to review the E-LAND's Business Model Innovation Tool with the purpose of identifying innovative business models for local communities as part of ''D6.3 Business models for energy communities''. We present the main features of this model.

The E-LAND business model innovation tool supports stakeholders to transform towards coordinators of low-carbon energy communities and provides a tool to manage business model innovation. The E-LAND business model innovator provides a package of 25 business model patterns for energy communities that proved to be successful for early mover companies and projects. The tool provides implementation references to business models of energy communities, system operators and seasonal storage for inspiration. The E-LAND business model innovation tool is designed to be applied in a workshop process.

E-LAND Business Innovation tool

The E-LAND BMI tool is a pattern-based approach to build a business model. The framework consists the five core areas: (a) community value proposition, (b) energy community members, (c) energy value capture, (d) key functions, and (e) network effects.

- Community value proposition: The core value proposition is the driving force behind the energy community. For this the main motivator to develop the energy community. Typically, energy communities are initiated as a reaction to a challenging situation, such as insufficient grid connection to the main grid, high carbon emissions or unrealized opportunities.

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- Energy community members: The community engagement is the secret power of energy communities. It is necessary to clearly define who the involved prosumers and consumers are, and which features they bring in.
- Energy value capture: Energy communities strive to become financially self-sustainable or at least try to find avenues which can support them financially. Key element to achieve this is to find and incorporate monetization mechanisms to their business. This core area provides various mechanisms through which energy related benefits can be monetized.
- Key functions: For an energy community to work key functions have to be fulfilled. The key functions define some core characteristics and tasks of the energy community.
- Network effects: Network effects are vital for energy communities to reach full operational capacity and thrive in the long-term. By explicitly defining that central network effects that substantiate the business model a strategic focus can be located.

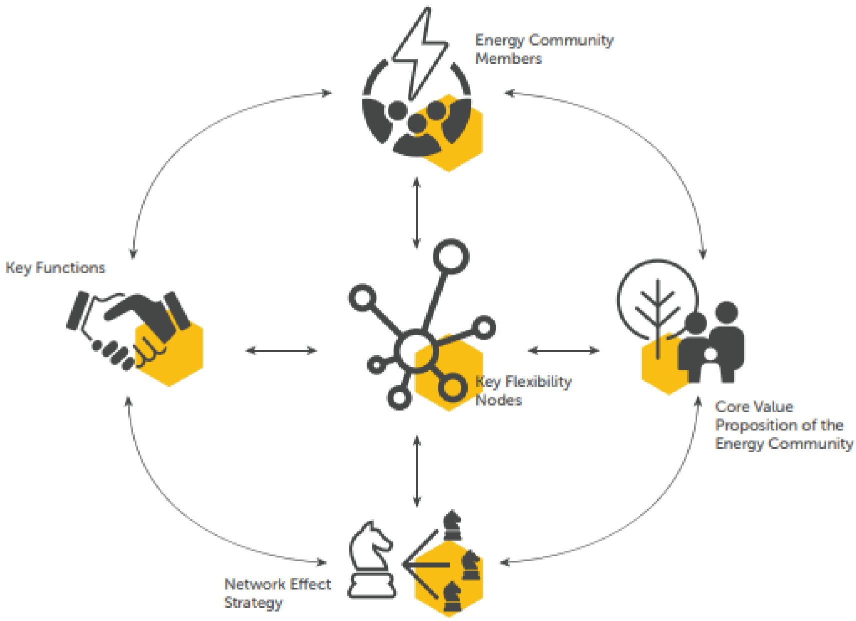

Figure 2: E-LAND Business Innovation tool-Five core areas, part of BMI tool

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6. Business Models for Eigeroy, Western Islands and Crete

6.1 Identification of Business models

Community energy business models allow citizens who are unable or unwilling to deploy clean energy on their properties (due to reasons such as low income, lack of capital, lack of space, insufficient renewable energy source, not owning the property, etc.) to buy a portion of or buy power from a shared clean energy project. Building a business model for a community can be organized on the local level through the physical interaction between the members of the renewable energy cooperatives or on the national level through virtual, online portal platform.

In order to identify and develop targeted business models that could be applied to ROBINSON business cases we distributed a questionnaire (Appendix) to the partners to collect information regarding the energy communities and business models. Based on the received information, the communication we had with our partners, the literature review we made, the most common forms of community energy in practice, and the following criteria and particularities of each island, we identified the following five (5) energy business models for communities that could be applied in RODINSON cases, without excluding other options:

Criteria:

- Different profiles of demand and availability of energy
- Balancing energy demand and supply
- Reducing the financial risk
- Benefiting from lower energy costs
- A lot of renewable energy resources, including wind, wave, and tidal energy
- Establishment of new industries
- Seasonality
- Reducing carbon emissions
- Lack of integrated storage systems
- Legislation framework

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6.1.1 PPP Business Model

A PPP involves a contract between a public-sector authority and a private party for a clean energy project. In PPPs, a public partner's role can include contributing to the financing, providing sites, monitoring performance of the private partner and enforcing its obligations, among others. The private partner's role includes providing financing, undertaking installation, technical operation and maintenance services and upon completion of the project providing public services such as electricity.

PPPs have several main features:

- They are long term contracts
- Parties share risk and responsibility
- Private partners bring their expertise and knowledge
- They supplement limited public sector funding by bringing in private sector capital.
- Private partners may operate the plant without any time limitations or for a pre-defined period under a long-term concession contract and transfer the ownership and operation of the plant back to the public partner after this period.

A community can apply this model through tendering for a private partner who would finance, design, build, own and operate a clean energy plant. PPP serves the interest of public and private partners and by engaging the capabilities of both parties provides, lower risk; because of sharing it, improved quality of services and provides high efficiency.

Drawbacks: High transaction costs due to complexity, market risk in the event the product prices fall, risk of insolvency of the private partner, financial exposure risk as PPPs bring an ongoing financial obligation to the community as part of a long-term agreement.

6.1.2 Energy Services Company (ESCO) Business Model

ESCOs deliver a variety of energy services such as heating and cooling, energy efficiency upgrades or other, to a customer's premises or facility. ESCOs manage the level of financial risk through providing performance standards e.g. pre-determined energy savings.

As ESCOs generally provide energy services and energy savings rather than actually selling energy, their main focus is on reducing consumer demand which results in lower energy use and CO2 emissions. ESCOs often design, develop, finance, and manage the project on a performance-based contract. The community can appoint an ESCO to carry out energy retrofitting on their building stock such as insulation, improving the indoor climate and integrating renewable energy sources such as solar PVs, heat pumps, etc.

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ESCOs encourages energy demand reduction, suitable for off-grid electrification projects because it relieves low-income rural households from financing through debt and helps ensure that equipment is properly maintained, no upfront investments for the customer, suitable for regulated and deregulated markets and also unregulated services such as heat.

Drawbacks: High transaction costs of tendering and contract management, not easy to apply due to regulatory barriers that prevent cities from long-term contracts, retention of energy cost savings to pay ESCOs, procure to select most value, etc. Also, long-term commitment requirement, difficult to reliably measure non-technical influences such as changed business practice, weather.

