Social Innovation and the Islands Energy Transition – The Case of Unije Island (HR)

Master Thesis submitted in fulfillment of the Degree

Master of Business Administration (MBA)

Submitted to Dr. Sabine Sedlacek

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AFFIDAVIT

I hereby affirm that this Master's Thesis represents my own written work and that I have used no sources and aids other than those indicated. All passages quoted from publications or paraphrased from these sources are properly cited and attributed.

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ABSTRACT

This master thesis reflects upon the concept of social innovation and its role in the energy transition of islands. In 2019 European Commission has introduced the “Green Deal” growth strategy, promoting climate action as the number one priority of the European Union, with the final goal of cutting emissions by 55% by 2030 and making Europe a climate-neutral continent by 2050.

As isolated energy systems, islands typically depend on energy imports from the mainland and mostly use fossil fuels for electricity, heating, and transport, which are a major source of carbon emissions. At the same time, islands have an abundance of locally available renewable energy sources (RES) at their disposal which makes them ideal test-beds for energy transition, or the technology-based switch of the energy system, from fossil-based to renewable energy. However, new RES technologies must be incorporated into society and, thus, to enable successful decarbonization, technological innovations need to be coupled with social innovations.

By combining theoretical and empirical investigations, the objective of this thesis was to explore the role of social innovation in energy transition and analyze whether social innovation can be considered a success factor in the energy transition process of case-study island, the Croatian small island of Unije.

Social innovations in energy transition processes can range from new energy market models, decentralized power generation and distribution, institutional support, to the development of appropriate innovation culture, new governance models, increasing citizens’ participation and cooperation in energy services, community energy initiatives, social incentives, green nudges, and similar.

Several EU best practice examples were studied to see whether their experiences could be applied on the case-study island and a Transformative Social Innovation (TSI) framework was used to present the social innovations showcased on those islands. Also, a community survey was conducted, targeting both permanent and occasional residents of Unije and investigating their viewpoints on the island’s ongoing energy transition process.

Based on the findings from literature and empirical research, it is concluded that social innovation can be considered a success factor in the energy transition of Unije and that many social issues are to be taken under timely consideration by the local/regional authorities in order to facilitate the successful island decarbonization.

ACKNOWLEDGMENTS

The motive for choosing precisely this topic for my master research was twofold. On the one hand, I wanted to stress the growing importance of social innovation in the strategic documents and policies of the European Union and the Member States. On the other hand, I wanted to emphasize the applicability of social innovation concepts not only in social sciences and humanities but also in technical sciences.

In almost 10 years of working in an energy agency, I have come across many examples that point to the necessity of interdisciplinary approaches in energy research. There are many important social issues to be considered on a path towards a successful energy transition. The complexity of the societal challenges we face today requires some new approaches and models, especially in times of financial crisis, including this current one, fueled by a global health pandemic.

One of the difficulties I encountered while preparing this thesis was limited, albeit growing, literature on social innovation, especially in the context of their connection to energy transition issues. Data related to the case study, the Island of Unije, was gathered mostly from the archives of the Regional Energy Agency Kvarner and the outputs of the INSULAE project funded by the European Union's Horizon 2020 research and innovation programme (Grant Agreement No 824433).

I thank my mentor, dr. Sabine Sedlacek, who guided me with great care throughout the process and whose professional and constructive advice contributed significantly to the final version of this thesis.

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Special gratitude goes to my parents, who have been a strong logistical support throughout all stages of my education, from elementary school to postgraduate days.

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LIST OF ABBREVIATIONS

SI	Social innovation
BEPA	Bureau of European Policy Advisers
BESS	Battery Energy Storage Systems
CE4EUI	Clean Energy for EU Islands
EMP	Energy master plan
EE	Energy efficiency
EU	European Union
MA	Municipality actor
MoU	Memorandum of Understanding
PV	Photovoltaic
Q (1/2/3…)	Question (1/2/3…)
REA Kvarner	Regional Energy Agency Kvarner
REI	Renewable energy island
RES	Renewable Energy Sources
ROI	Return of investment
SES	Smart Energy System
TSI	Transformative Social Innovation
UNEP	United Nations Development Programme

1 INTRODUCTION

The Paris Agreement, an international treaty on climate change (UNFCC, 2015) adopted in 2016, presented a global consensus to limit global warming to well below 2 °C. Numerous greenhouse gases contribute to global warming, but CO_2 is the most prevalent. The scientists worldwide are unequivocal - human influence has caused *"widespread and rapid changes in the atmosphere, ocean, cryosphere, and biosphere"* (IPCC, 2021, p.6), and bringing net carbon emissions to zero is a necessity.

This means cutting the world's reliance on fossil fuels and decarbonizing the global economy by the end of the century. In the energy sector, decarbonization implies increasing the EE, the use of RES, and energy security (Leal-Arcas, et. al., 2019). This calls for a transition of the energy sector from fossil-based to renewable energy sources on all levels, from global to local.

This master thesis aims to present the importance of social innovation (SI) in the local energy transition processes, focusing on the decarbonization of islands. Typically, *"islands have high energy prices, rely on imported fuels, lack space and resources, and are vulnerable to natural disasters"* (Serpell O. , 2020) Still, they *„could be powerful leaders in the energy transition and become hubs of innovation and experimentation— if a policy or system can balance the load on an island, it can certainly help balance load in far more integrated and robust mainland energy systems*" (Serpell, 2020, p.2). On the other hand, islands are specific because they have an abundance of locally available energy resources (wind, sun, waves) which, after a successful energy transition and a switch from carbon-dense fuel to renewables, could contribute to islands' resilience and significantly reduce their carbon emissions.

However, research and empirical evidence from different EU islands (Heaslip & Fahy, 2018; Selvakkumaran & Ahlgren, 2021; Sperling, 2017) suggest that renewable technology installations are not the central aspect of successful local energy transitions. What seems to be of utmost importance are the social issues or the social innovations that contribute significantly to citizen engagement and new technology acceptance.

In its empirical part, this thesis will focus on the Croatian small island of Unije, by analyzing how the energy transition of Unije could be accelerated by relying more strongly on the social aspects rather than focusing solely on the new renewable energy technology introduction.

1.1 Research scope

Islands are considered to have a large but untapped potential for renewable energy. In May 2017 the European Commission, together with 14 EU countries[1] signed a political declaration to launch the new "Clean Energy for EU Islands (CE4EUI)" initiative in order to accelerate the clean energy transition on islands (European Commission, 2017). In 2018, the Croatian Parliament adopted a new Law on islands (Official Gazette No. 116/18) which provided conditions for demographic and economic revitalization of the islands and their self-sustainability. The Croatian NUTS III region of Primorje Gorski Kotar County acknowledged the relevance of the islands' decarbonization initiatives and initiated a pilot project "Unije: Self-Sufficient Island" intending to revitalize Unije island and make it energy independent, as well as to create an island energy transition model that could be replicated to other islands which depend heavily on fossil fuels and imports of energy from the mainland.

Currently, the island of Unije does not have any significant generating capacity so, regarding electricity supply, Unije relies on the power cable that connects it to the neighboring island of Lošinj. There are also no water sources except for the recently installed desalination unit so the island depends on weather conditions and water imports from the island of Lošinj (Jardas et. al., 2011). All this creates certain challenges concerning the stability of energy and water supply on the island.

From the technical point of view, much has already been done on the island, coordinated by the Regional Energy Agency Kvarner - from the installation of desalination unit and water pipeline works to the 1MW PV plant with a battery storage system that is to be built in 2021. Also, funding has been secured for smart energy data monitoring (energy consumption, temperature, etc.) and small PV systems for several island households (FEDARENE, 2019). However, all this smart technology will be completely redundant if the islanders refuse to embrace it.

The energy transition cannot be seen only as a technological issue. Many social aspects need to be addressed to enable a successful decarbonization process, such as the new energy market models (e.g. in community energy), changes in attitude (e.g. the acceptance of RES) or behavior (e.g. personal energy savings, green nudges), improvements in risk communication (e.g. for better acceptance of large energy projects), etc. Social acceptance of RES focuses on the willingness to use new technologies and to monitor energy consumption behavior. If local community members do not adapt to decarbonization and adopt the new RES technology, the

[1] Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Malta, Portugal, Spain, and Sweden

project fails. Thus, for successful technology adoption, it is important to implement adequate social interventions or innovations.

1.2 Research objectives, questions, and steps

Social innovation is defined as *"new solutions (products, services, models, markets, processes, etc.) that simultaneously meet a social need (more effectively than existing solutions) and lead to new or improved capabilities and relationships and better use of assets and resources. In other words, social innovations are both good for society and enhance society's capacity to act"* (The Young Foundation, 2012, p.18). Social innovations in energy transition processes can range from new energy market models, decentralized power generation and distribution, institutional support to the development of appropriate innovation culture, new governance models, increasing citizens' participation and cooperation in energy services, community energy initiatives, social incentives, and similar.

"Social innovation and energy is an emerging field, with a limited number of publications referring to the social practices involved, and there is, therefore, a need to tap into the knowledge and expertise of diverse stakeholders" (De Geus & Wittmayer, 2019, p.9). This master thesis will strongly rely on the data and experiences of the Regional Energy Agency Kvarner, a governmental agency set up to facilitate the energy transition of the Primorje Gorski Kotar County. Wittmayer et al. (2020) also argue that the governments themselves can be socially innovative "living labs" but that the role of the state in social innovation processes is rarely mentioned in the literature. This master thesis thus aims to tackle both – the bottom-up community energy initiatives as the most frequent type of social innovations in the field of energy and the role of local (regional) governmental organizations in accelerating the energy transition.

The research question to be addressed in this thesis is the following: What is the role of social innovation in energy transition and can social innovation be considered a success factor in the island of Unije energy transition process?