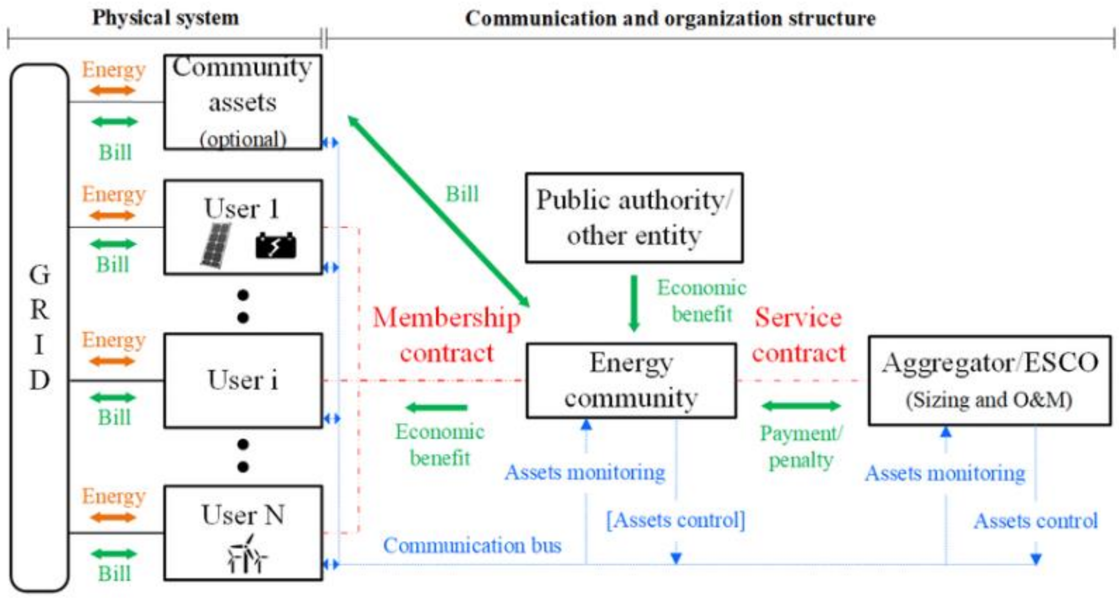

Figure 3: Business model of the energy community with externalizes design and operation[45]

6.1.3 Community energy Business Model

A community energy business model is generally established through shared ownership or joint ventures, where benefits are shared by the community, crowd-funded projects and community ownership models such as co-operatives, social enterprises, community charities, development trusts and community interest companies. Community energy projects have several main features:

- Citizens and communities own, or participate in the production of clean energy, and/or

[45] https://www.researchgate.net/figure/Business-model-of-the-energy-community-with-externalized-design-and-operation_fig2_352903058

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- Most of the community energy project's profit is given back to the community through revenue distribution or other benefits such as programmes targeting vulnerable and fuel-poor households, providing energy advice to community members, and/or
- The clean energy installation provides power to the community members.

Depending on the regulations and structure of the model there are several ways of financing a community energy project:

- ✓ Avoided electricity cost through self-consumption or PPA if the community energy project is located on-site.
- ✓ PPA if the community energy project will be selling power to a third-party or utility.
- ✓ (Virtual) net metering on participants' bills if regulations allow.

There are several forms of community energy models:

Utility sponsored model: The utility owns or operates a project that is open to voluntary community participation. This model has the advantage of making use of the existing legal, financial and program management infrastructure of utilities.

City owned or sponsored model: This model involves ownership of the clean energy installation by a city. The power produced is sold to a third party (a utility) or consumed on-site to offset energy usage at public facilities such as schools, community buildings, etc. Its advantages are exemption from lease or property tax payments if located on a city-owned site, and access to low-cost financing with municipal bonds. 17 When the project generates sufficient additional revenue, there could be indirect benefits in the form of community-benefits such as programmes targeting vulnerable and fuel poor households, providing energy advice to community members, etc.

6.1.4 Virtual power plant (VPP) Business Model

A virtual power plant (VPP) is a software platform that remotely controls a network of medium and small-scale generator units such as solar, micro combined heat and power plant (CHP), wind, biogas, small hydro, storage systems connected to flexible consumers that have the capacity to increase or decrease their demand. All units are remotely controlled and dispatched through the VPP's central control room while remaining independent in their ownership and administration. A community can apply this business model through getting involved in the creation and facilitation of a VPP. Individual households and businesses can become part of VPP as flexible consumers and provide smart response to VPP and prosumers, decentralised energy generators, and storage systems can participate in VPP

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through providing variable power resource. The objective is to smartly control generation and consumption of the connected units, trade the generated and consumed power in a profitable way and take advantage of high prices so that participating consumers pay lower energy bills through re-numeration and reduced electricity costs and participating generators make more profit through accessing higher prices. For example, during periods of peak load, VPP can discharge connected electric vehicles, batteries, and decrease the consumption of the flexible consumers in order to relieve the load on the grid and take advantage of high prices. Through controlling generation and consumption levels in VPP's network, VPP sells the electricity or ancillary services on the electricity and balancing markets, or the aggregated power is regionally dispatched to match supply and demand in the region.

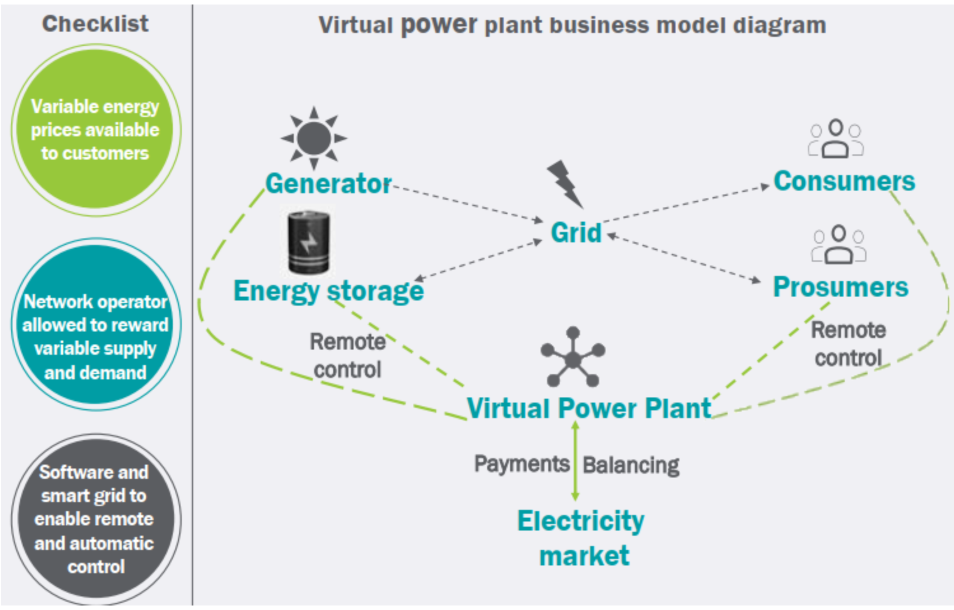

Figure 4: Virtual Power Plant (source: Clean energy business model manual)

6.1.5 Energy Cooperatives Business Model

It is a community organization owned and managed by its members. The cooperative is responsible for carrying out and overseeing all administrative and operational tasks such as the installation, maintenance, and financial management, etc. Cooperatives can be profit-driven companies but allow members to own shares in clean energy projects, share the profits of the projects through dividends and often get their electricity supply at a fair price from the community clean energy installation instead of a larger utility.