This entails several sub-questions: What are the social aspects of local energy transitions? Which types of social innovation could support local energy transitions in the islands? What are the foreign islands' best practices when it comes to using social innovation to accelerate their energy transitions that could also be applied on Unije island? Who are the actors (e.g. local authorities, organizations, practitioners, energy providers) on the island of Unije pilot that need to address the social side of technical zero-energy innovations and how should it best be done? What types of social innovations can be introduced by the local (regional) government to support the energy transition process?

To answer these questions, the following research process steps will be taken:

First, the existing research evidence will be reviewed, defining “social innovation” and checking how social innovation in energy (SIE) is currently researched.

Based on the literature review, it will be further analyzed how social innovation is linked specifically to the energy transition issues and whether its impact on the decarbonization processes can be considered positive.

In the next phase, based on the readings, a few practical examples will be described, demonstrating how some of the European islands have already integrated social innovations in their energy transition processes. The thesis will further assess which best practices of other islands might apply to the case of Unije island.

In parallel, the local community on Unije will be surveyed to find out their opinions on the importance of social innovations for a successful energy transition of the island of Unije.

After gaining an insight into best foreign practices (what worked well on other islands) in combination with the bottom-up local community pulse survey (checking their needs and expectations), a set of practical recommendations for the regional government on how to further steer local island energy transition processes on the island of Unije will be provided, emphasizing the potential contribution of social innovation to the island’s energy transition.

1.3 Structure of the thesis

In line with the planned research steps, the thesis will be structured in five interconnected chapters:

The introductory chapter (Chapter 1) will provide general background, explain the research aims and objectives, and provide a literature review analyzing the scope of available research articles on the topic and reflecting on the position of social innovation concepts in the energy research field.

The following chapter (Chapter 2) will provide a theoretical framework. A set of potential contributions of social innovation to the energy transition arising from the literature will be outlined and explained in detail.

As a bridge between the theoretical and empirical part, the methodology chapter (Chapter 3) will offer a description of the research methods and instruments as well as the clarification of the process of selecting the case study and EU islands’ best practices presented in the thesis.

The subsequent chapter (Chapter 4) will present the empirical part of the research. Foreign islands' best practices that could be applied to the island of Unije will be examined. On the other hand, a survey will be done among the local community on Unije, questioning their attitude towards energy transition. Also, surveys with other important stakeholders (implemented within the H2020 project INSULAE) analyzing who should be the main actors involved in this transition, how the process should be managed, whether they would be willing to engage personally, what are non-technological barriers that could block/slow down the island's energy transition and similar - will be presented.

Presentation of results and discussion will follow in the final chapter (Chapter 5), assessing whether social innovations could be considered a success factor in the island of Unije energy transition process. Also, some practical recommendations for the regional government will be provided in conclusions that are expected to emerge from the master thesis research, helping to better steer the local island energy transition processes on the Island of Unije by taking into consideration the important social aspects of decarbonization process and not relying solely on the technology.

2 THEORETICAL FRAMEWORK

As said in the previous chapter, the islands' energy transition processes that are the subject of this thesis, should not be examined solely from the technological point of view. Energy transition results from the synergy or adequate policy setting, securement of the funding, and then the technology implementations, as shown in the diagram below (Figure 1).

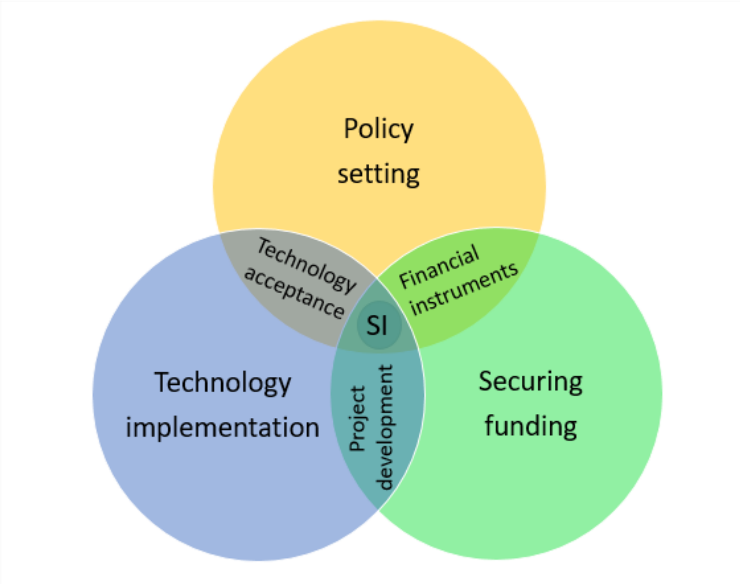

FIGURE 1: SOCIAL INNOVATION DIAGRAM, SOURCE: AUTHOR

First, adequate policies need to be set, translating the political vision into programmes. Second, financial instruments need to be developed, to enable the realization of concrete projects. Once the funding is secured, project design begins, leading to technology implementation. Nevertheless, the energy transition cycle does not end here. To have a successful transition, the technological solutions implemented need to be accepted by the public.