Enables community members that cannot or choose not to install a clean energy at their properties to access clean energy, minimizes adverse social and environmental impacts of the project, Increases social acceptance through community involvement in the local clean energy policy, Increases local energy security as well as economic resilience and generation of local

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jobs. Energy cooperatives are one of the most common forms of local energy communities. They are membership based and democratic and can provide different services across the energy sector such as: self-production and consumption.

The success of the model is highly dependent on regulation and support schemes, availability of financing and finance mechanisms, and local skills, challenging and time-consuming stakeholder coordination, reliant on volunteers and requires passionate local community members to develop a successful project, high risk as volunteer managers can lack commitment and appropriate management skills.

6.2 Financial instruments

Financial instruments are used to finance clean energy projects in both the private and public sector. They are very important because the cost of a clean energy investment primarily comprises the upfront cost, one of the most important barriers to clean energy deployment. Financial instruments bring many advantages to clean energy deployment since they remove barriers to entry, they create a revenue stream and financing basis for business models, they have the design flexibility to be adjusted to support different technologies or actors.

In addition, financial instruments can help circumvent other obstacles such as lack of long-term or project financing from the private sector or underdeveloped financial markets where it is difficult to obtain financing at reasonable costs. Therefore, publicly funded financial instruments should target the elimination of barriers or risks that are hindering private investment as well as to deliver the greatest amount of private funding using the smallest amount of public funds. Therefore, it is important to select the correct type and level of financial instrument in order to tackle these barriers effectively.

Financing mechanisms

The common financing mechanisms that have been used widely in various sectors are:[46]

- **The Grand Funding**, referring to amounts that awarded with no obligation to be repaid, often being used to facilitate the planning and development phases of a project. Grants are awarded for a specific purpose and do not have to be repaid. They are often used to facilitate the planning and development phases of a project. State grants are not generally used to fully fund capital phases of a project because state aid rules limit the amounts that are available if the project also intends to benefit from additional public financial incentives at a later stage.
- **The Dept Finance**, referring usually to loans, the most common type of dept financing, generally used to fund the development and construction phases of a project. Loans are the most common type of debt financing and are generally used to fund the development and construction

[46] https://www.spenergynetworks.co.uk/pages/finance_funding.aspx#finance-types

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phases of a project. Loans involve borrowing a sum of money from a 3rd party which is repaid with interest at an agreed future date. Lenders will generally require some degree of equity funding as a condition of debt finance, so most projects are funded by a mixture of debt and equity.

  - **Equity Finance**, the process of raising capital through the sale of shares, mainly by bilateral agreements with the investors for sharing the profits and involve them in the decision-making processes since the project's initiation and can be used at any stage of a project's lifecycle. There are no interest charges or fixed repayments to be made but you will have to give investors a percentage of the profits and consult with them about decisions affecting the project.

- **Financial Incentives & Subsidies**, which are usually available to renewable energy projects in operation phase and are capable to provide a guaranteed revenue stream over a set period.
- **Self-funding:** This is one of the simplest financing mechanisms, where the system owner, usually also the power consumer, uses their own cash to pay for the installation outright. This financing mechanism is heavily dependent on support schemes and also available to only investors who have large amounts of cash readily available.

The table below represents how much control or influence a community can exert on each of the following financial instruments. These may differ for each community depending on the regulatory context and powers of the community. Innovative financial instruments that communities can use to accelerate clean energy deployment:[47]

[47] CLEAN ENERGY BUSINESS MODEL MANUAL November 2018

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Table 9: Financial instruments

	Description	Removes capital cost barrier	Easy implementation/ transaction structure	Provides on-going additional revenue to consumer	Return on capital for financier	Public/ community involvement	Low capital/public funding required	No regulatory/ legislation complexity
Crowdfunding	Allows many investors or community members to each put in small amounts of money in order to raise funds for a clean energy project. Is often combined with loans or equity financing mechanisms. It can thus provide finance to a broader range of projects such as innovative and small-scale projects which might struggle to get other forms of financing.	✓	✓		✓	✓	✓	✓
Feed-in scheme	Clean energy generators receive a direct payment per unit of energy produced i.e. feed-in tariff. Level of feed-in schemes generally vary depending on the size of the installation, technology and fuel used and the payment is generally based on production or export levels.			✓		✓		
Renewable energy certificate	Scheme at a national level: requires producers to generate a specified proportion of energy from renewable sources, suppliers to supply a given proportion from renewable sources, or consumers to consume a given proportion from renewable sources. Promotes investment in local renewable energy projects as investors seek to capture two streams of revenue: e.g. power sales and the sale of RECs.			✓			✓	
Net metering	Prosumers can net off the generation from their consumption over a large timeframe. Can be used under a self-consumption business model. There are several variations of net metering such as aggregate net metering and virtual net metering. These variations can be used with other different business models such as PPA, community energy, etc.			✓		✓	✓	

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	Description	Removes capital cost barrier	Easy implementation/ transaction structure	Provides on-going additional revenue to consumer	Return on capital for financier	Public/ community involvement	Low capital/public funding required	No regulatory/ legislation complexity
On-tax bill financing	Is a mechanism used by local governments to provide lowinterest loans for homeowners to invest in clean energy, which they gradually pay back through slightly higher property taxes.	✓			✓	✓		
On-energy bill financing	The goal is to eliminate the upfront cost of the clean energy installation to the customer by financing it with an addition to their regular energy bill. The loan payments are made over a long period and with a low interest rate. The repayment obligation typically remains with the property and not the homeowner or company. Overcomes the barrier of high-up front costs.	✓			✓	✓		
Tax incentives	Instrument instruments used by governments to promote the introduction of new clean energy technologyEffective for supporting the introduction of a new clean energy technology.Brings considerable value to investors that have large tax liabilities.	✓	✓			✓	✓	✓
Investment grants	The investment grants/rebates are generally in the form of cash and used to encourage deployment of clean energy technologies and eliminate the investment cost barrier through reducing the upfront cost to the customer. They are used by states, municipalities, cities, utilities, and other non-governmental organisations to encourage the use of certain renewable energy technologies.	✓	✓			✓		✓
Green bond	Are similar to regular bonds, except for the fact that their proceeds are used to finance exclusively green projects which are tracked to ensure green compliance. As many cities have limited access to capital markets37, green bonds can help municipal governments to raise funds to invest in clean energy projects. Like other type of bonds, investors – buyers of green bonds – receive a financial return on their investments.	✓			✓		✓	✓

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	Description	Removes capital cost barrier	Easy implementation/ transaction structure	Provides on-going additional revenue to consumer	Return on capital for financier	Public/ community involvement	Low capital/public funding required	No regulatory/ legislation complexity
Pay as you go	the clean energy equipment or system supplier removes the up-front capital barrier through providing the clean energy system to the customer for an initial small (or no fee) and the customer pays to use the energy through a top up system. Enables the low-income households to access clean energy systems and removes the high up-front cost barrier.	✓			✓	✓		✓

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Crowdfunding platforms provide financing in the form of loans, equity or grants. In equity crowdfunding, the investors become co-owners or shareholders of the clean energy project. This brings many smaller private and non-professional investors together where the crowdfunding platform acts as an intermediary for them. Cooperatives can be formed through equity crowdfunding, where the investors jointly own and run the project and share out the proceeds of the project.