Social innovation examples can be found in all parts of this cycle. Those can be new ways of reaching governance decisions, alternative funding mechanisms, innovative project management tools, or new methods for citizen engagement, or technology acceptance strategies. Thus, social innovations can be analyzed from several perspectives (managerial, economic, behavioral, social, etc.). This thesis will try to outline those social innovations that can be relevant for the energy sector and support decarbonization processes.

2.1 Social innovation

From the general point of view, research and innovations are supposed to contribute to finding solutions to complex and interconnected socio-economic challenges. In contrast to technological innovations that offer practical and almost immediately applicable, although not always sustainable, solutions, social innovations do not always offer quick results and are meant to have a long-term impact. In Croatia, social innovation as a concept is still relatively unrecognized, even though in the last few years it did receive some public attention, which is seen, for example, from the establishment of public awards for social innovations implemented by the National Foundation for Civil Society Development (2012) and the Croatian Cities Association (2013) or the small-scale social innovation funding programmes such as the ones of the Foundation for Partnership and Civil Society Development (2019) and the Business Club PartneRI (2019).

Although it can be considered as just another buzzword, or a *"passing fad that is too vague to be usefully applied to academic scholarship"* (Pol, Ville, 2009, p.878) it is believed by authors (Drucker, 1987, Mulgan, 2007, Murray, 2010) that this is not the case and that the term "social innovation" is academically legitimate.

The first scientific mentions of the term "social innovation" date back to the beginning of the 20th century when the political economist Alois Schumpeter (1883-1950) claimed that in the response to the complex modern societal challenges it will be necessary that the public sector takes on an active role, as a front-runner and creator of prerequisites for the development of social innovations and entrepreneurship (Schumpeter, cited by McNeill, 2012).

At the end of the 20th century, Peter Drucker in his book "The Frontiers of Management: Where Tomorrow's Decisions Are Being Shaped Today" (1987) devotes its last chapter to social innovations, calling them the new dimension of management. Drucker (1987) emphasizes the importance of non-technological innovations for the economy and society and offers the example of General Electric, a company that was the first to put together multidisciplinary teams of experts to connect science and technology, which was not the usual practice beforehand.

Ten years after Drucker, another author (Kanter 1999, cited by Logue, 2019) brings social innovations in connection with the business sector again, claiming that companies ought to contribute to the solving of societal challenges, to move forward from mere corporate responsibility (i.e. minimizing negative externalities) towards the understanding of societal needs as business opportunities. In other words, to upgrade social responsibility with social innovations. As one example, the author lists the change of the mainstream bank's business model, from being centralized in the business quartiers to opening branch offices in lower-income neighborhoods and offering tailored loans to citizens, co-funding the realization of local projects and thereby increasing the pool of bank customers.

In 2007, Geoff Mulgan with his definition of social innovation as *"innovative activities and services that are motivated by the goal of meeting a social need and that are predominantly developed and diffused through organizations whose primary purposes are social"* (Mulgan et al.,2007:8) shifts the focus from business to social sphere. Mulgan points out Ms. Florence Nightingale (founder of the first nursery school in London), cooperatives, and public unions as the first SI examples – aiming to improve patient care or working conditions.

In line with Mulgan's reasoning, Murray et al. (2010) state that the prefix "social" marks the potential of certain innovations to be applied to whatever aspect of everyday life that requires improvement and better needs' satisfaction. In simple words, social innovations are new ideas, ways of work, or organizing that successfully recognize the problems and create solutions to satisfy social needs.

In the report prepared by Agnès Hubert from the Bureau of European Policy Advisers (BEPA), which was endorsed by the European Commission and listed on the website of its publications, social innovations are defined as *"new ideas (products, services, and models) that simultaneously meet social needs (more effectively than alternatives) and create new social relationships or collaborations. In other words, they are innovations that are not only good for society but also enhance society's capacity to act"* (Hubert, 2011, p.24).

If we further analyze available definitions, we see that the social innovation concept can (and has been) approached from many different perspectives (Table 1).

Type of perspective	**Definition**
Pragmatic	Social innovation is "innovative activities and services that are motivated by the goal of meeting a social need and that are predominantly developed and diffused through organizations whose primary purposes are social". [Mulgan et al. (2007, p.8) Social Innovation, What It Is, Why It Matters, and How it Can Be Accelerated].
Managerial	Social innovation "can concern conceptual, process or product change organizational change and changes in financing, and can deal with new relationships with stakeholders and territories. 'Social innovation' seeks new answers to social problems by identifying and delivering new services that improve the quality of life of individuals and communities; identifying and implementing new labor market integration processes, new competencies, new jobs, and new forms of participation, as diverse elements that each contribute to improving the position of individuals in the workforce." [OECD LEED Forum on Social Innovations, URL: https://www.oecd.org/fr/cfe/leed/forum-social-innovations.htm]
Behavioral	Social innovations are supposed to "bring about the behavioral changes which are needed to tackle the major societal challenges, such as climate change." [European Commission (2010, p.23) Europe 2020 Flagship Initiative Innovation Union]
Critical	"Social innovation is conceived as a process of empowerment and political mobilization targeting a bottom-up transformation of the