NESOI is a Platform that provides such financial tools. NESOI will increase the island local authority staff knowledge on both technical and procedural aspects, giving them the opportunity to accelerate the development of energy projects. Different instruments will be available for islands looking to undertake similar initiatives: the organization of dedicated on-site Workshops, the e-learning material available in the dedicated section of the Platform, the sharing of best practices via the Island Stories and the possibility to meet tech/services providers of energy transition solutions.

European City Facility: The EUCF supports support municipalities, local authorities, their groupings and local public entities aggregating municipalities/local authorities in Europe with tailor-made, fast and simplified financial support for the energy transition (in the form of EUR 60,000 lump sums).

6.3 Values across stakeholders

According to the *D6.1 "Evidence base prototype for the scale up and uptake of project concepts"*, stakeholders' names, types of stakeholders, and relationships to the project were identified. Almost all the stakeholders have positive expectations, high willingness to cooperate, and have high influence and power to the project except neighbours and surrounding industries.

Based on this list, values across stakeholders were identified and described, as shown in the table below. For easier reading we used numbers to describe the relevant stakeholders, such as:

1. Technology providers and suppliers incl. RES and energy storage	5. Financial partners (ESCOs, banks, private funds, other funds)
2. Energy storage experts	6. Local or regional authorities – municipalities (Citizens associations)
3. Utilities including district heating companies	7. Institutional stakeholders (chambers, professional)
4. Electricity regulators and grid operators	8. Industries
	9. Commercial customers

Table 10: Identified values across stakeholders

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Values	Description	Impact (Low, Medium, High)	Stakeholders impacted most
Improve energy efficiency	Less energy loss due to a closer link between production and consumption	Medium to High	4,5,6,7
Grid stability, continuity, and reliability	Avoiding power outages and electricity failures	Medium to High	4,7,8,9
Safety	Avoiding accidents by means of procedures and design	Medium	4
Security	Protection against cyberattacks or other rogue actions	Medium to High	4,8,9
Affordability	Installation, management and energy costs are within a feasible price range	Medium to High	6,8,9
Return on investment	Financial return on investment, relative to the investment's cost	Medium	5,6,8,9
Lower energy bills	Short- and long-term net savings on energy bills	Medium to High	6,7,8,9
Replicability	The same EnCo system is applicable across different sites	High	1,2
Innovation	Pioneering in new techniques and systems	High	1,2
Employment	Setting up an energy community creates additional jobs	High	6,7,8,9
Commercial validation of products and services	Being able to offer one's own energy-related products and services within the EnCo	Medium to High	1,2,3,4
Inclusiveness	Incorporating social costs and a contribution to the socially vulnerable	Medium to High	7,8
Community building	More cooperation and knowledge sharing	Medium to High	6,7,8,9
(Green) image building	Business card to the outside world	Medium	7,8,9
Energy independence/Autonomy	Participatory self-management of the energy system and independence from market price fluctuations	Medium	5,7,8,9

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Values	Description	Impact (Low, Medium, High)	Stakeholders impacted most
Behavior change (Awareness)	Stimulates more concern for sustainability and more efficient use of energy in other aspects of daily life	Medium	7,8,9
Increased renewable energy penetration	Less fossil fuels	High	6,7,8,9
Emissions reduction	Lower fossil fuel emissions and better air quality	Medium to High	7,8,9
EU policies	Coordination with current planning and policy processes	Medium to High	4,6

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7. Application of Business Model Canvas (BMC)

In the D7.7 the Business Model Canvas (BMC) was described. Is one of the most commonly used frameworks in the business literature for analyzing firms' business models is the Business Model Canvas (BMC). Created by Osterwalder and Pigneur in 2010 it consists of a strategic management template used for developing new business models and documenting existing ones (Barquet, et. Al, 2011; De Reuver et al. 2013). Additionally, documents business models in a simple, unbureaucratic and easily understandable way while at the same time supporting a uniform understanding of the business model within the company (Osterwalder and Pigneur, 2010). Through a visual chart, the BMC facilitates the representation of an organization's business logic in terms of how it is organizing its operations for creating, delivering, and capturing value (Schütz et al. 2021).

The BMC consists of nine interconnected elements. The 9 nine elements are described below:

1. **Customer Segments**: The different groups of customers an organization will reach to provide a service or offer a product. It consists of a seminal step for each organization in order to identify for whom the solution is expected to create value and try to serve.
2. **Value Proposition**: The value proposition describes the combination of products and services which provide value to the customer and provide solutions to the problems he/she faces. These products and services are what distinguish the product or service from its competitors.
3. **Revenue Streams**: This element describes how an organization generates revenues from each Customer Segment.
4. **Channels**: This element describes the different efficient and cost-effective channels that can be selected to communicate and deliver products and services to individual customer segments.
5. **Customer Relationships**: The types of relationships an organization will establish with each Customer Segment to ensure the success of its business model. These relationships can take various different forms depending on the nature of the product or the service offered by the organization.
6. **Key Activities**: Key activities comprise the most important processes that need to take place in order for a business model to work (e.g. designing, manufacturing, and delivering a product, software development, supply chain management etc.).
7. **Key Resources**: The required resources needed to create value for an organization. These can be financial, technological, intellectual, human, etc.

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8. **Key partners**: The network of suppliers and partners that assist the organizations' business models work. Organizations establish relationships with these partners to optimize processes or acquire resources.
9. **Cost Structure**: Cost structure includes all the costs incurred to operate a business model (e.g, manufacturing and R&D costs etc.). It consists of one of the most important element of the BMC since it can be a decisive factor to influence the selection between different business models.

We developed five (5) Business Model Canvas for the demonstration island of Eigeroy, one for Western Islands and one for Crete according to the GA, based on the five selected business models for energy communities that we described in the previous paragraphs.