	functioning of a social system, in terms of stakeholders and in terms of distribution of material and immaterial resources." [Moulaert et al. (2009) In: Balamatsisas, 2018]
Economic	Social Innovation is "about bringing innovation to deliver life-changing outcomes for society and individuals... The guiding principle is to drive economic benefits while improving social and environmental conditions." [Frost & Sullivan (2014, p.13) Social Innovation Whitepaper]
Comparative	"Social innovation is distinctive both in its outcomes and in its relationships, in the new forms of cooperation and collaboration that it brings. As a result, the processes, metrics, models, and methods used in innovation in the commercial or technological fields, for example, are not always directly transferable to the social economy". [Murray et al. (2010, p.6) The Open Book of Social Innovation].
Social	Social innovations are defined as "new solutions (products, services, models, markets, processes, etc.) that simultaneously meet a social need (more effectively than existing solutions) and lead to new or improved capabilities and relationships and better use of assets and resources. In other words, social innovations are both good for society and enhance society's capacity to act." [The Young Foundation (2012, p.18) Defining Social Innovation].
Non-profit	"Even though the vast majority of social innovations are business innovations as well, it would be a blunder for governments (particularly, those of rich countries) not to encourage innovation without a profit motive. In the language of sets, these social innovations are the difference between the set of all social innovations and the set of all business innovations, that is, the set of social innovations that are not business innovations. These social innovations address needs that are not satisfied through the market mechanism (because they do not exhibit potential profits) may be called pure social innovations." [Pol, Ville (2009, p.883) Social innovation: Buzz word or enduring term? The Journal of Socio-Economics]
Sectoral: Energy	"In the context of the energy transition, social innovation can be defined as innovation that is social in its means and which contributes to the low carbon energy transition, civic empowerment and social goals pertaining to the general wellbeing of communities." [Hoppe, DeVries (2018, p.1) Social Innovation and the Energy Transition. Sustainability 2019, 11, 141]

TABLE 1: DIFFERENT DEFINITIONS OF SOCIAL INNOVATION, OBSERVED FROM DIFFERENT PERSPECTIVES, SOURCE: VARIOUS SOURCES, ADAPTED BY THE AUTHOR

Regardless of the approach taken, these definitions put a value on the final benefits for society. According to the manual "Participation of citizen's leads to social innovations", available in the Croatian language under the title "Participacijom građana do društvenih inovacija" (ed. Karzen, 2017, p.7) we can say that the innovation is social when it can:

- Meet societal needs and requirements;
- Contribute to efficient use of resources (human, financial and other);
- Improve the quality of life of citizens/target groups;
- Reduce inequalities;
- Contribute to change in relations;
- Change existing paradigms and practices (the way we think about things) and common patterns of action;
- Encourage citizens – individuals and communities – to take part in problem-solving.

Looking globally, in the past ten years, we have faced a growing interest of researchers in social innovations (Figure 2), which is evident from the number of mentioning the term in headlines, abstracts, or keywords of research papers (Logue, 2019).

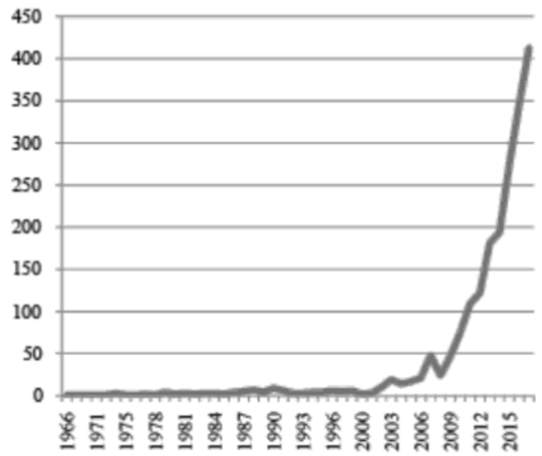

FIGURE 2: THE NUMBER OF TIMES THAT THE "SOCIAL INNOVATIONS" WERE MENTIONED IN SCIENTIFIC LITERATURE, 1996.-2017., SOURCE: LOGUE, 2019.

The growing interest for social innovations can be observed also on another level – by the number of public searches on Google (Figure 3), from 2004-2021[2]:

[2] "Numbers represent search interest relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular. A score of 0 means there was not enough data for this term." Source: Google Trends