Table 11: Business Models for energy communities in ROBINSON cases

a/a	Business Model	Demo case
1	**Public-Private Partnership (PPP)**	Eigeroy
2	**Energy Services Company (ESCO)**	Eigeroy
3	**Community energy**	Eigeroy
4	**Virtual power plant (VPP)**	Eigeroy, Western Isles
5	**Energy Cooperatives**	Eigeroy, Crete

7.1 Business Model Canvas for Eigeroy case

The demonstration will be on the island of Eigerøy in Norway. ROBINSON involves all relevant stakeholders: The representative of the municipality (ENH), fish industry (PRIMA), grid operator (DALANE), local market and business expert (EI), will ensure the demonstration feasibility, as well as the sustainability of the system to reach its full-scale.

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ROBINSON – Business Model Canvas (1)

EIGEROY _ Community energy BM

Key partners

- ✓ NORCE, ENH
- ✓ DALANE, PRIMA
- ✓ Energy community?
- ✓ Technology providers and suppliers incl. RES and energy storage
- ✓ Industrial companies & technical staff
- ✓ Electricity regulators and grid operators
- ✓ Financial partners
- ✓ Citizens associations
- ✓ Industries representatives
- ✓ Energy Researchers

Key activities

- ✓ Combined heat and power unit
- ✓ Steam boiler
- ✓ Twind turbine
- ✓ Electrolyser
- ✓ AD-BES system
- ✓ Gasifier
- ✓ Gas fuel mixer
- ✓ PV systems
- ✓ EMS
- ✓ Energy storage systems
- ✓ Infrastructure for EV & ships

Key resource

- ✓ Experienced consortium
- ✓ Financial instruments
- ✓ Private partners bring their expertise and knowledge.
- ✓ Fixed fee paid by the prosumers

Value & services

- ✓ Lower energy costs (most of the community energy project's profit is given back to the community through revenue distribution or other benefits such as programmes targeting vulnerable and fuel-poor households, providing energy advice to community members.
- ✓ Offer energy saving solutions to local community.
- ✓ Create new services and business opportunities in the area of energy efficiency and renewables.
- ✓ Seasonal storage, Batteries, Hydrogen
- ✓ Decrease the requirement for high installed power capacity.
- ✓ Carbon reduction from use of RES and energy storage.
- ✓ Energy management system to control and optimize energy usage
- ✓ General energy use awareness from users.
- ✓ Citizens and communities own or participate in the production of clean energy.
- ✓ Grid efficiency

Customer relationships

- ✓ Personal assistance
- ✓ Co-creation
- ✓ Retailers
- ✓ Companies and other municipal utilities to incorporate.
- ✓ Consultants
- ✓ Community energy to stimulate local RES investment.

Channels

- ✓ Local or regional authorities –municipalities
- ✓ Municipal or regional companies
- ✓ Institutional stakeholders (chambers, associations)
- ✓ Financial partners (shared

Customer segments

- ✓ Local industries (energy intensive e.g. fish industries, etc.)
- ✓ Existing residents who will benefit from energy savings or see increased access to energy and heat.
- ✓ Local fleet of vehicles powered by green gases.
- ✓ Ships owners use green electricity for ships unloading fish in local harbors.
- ✓ Commercial customers
- ✓ Prosumers
- ✓ Farmers

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			ownership or joint ventures, banks private funds, crowd-funded projects, other funds) ✓ Citizens associations	

Cost structure ✓ Costs of equipment ✓ Cost of expanding infrastructure ✓ Technical support	Revenue structure ✓ Public and private investment ✓ Improve energy efficiency leads to cost savings ✓ From EV and ships users

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ROBINSON – Business Model Canvas (2)

EIGEROY _ Cooperative BM

Key partners

- ✓ NORCE, ENH
- ✓ DALANE, PRIMA
- ✓ Energy community?
- ✓ Technology providers and suppliers incl. RES and energy storage
- ✓ Industrial companies & technical staff
- ✓ Electricity regulators and grid operators
- ✓ Financial partners
- ✓ Citizens associations
- ✓ Industries representatives
- ✓ Local population

Key activities

- ✓ Combined heat and power unit
- ✓ Steam boiler
- ✓ Twind turbine
- ✓ Electrolyser
- ✓ AD-BES system
- ✓ Gasifier
- ✓ Gas fuel mixer
- ✓ PV systems
- ✓ EMS
- ✓ Energy storage systems
- ✓ Infrastructure for EV & ships

Key resource

- ✓ Experienced consortium
- ✓ Financial instruments
- ✓ Private partners bring their expertise and knowledge.
- ✓ Fixed fee paid by the prosumers

Value & services

- ✓ Offer energy saving solutions to local community.
- ✓ Create new services and business opportunities in the area of energy efficiency and renewables.
- ✓ General energy use awareness from users.
- ✓ Utilization of the Various biomass resources (industrial & domestic wastes: e.g. fish waste, wood).
- ✓ Seasonal storage, Batteries, Hydrogen
- ✓ Decrease the requirement for high installed power capacity.
- ✓ Carbon reduction from use of RES and energy storage.
- ✓ Energy management system to control and optimize energy usage.
- ✓ General energy use awareness from users.
- ✓ Grid efficiency

Customer relationships

- ✓ Personal assistance
- ✓ Co-creation
- ✓ Retailers
- ✓ Companies and other municipal utilities to incorporate.
- ✓ Energy cooperatives to stimulate local RES investment.
- ✓ Consultants

Channels

- ✓ Local or regional authorities –municipalities
- ✓ Municipal or regional companies
- ✓ Institutional stakeholders (chambers, associations)

Customer segments

- ✓ Local industries (energy intensive e.g. fish industries, etc.)
- ✓ Existing residents who will benefit from energy savings or see increased access to energy and heat.
- ✓ Local fleet of vehicles powered by green gases.
- ✓ Ships owners use green electricity for ships unloading fish in local harbors.
- ✓ Commercial customers
- ✓ Prosumers
- ✓ Farmers

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			✓ Financial partners (ESCOs, banks private funds, other funds) ✓ Citizens associations	

Cost structure	Revenue structure
✓ Costs of equipment ✓ Cost of expanding infrastructure ✓ Technical support	✓ Public and private investment ✓ Improve energy efficiency leads to cost savings ✓ From EV and ships users

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ROBINSON – Business Model Canvas (3)

EIGEROY _ Energy Services Company (ESCO) BM

Key partners

- ✓ NORCE, ENH
- ✓ DALANE, PRIMA
- ✓ Energy Community
- ✓ Public authority or other entity
- ✓ Technology providers and suppliers incl. RES and energy storage
- ✓ Electricity regulators and grid operators (e.g.: TSOs, DSOs)
- ✓ Citizens associations
- ✓ Financial partners
- ✓ Industries representatives
- ✓ ESCOs
- ✓ Energy experts, Researchers

Key activities

- ✓ Combined heat and power unit
- ✓ Steam boiler
- ✓ Twind turbine
- ✓ Electrolyser
- ✓ AD-BES system
- ✓ Gasifier
- ✓ Gas fuel mixer
- ✓ PV systems
- ✓ EMS
- ✓ Energy storage systems
- ✓ Infrastructure for EV & ships

Key resource

- ✓ Experienced consortium
- ✓ Financial instruments
- ✓ Private partners bring their expertise and knowledge
- ✓ From the reduction of financial risk

Value & services

- ✓ Reduce consumer demand and upgrade energy efficiency.
- ✓ Reducing greenhouse gas emissions, and lowering costs on a household and economy-wide level.
- ✓ Balancing the grid by means of the DR services.
- ✓ Valorisation of buildings through energy certification.
- ✓ Raising occupants' awareness to energy consumption.
- ✓ Condition based maintenance or efficiency-based maintenance.
- ✓ Energy management based on shared savings.
- ✓ Create new services and business opportunities in energy efficiency and renewables.
- ✓ Improving the indoor climate and integrating renewable energy sources.
- ✓ Improving energy security and demonstrating a commitment to sustainability and environmental responsibility.

Customer relationships

- ✓ Personal assistance
- ✓ Co-creation
- ✓ Retailers
- ✓ Direct contract
- ✓ Companies and other municipal utilities to incorporate.
- ✓ Consultants
- ✓ ESCOs stimulate local RES investment and reduce consumer demand.

Channels

- ✓ Local or regional authorities –municipalities
- ✓ Municipal or regional companies
- ✓ Institutional stakeholders (chambers, associations)
- ✓ Financial partners (banks

Customer segments

- ✓ Local industries
- ✓ Residents who will benefit from energy savings
- ✓ Public institutions
- ✓ Hospitals, Schools
- ✓ Government buildings
- ✓ Local fleet of vehicles powered by green gases.
- ✓ Ships owners use green electricity for ships unloading fish in local harbors.

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		✓	private funds, other funds) ✓ Citizens associations	

Cost structure ✓ Costs of equipment ✓ Cost of expanding infrastructure ✓ Technical support	Revenue structure ✓ Public and private investment ✓ Improve energy efficiency leads to cost savings ✓ Optimal schedules of the devices at the local level and thus increase its revenues (as a portion of the prosumer's profits) ✓ From EV and ships users

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ROBINSON – Business Model Canvas (4)

EIGEROY _ Public-Private Partnership (PPP) BM

Key partners

- ✓ NORCE, ENH
- ✓ DALANE, PRIMA
- ✓ Energy Community
- ✓ Technology providers and suppliers incl. RES and energy storage
- ✓ Industrial companies & technical staff
- ✓ Electricity regulators and grid operators
- ✓ Financial partners
- ✓ Citizens associations
- ✓ Industries representatives

Key activities

- ✓ Combined heat and power unit,
- ✓ Steam boiler
- ✓ Twind turbine
- ✓ Electrolyser
- ✓ AD-BES system
- ✓ Gasifier
- ✓ Gas fuel mixer
- ✓ PV systems
- ✓ EMS
- ✓ Energy storage systems.
- ✓ Infrastructure for EV & ships

Key resource

- ✓ Experienced consortium
- ✓ Financial instruments
- ✓ Private partners bring their expertise and knowledge.
- ✓ Reducing the financial risk.

Value & services

- ✓ Balancing energy demand and supply (Seasonality).
- ✓ Improve energy efficiency.
- ✓ Offer energy saving solutions to local community.
- ✓ Create new services and business opportunities in energy efficiency and renewables.
- ✓ Utilization of the Various biomass resources (e.g. fish waste, wood).
- ✓ Seasonal storage, Batteries, Hydrogen
- ✓ Decrease the requirement for high installed power capacity.
- ✓ Carbon reduction from use of RES and energy storage.
- ✓ Energy management system to control and optimize energy usage.
- ✓ General energy use awareness from users.

Customer relationships

- ✓ Personal assistance
- ✓ Co-creation
- ✓ Retailers
- ✓ Companies and other municipal utilities to incorporate.
- ✓ Public-Private Partnership (PPP) to stimulate local RES investment.
- ✓ Consultants

Channels

- ✓ Local or regional authorities –municipalities
- ✓ Municipal or regional companies
- ✓ Institutional stakeholders (chambers, associations)
- ✓ Financial partners (ESCOs,

Customer segments

- ✓ Local industries (energy intensive e.g. fish industries, etc.)
- ✓ Existing residents who will benefit from energy savings or see increased access to energy and heat.
- ✓ Local fleet of vehicles powered by green gases.
- ✓ Ships owners use green electricity for ships unloading fish in local harbors.
- ✓ Commercial customers
- ✓ Prosumers

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			banks private funds, other funds) ✓ Citizens associations	

Cost structure ✓ Costs of equipment ✓ Cost of expanding infrastructure ✓ Technical support	Revenue structure ✓ Public and private investment ✓ Improve energy efficiency leads to cost savings ✓ From EV and ships users

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ROBINSON – Business Model Canvas (5)

EIGEROY _ Virtual Power Plant (VPP) BM				
Key partners	Key activities	Value & services	Customer relationships	Customer segments
✓ NORCE, ENH ✓ DALANE, PRIMA ✓ Energy Community ✓ Public authority or other entity ✓ Technology providers and suppliers incl. RES and energy storage. ✓ Electricity regulators and grid operators (e.g.: TSOs, DSOs). ✓ Citizens associations ✓ Financial partners ✓ Industries representatives	✓ Combined heat and power unit, ✓ Steam boiler ✓ Twind turbine ✓ Electrolyser ✓ AD-BES system ✓ Gasifier ✓ Gas fuel mixer ✓ PV systems ✓ EMS ✓ Energy storage systems. ✓ Infrastructure for EV & ships	✓ Help communities to optimize energy usage and reduce energy costs by sharing resources and balancing energy demand and supply. ✓ Carbon reduction from use of RES and energy storage. ✓ Reduction of carbon taxes due to the reduction of CO_2. ✓ Is a decentralized energy system that aggregates the energy generation and storage capabilities of multiple buildings or homes in a community. ✓ Integrates many resources, such as: Renewable Energy Sources (RES), energy storage systems. ✓ Offer energy saving solutions to local community.	✓ Personal assistance ✓ Co-creation ✓ Retailers ✓ Companies and other municipal utilities to incorporate. ✓ Consultants ✓ Virtual Power Plant (VPP) to stimulate local RES investment.	✓ Local industries (energy intensive e.g. fish industries, etc.) ✓ Existing residents who will benefit from energy savings or see increased access to energy and heat. ✓ Local fleet of vehicles powered by green gases. ✓ Ships owners use green electricity for ships unloading fish in local harbors. ✓ Public institutions ✓ Hospitals, Schools

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Key resource

- ✓ Experienced consortium
- ✓ Financial instruments
- ✓ Private partners bring their expertise and knowledge.
- ✓ From the reduction of financial risk.
- ✓ Portion of the compensation provided to prosumers for their participation in explicit demand and response (DR) events.
- ✓ Fixed fee paid by the prosumers

- ✓ Create new services and business opportunities in energy efficiency and renewables.
- ✓ Seasonal storage, Batteries, Hydrogen
- ✓ Decrease the requirement for high installed power capacity (techniques like load shifting and direct load curtailment can optimize power consumption and decrease the requirement for high installed power capacity).
- ✓ Energy management system to control and optimize energy usage.