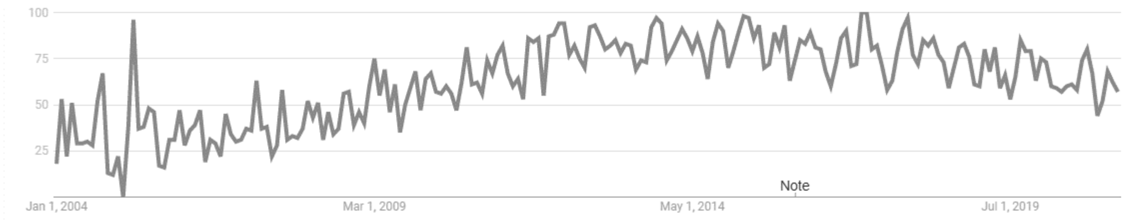

FIGURE 3: INTEREST OVER TIME ON GOOGLE, SEARCH TERM: SOCIAL INNOVATION, 2004-2021, SOURCE: GOOGLE TRENDS

Social innovation appears as a research concept not only in social sciences and humanities but also in technical sciences, i.e. in the research of power sector decarbonization. According to Hoppe & De Vries (2019, p. 1&2), decarbonization cannot be seen solely as a technological issue, it also requires social innovations "as the uptake and use of the latter calls for new ways of organizing and governing energy supply and energy systems (and thus, regulatory response)." Furthermore, authors (Hoppe & De Vries) stress the importance of behavioral barriers, such as the social acceptance of local RES that are of immense importance in successful energy transitions.

Within the "Seventh Framework Program's for research, technological development and demonstration activities - FP7 (2007-2013)", theme "Research in Socio-economic Sciences and Humanities (SSH)", over 30 projects directly in the field of social innovation were funded, including the often quoted SI-DRIVE and TEPSIE projects (FP7 SSH, 2021).

The report of (Moulaert, et. al., 2017) points out that in previous literature and projects social innovations were mostly not focused on a certain economic sector, nor a particular field, but rather demonstrated a variety of practices and activities addressing the social challenges. In the last few years, the situation appears to have changed, offering more articles on the application of social innovation in certain domains.

The H2020 programme also provided support to social innovation research, granting funding for successful projects, some of which are currently investigating the links between social innovation and energy transition, e.g. (European Commission, 2021):

- "SONNET - Social innovation in energy transitions" (Grant agreement ID: 837498, 1 June 2019 - 31 May 2022)
- "NEWCOMERS - New Clean Energy Communities in a Changing European Energy System" (Grant agreement ID: 837752, 1 June 2019 - 31 May 2022)
- "SocialRes - Fostering Socially Innovative and Inclusive Strategies for Empowering Citizens in the Renewable Energy Market of the Future" (Grant agreement ID: 837758, 1 May 2019 - 31 August 2022)
- "COMETS - COllective action Models for Energy Transition and Social Innovation" (Grant agreement ID: 837722, 1 May 2019 - 30 April 2022)

The SONNET Project in its 2020 (H2020 SONNET Project, 2020) Report on a preliminary typology of social innovation in the energy (Deliverable 1.1) mapped out about 500 different social innovation in energy (SIE) initiatives across different EU countries and also brought a characterization of different types of social innovation in the energy sector, some of which will be described and commented further in this thesis. According to this Report, social innovations in the energy sector are present in energy supply and demand, mobility, heat, electricity, and ICT, they entail the active contributions from different stakeholders (consumers, citizens, organizations) and go beyond the purchase and adaptation of low carbon technologies. However, the SONNET partners argue there is still not much research that has explicitly focused on social innovation in energy.

There is also no single interpretation of what social innovation in energy transition can entail (Matschoss K., et. al., 2020). However, Matschoss K., et. al. point out some of its characteristics, saying that it is an innovation that is social in its means or methods, it often emerges bottom-up rather than top-down, contributes to civic empowerment, improves relationships or collaborations, advances the low carbon energy transition usually at a local or regional scale, takes into account the native cultural particularities, social needs or goals and strives for the general wellbeing of the society during its implementation or execution.

Regarding their role in energy systems, social innovations could include “new and alternative business models, novel policy instruments, financing schemes, participatory governance approaches to energy questions, or new discourses” (Wittmayer, J.M., 2020, p.1).

This thesis hopes to contribute further to broadening the understanding of social innovation in energy transition processes by analyzing the location of Unije island in Croatia. To do so, apart from defining social innovation concepts, the terms “energy transition” and, more precisely, “energy transition in the islands” need to be elaborated.

2.2 Energy transition

The International Renewable Energy Agency states that the energy transition is *“a pathway toward the transformation of the global energy sector from fossil-based to zero-carbon by the second half of this century”* (IRENA, 2021).

Also referred to as the “decarbonization of the energy sector” (Papadis, Tsatsaronis, 2020) and the “decarbonization of the electricity generation sector” (Gupta et al., 2021), or described as the “sustainable energy description” (Nogueira Soares, Gava, & de Oliviera, 2021), “clean energy transition” (Liao, Erbaugh, Kelly, & Agrawal, 2021), or “just energy transition” (Mang-Benza, 2021), energy transition, in any case, requires prompt actions on a global level, together with additional actions that will mitigate the negative effects of climate change and reduce all kinds of harmful emissions.

Sustainable energy transition focuses on the need of stakeholders to first build the governance that would allow changes in the practices of current energy regimes. They observe the socio-technical perspective of energy transition which allows them to understand the political complexity of sustainable transition processes (Nogueira Soares, Gava, & de Oliviera, 2021).