Channels

- ✓ Local or regional authorities –municipalities
- ✓ Municipal or regional companies
- ✓ Institutional stakeholders (chambers, associations)
- ✓ Financial partners (ESCOs, banks private funds, other funds)
- ✓ Citizens associations

- ✓ Government buildings

Cost structure

- ✓ Costs of equipment
- ✓ Cost of expanding infrastructure
- ✓ Technical support

Revenue structure

- ✓ Public and private investment
- ✓ Improve energy efficiency leads to cost savings
- ✓ Revenues from Demand & Response events.
- ✓ From EV and ships users

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7.2 Business Model Canvas for Western Isles case

ROBINSON – Business Model Canvas

WESTERN ISLES _ Virtual Power Plant (VPP) BM

Key partners	Key activities	Value & services	Customer relationships	Customer segments
✓ CNES, ERI ✓ Energy Community ✓ Public authority or other entity ✓ Technology providers and suppliers incl. RES and energy storage ✓ Electricity regulators and grid operators (e.g.: TSOs, DSOs) ✓ Financial partners ✓ Citizens associations ✓ Industries representatives	✓ Combined heat and power unit ✓ Steam boiler ✓ Twind turbine ✓ Electrolyser ✓ AD-BES system ✓ Gasifier ✓ Gas fuel mixer ✓ PV systems ✓ EMS ✓ Energy storage systems ✓ Infrastructure for EV & ships	✓ Integrates many resources, such as: Renewable Energy Sources (RES), energy storage systems. ✓ Utilization of the Various biomass resources (industrial & domestic wastes) ✓ Decrease the requirement for high installed power capacity (techniques like load shifting and direct load curtailment can optimize power consumption and decrease the requirement for high installed power capacity). ✓ Help communities to optimize energy usage and reduce energy costs by sharing resources and balancing energy demand and	✓ Personal assistance ✓ Co-creation ✓ Retailers ✓ Companies and other municipal utilities to incorporate. ✓ Consultants ✓ Virtual Power Plant (VPP) to stimulate local RES investment.	✓ Local industries ✓ Existing residents who will benefit from energy savings or see increased access to energy and heat. ✓ Local fleet of vehicles powered by green gases. ✓ Ships owners use green electricity for ships. ✓ Prosumers ✓ Public institutions ✓ Hospitals, Schools ✓ Government buildings

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	Key resource		Channels	
	✓ Experienced consortium ✓ Financial instruments ✓ Private partners bring their expertise and knowledge. ✓ From the reduction of financial risk. ✓ Portion of the compensation provided to prosumers for their participation in explicit demand and response (DR) events. ✓ Fixed fee paid by the prosumers	supply. ✓ Carbon reduction from use of RES and energy storage. ✓ General energy use awareness from users. ✓ Reduction of carbon taxes due to the reduction of CO2 ✓ Is a decentralized energy system that aggregates the energy generation and storage capabilities of multiple buildings or homes in a community. ✓ Create new services and business opportunities in energy efficiency and renewables. ✓ Seasonal storage, Batteries, Hydrogen ✓ Energy management system to control and optimize energy usage.	✓ Local or regional authorities –municipalities ✓ Municipal or regional companies ✓ Institutional stakeholders (chambers, associations) ✓ Financial partners (ESCOs, banks private funds, other funds) ✓ Citizens associations	

Cost structure	Revenue structure
✓ Costs of equipment ✓ Cost of expanding infrastructure ✓ Technical support	✓ Public and private investment ✓ Improve energy efficiency leads to cost savings ✓ Revenues from Demand & Response events. ✓ From EV and ships users

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7.3 Business Model Canvas for Crete case

ROBINSON – Business Model Canvas

CRETE_ Cooperative Energy BM				
Key partners	Key activities	Value & services	Customer relationships	Customer segments
✓ Technical University of Crete ✓ Regional of Crete ✓ Energy Community (e.g: Minoan) ✓ Technology providers and suppliers incl. RES and energy storage ✓ Industrial companies & technical staff ✓ Electricity regulators and grid operators ✓ Financial partners	✓ Combined heat and power unit, ✓ Steam boiler ✓ Twind turbine ✓ Electrolyser ✓ AD-BES system ✓ Gasifier ✓ Gas fuel mixer ✓ PV systems ✓ EMS ✓ Energy storage systems.	✓ Reduce dependency on imported fossil fuels. ✓ Offer energy saving solutions to local community. ✓ Create new services and business opportunities in the area of energy efficiency and renewables. ✓ Utilization of the Various biomass resources (e.g. agricultural organic wastes, olive ensure a stable and reliable supply of RES energy-seasonal storage TES, Batteries, Hydrogen). ✓ Decrease the requirement for high installed power capacity. ✓ General energy use awareness from	✓ Personal assistance ✓ Co-creation ✓ Retailers ✓ Companies and other municipal utilities to incorporate. ✓ Consultants ✓ Energy cooperatives to stimulate local RES investment.	✓ Local industries (energy intensive e.g. other food industries, etc.) ✓ Existing residents who will benefit from energy savings or see increased access to energy. ✓ Local Cooperative's Olive Oil Mill ✓ Hotels ✓ Prosumers

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✓ Citizens associations ✓ Industries representatives	Key resource ✓ Experienced consortium ✓ Crete business innovation platform ✓ Financial instruments	users. ✓ Carbon reduction from use of RES and energy storage. ✓ Energy management system to control and optimize energy usage	Channels ✓ Local or regional authorities –municipalities ✓ Municipal or regional companies ✓ Institutional stakeholders (chambers, associations) ✓ Financial partners (ESCOs, banks private funds, other funds) ✓ Citizens associations	

Cost structure	Revenue structure
✓ Costs of equipment ✓ Cost of expanding infrastructure ✓ Technical support	✓ Public and private investment ✓ Improve energy efficiency leads to cost savings.

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7.4 Business Model Archetype for the demonstration island case

The following "archetype" business model (BM) was selected with the aim to illustrate the roles of the multiple actors in the decentralized smart grid and identify the composite services that may be realized from their interactions. It is characterized as "archetype", because it aims to account for a set of services in which each tool may play a role. [48] In this context, business model focus on the commercial exploitation of a set of tools that each involved actor manages and investigates the added value to be provided by the joint utilization of the functionalities. The objectives are economically oriented, in the sense that they aim to maximize the potential profits for the participating actors.
For the demo island we select to apply the VPP energy business model, which has central role in the business description and represents a basic component of an interactive and dynamic distribution network, as a system that integrates many resources, such as: solar, wind, CHP, electrolyser, thermal energy storage.

Methodology

Business Model Archetype (BM) is presented using business modelling canvas. The aim of this BM is to investigate the added **value gaine**d by the prosumers from their participation in the VPP, due to the more efficient utilization of their production and consumption-shifting capabilities (both at local and aggregation level). The additional potential **revenues** will be gained by purchasing their production surplus in the wholesale market (compared e.g., with the regulated feed-in tariffs or premiums for the participation of small-scale producers). Furthermore, the BM investigates the **added value** that will be provided by the VPP tool to the VPP Operator. The potential additional revenues are expected to be realized mainly due to the optimization functionalities of the tool, which allow the agent to decide the optimal assignment of the requested services to its assets and consequently increase the set of services that may be offered (e.g. increase the magnitude of demand shifting that the VPP Operator can offer in the balancing market). Additionally, the optimal advice to the prosumers is expected to extend its clientele (more prosumers willing to become members of the VPP) and thus its revenues.

VPP assets among the alternatives that arise in the wholesale market (energy selling or DR participation). In this way, the VPP Operator will be able to offer competitive bids to the DSO and achieve increased gains for its members, a fact that results to an extended portfolio and higher market share. The role of the ESCO in these scenario is to elaborate the necessary data and provide the

[48] Business models for decentralized energy, Queen Mary University of London, School of Law Legal Studies Research Paper No. 311/2019

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optimal suggestions to the prosumers .e.g. to reschedule the consumption of the devices at the local level, such that the consumption pattern communicated by the VPP Operator is met.

The value network is presented below can be used from the energy community stakeholders as a template for business models in the Smart Grid environment.

Central role in the BM has the Virtual Power Plant (VPP) which represents a basic component of an interactive and dynamic distribution network, as a system that integrates many resources, such as: Renewable Energy Sources (RES), energy storage systems and flexible/controllable loads of domestic and tertiary prosumers.

Table 12: Business model description for the added value for prosumers & VVP in a canvas

Actors involved	• Prosumer • VPP operator • ESCO • DSO
Roles involved	• Production • Power Consumption • Energy Storage (batteries and RES installed) • VPP Operator (Aggregator Services) • EMS • Power Distribution (DSO)
Value proposition	**Prosumer** • Will be able to schedule its consumption, production and storage capabilities more efficiently. • Will be able to operate the energy needs by avoiding costly new infrastructure and related operational costs. • Will be able to sell its production surplus to the wholesale market. • Will receive additional revenues from its flexibility capabilities and its participation in explicit Demand & Response events. • Will have the opportunity to give its contribution for the environment protection, when participating in explicit DR events for the RES curtailment avoidance. • Significant decrease of CO2 emissions leading to lowering taxes **ESCO** • Will decide the optimal schedules of the devices at the local level and thus increase its revenues (as a portion of the prosumer's profits) **VPP operator** • Will provide a combination of services, thus utilizing more efficiently the assets of its members. • Will provide optimal schedules and thus increase its clientele. • Will manage better its internal resources in order to decide more efficiently if it is more profitable to store or sell the energy surplus. • Will be able to provide explicit demand-respond services, thus increasing its earning. **DSO**

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	• Will be able to receive in an easier way support for balancing the grid by means of the DR services provided by VPP operators.
Revenue streams	**Prosumer** • Payments from the aggregator for its contribution in the explicit DR events. **VPP operator** • Revenues for operating as an intermediary between the prosumers and the energy markets (receives a portions of the prosumers' profits). • Revenues for providing DR services to the DSO. **EMS** Revenues for providing the sophistication of the energy management tools' functionalities. Their revenues may be either a portion of the compensation provided to prosumers for their participation in explicit DR events, or a fixed fee paid by the prosumers (or their combination). **DSO** Decreased operational costs by avoiding the grid congestion and RES curtailment.
Cost streams	**Prosumer** • Part of its revenues will be given to the ESCO for the optimal schedule of the local devices. • Payment to the VPP Operator. **VPP Operator** • Economic investment for the development and operation of the software and communication channels and technologies. • Payments to VPP participants for their involvement in the DR services realization and for their power production. **ESCO** • Economic investment for the development and operation of the software tools for energy management and communication channels and technologies, **DSO** • Payment to the VPP Operator for provisioning the DR services.
Barriers	• The lack of a standardized framework for the measurement of the baseline consumption and the inadequate installed equipment (smart meters) prevent the revenues from their contribution in DR events to be realized and hinder their active participation in such programs. • The regulatory barriers in many member states, where the aggregation of small loads is illegal, or do not guarantee a level playing field for the competitive participation of the aggregators in the balancing markets.

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8. Deviations from DoA

No deviations from DoA to be reported.

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9. Conclusions

The deliverable reports on the outcomes of the Task 6.3 including the identified and replicable business models on energy systems management and the formation of energy communities, coming from ROBINSON project. During the implementation of this task as presented in this report five (5) energy business models were identified and accordingly five Business Model Canvases were developed for Eigeroy, and one BMC for Western Isles and Crete. The analysis of these Models indicated the different actors, customers, services, revenues, resources, etc, that each model provides making the best use of all benefits brought to the clients and local stakeholders the technologies and innovations.

Furthermore, the "archetype" business model (BM) that was developed to illustrate the roles of the multiple actors in the decentralized smart grid and identify the composite services that may be realized from their interactions, can be used as a template for business models in the Smart Grid environment from the energy community stakeholders.

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10. Appendix

The following questionnaire was distributed to partners to collect information regarding energy communities and business models.

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Smart integRation Of local energy sources and innovative storage for flexiBle, secure and cost-efficIent eNergy Supply ON industrialized islands

PARTNER's QUESTIONNAIRE

The information collected from the questionnaire will help to develop targeted business models. The information collected shall be included in deliverable "*D6.3 : Business models for energy communities, which must be submitted in M36".*

Energy communities and business models

Energy communities in operation

1. Please fill in the table below with the available information for your case (Eigeroy, West Isles, Crete):

Name	
Country	
Year	
Members	
Organisation type	(e.g. Community-owned renewable energy projects, Energy cooperatives, Virtual power plants?)
Activities	Generation renewable electricity, renewable heat source? Energy storage?
Technology / Energy	CHP plant, Biogas reactor, Electric battery, EV charging station, Heat Pump, Solar PV system, Heat Storage, Hydro, distribution network??
Renewable generation (or capacity)	(if available)
Description	
Objectives	(e.g energy independence? reduce air pollution? include distributing electricity? distribution of thermal energy, deploy local renewables?? Ensure energy independence?)

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GENERAL QUESTIONS

1. Which are the needs and requirements of your communities?

   ____

2. Which type of energy community would be suitable for your community?

   ____

3. What kind of development potential do you foresee for energy communities in the island?

   ____

4. How can energy communities affect the grid? Are the grids ready for distributed energy production?

   ____

5. What role do you think energy communities might take on in the value chain of energy production?

   ____

6. What are the main barriers for energy communities in the island market?

   ____

7. What are your main drivers and benefits to participate/start an energy community?

   ____

8. What best practices could you share with other islands stakeholders interested in developing energy communities?

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____

Business models

1. Do you have energy business models (VPP, PPP, ESCO, Cooperative etc) in operation and if so which ones?

   ____

2. Any other business models developed in projects you have already implemented, or you are currently developing:
   a. Please give a description of your business model (type, actors, technology involved, etc).

   ____

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