Originally a trade union concept, the *just energy transition* acknowledges that the prosperity of some regions largely depends on fossil fuel industries and that those workers and communities should not be disproportionately burdened by a shift to a low carbon economy (BlueGreen Alliance, 2019). Similar to the European Green Deal (European Commission, 2019) main principle, no one should be left behind.

The work of some authors (i.e. Mang-Benza, 2021) focuses on particular groups, such as women in the energy sector, but the term itself is largely used in the context of securing the prosperity of all ex-fossil industry workers.

Finally, *clean energy transition* as a concept focuses on access to clean energy which is one of the 17 Sustainable Development Goals (SDGs) that seeks to "ensure access to affordable, reliable, sustainable and modern energy for all" (UN DESA, 2021).
Energy transition *"refers to a process of changing from one form of the energy system, supply, or demand to another"* (Sovacool, Hess, & Cantoni, 2021, p.2) or *„a change in fuels and associated technologies, switching from the use of fuel wood to petroleum or changing from steam engines to internal combustion engines"* (Sovacool, Hess, & Cantoni, 2021, p.2).
In simple words, modern energy transition is a transformation from fossil-based systems (such as coal, natural gas, and oil) to RES (such as sunlight, wind, rain, tides, waves, geothermal heat, and biomass) in both energy production and consumption.

However, the energy transition can also be examined from other, non-technological perspectives (Table 2) since the energy transition demands a shift not only in technology but also in political regulations, power sector regulations, and the behavior of users and adopters (Sovacool B.K., 2016).

Type of perspective	**Definition**
Economic	"The switch from an economic system dependent on one or a series of energy sources and technologies to another." (Fouquet R. and Pearson P.J.G., 2012, In: Sovacool B.K., 2016, p.203)

Societal	"A particularly significant set of changes to the patterns of energy use in a society, potentially affecting resources, carriers, converters, and services." (O'Connor P.A., 2010, In: Sovacool B.K., 2016, p.203)
Environmental	"The purpose of the energy transition is not only GHG emission minimization it is also connected to air, water, and environmental pollution reduction." (Mikulčić, 2021, p.3)

TABLE 2: DIFFERENT DEFINITIONS OF THE ENERGY TRANSITION, OBSERVED FROM DIFFERENT PERSPECTIVES, SOURCE: VARIOUS SOURCES, ADAPTED BY THE AUTHOR

Some authors (Gielena & et. al., 2019, Huang & Zou, 2020) highlight the importance of increasing the proportion of RES in the total energy consumption. The European Commission's Energy roadmap 2050 (2011) calls *"for a transition to a low-carbon energy system in which about two-thirds of our energy should come from renewable sources"* and *"electricity production needs to be almost emission-free, despite higher demand"* (2011, from the Foreword by Günther H. Oettinger, European Commissioner for Energy).

Energy transition takes time, it is believed that typically half a century is needed to pass from the first market uptake to the majority market share for energy transition (Sovacool K., 2019). Yet, the European Commission has set an ambitious goal for the EU to become a climate-neutral economy by 2050. The energy transition towards a zero-emission future is already taking place, with more and more countries opting for renewable-based systems. This vision of a new energy system based on renewable instead of fossil and nuclear energy is strongly supported by the current EU strategic policies (the most recent being the European Green Deal). However, the speed of this transition is still far from what is needed to reach the 2016 Paris Agreement objective *"to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels"* (UNFCC, 2021). Despite the widespread political support to the Agreement, *"energy-related carbon dioxide (CO2) emissions increased 1.3% annually, on average, over the period 2014 to 2019. Last year, 2020, was an outlier due to the pandemic, as emissions declined 7%"*, (Carbon Brief, 2020) but the Report concludes that a rebound is expected.

Global warming, if it continues increasing, is expected to have serious consequences for human health, water supply, food production, etc. At the same time, it is still questionable to what extent is the population ready to change its habits, e.g. travel less, switch to plant-based nutrition instead of meat, save energy in everyday life, recycle, foster the circular economy principles, etc. The proposed alternative to the current economic model, which is considered unsustainable in the long run, is the green economy. Although green economy as a term appeared back in the 1980s in a so-called Blueprint for a Green Economy Report, its stronger acceptance can be traced following the global financial crisis in 2008 when it became evident that an alternative vision for growth and development is needed (Neusteurer, 2016). The green economy was defined by UNEP as „low carbon, resource-efficient and socially inclusive" (UNEP, 2021).

However, there is also a belief that green economy cannot stop the environmental degradation, opting for an alternative called „degrowth" (Krpan & Basso, 2021) whose supporters call for the abandonment of the idea that the increase in gross domestic product accurately indicates progress and that the society is ought to live better while producing less. In other words, maybe the goal should not be the production of more energy, but the re-conception of current lifestyle and energy consumption habits. Although politics has set its sail towards zero-carbon, there is still an ongoing debate in the public sphere whether renewable energy will be able to replace fossil fuels. Following the set political objectives, countries will eventually have to rely on renewable sources, but we will probably no longer be the high-energy society as we are now. Or, some new solutions and technology will have to emerge to enable us to behave the same but use less energy. In any case, *„major reductions in energy demand will require the widespread uptake of technical and social innovations"* (Geels & et. al., 2018).

As previously stated, the European Union is strategically determined to become a low-energy economy which is outlined in many of the current documents, laws, and initiatives, i.e. the first European Climate Law (2020), European Green Deal, and the two sectoral strategies resulting from it in 2020 - the "EU Strategy for energy system integration" and the "Hydrogen strategy for a climate-neutral Europe", Energy Roadmap 2050, the new energy rulebook – called the "Clean Energy for all Europeans package" as well as the Member States' integrated 10-year national energy and climate plans (NECPs).

In December 2019, the Commission presented a new growth strategy for the EU, the **European Green Deal**, aiming to transform Europe into a climate-neutral continent, but also to take several non-energy measures to build a better society and a more prosperous economy. Thus, this plan for a greener Europe covers the area of climate, environment, and energy, but also agriculture, industry and circular economy, financing and cohesion, societal issues such as education, employment, and social rights, and international relations – recognizing that the global nature of challenges that are to be addressed require a global consensus and cooperation.

With the **European Climate Law** (March 2020) the Commission proposed a target of net-zero greenhouse gas emissions by 2050, and the Member States are required to take all necessary measures to meet this objective.

Adoption of the **EU strategies for energy system integration and hydrogen** in July 2020 paved the way further towards decarbonization of the energy sector.

Finally, in January 2021 the European Commission launched **"The New European Bauhaus"**, a creative initiative *"breaking down boundaries between science and technology, art, culture, and social inclusion, to allow design to find solutions for everyday problems"* (European Commission, 2021) which is very much in line with the social-innovation concepts. Intended as a bridge between science, technology, art, and culture, with the support of different involved stakeholders, the initiative is supposed to contribute to the realization of the European Green Deal objectives through pilot projects developed for further EU-wide replication and also the Bauhaus award that will give credit to inspiring projects worth sharing. The first Croatian organization to join the New European Bauhaus is REGEA - the North-West Croatia Regional Energy Agency.

Another Commission initiative worth mentioning is the **"Clean Energy for EU islands (CE4EUI)"** initiative launched in 2018 as part of the wider strategic orientation towards the decarbonization of islands, which is the sub-topic to be described in the next chapter.

2.2.1 Energy transition in the islands (political agenda)

Non-interconnected islands have an important role in the EU's transition to a carbon-neutral Europe by 2050 (Eftymiopoulos et. al., Spataru, 2016, In: Stephanides, 2019). Several initiatives that will be described (from the Pact of Islands and EU Commission's MoU's to bottom-up initiatives) outline precisely the islands as the ideal pilot areas for energy transition processes, for various reasons:

- Due to the expected sea level rising and temperature increase, islands are among the first areas to experience the devastating impacts of climate change;
- Islands have some common handicaps, they are often dependent on fossil fuels, have high transportation costs with limited access to markets;
- Many islands have sometimes poor or limited energy connection to the mainland (or complete lack thereof);
- Many islands face serious depopulation issues, so any local development and potential for opening green jobs contributes also to the securement of population numbers;
- Tourism, as the main economic sector on the islands, leads to seasonal energy demands which are much higher than after the season, which leads to infrastructure issues;
- At the same time, due to the availability of renewable energy sources (sun, wind, sea tides) they can easily accept new RES infrastructure and make its operation economically feasible.

Thus, in the past 10 years, several EU initiatives appeared on the horizon with a dedication to accelerating the energy transition of islands.

Back in 2010, within the ISLE-PACT project (ISLE-PACT, 2010) funded by the EU Commission Directorate-General for Energy (2010-2012) a special methodology for islands was developed as a counterpart to the Covenant of Mayors' (CoM) initiative. While CoM is the largest cooperation movement involving local and regional authorities who commit to increasing the energy efficiency and reducing CO_2 emissions by adopting the local "Sustainable Energy and Climate Action Plans (SECAPs)", the ISLE-PACT initiated the foundation of the **Pact of Islands**. Similar to CoM, the Pact of Islands signatories entered into a political engagement to meet the project's objectives and prepare the **Islands Sustainable Energy Action Plans (ISEAPs)** including the Baseline Emission Inventory (BEI) which outlined how energy objectives will be reached. According to the initiative's website, 64 island authorities signed the Pact of Islands, mostly from Cyprus, Italy, Greece, Malta, and Spain.

The European Commission's "Clean Energy for All Europeans" package of proposals presented in November 2016 contained also an announcement of the new initiative that will be devoted to islands. In May 2017 on Malta, the European Commission, together with 14 Member States[3] signed a political declaration **("the Valetta Declaration")** to launch the new "Clean Energy for EU Islands (CE4EUI)" initiative whose aim was to foster the energy transition on European islands, reduce their dependency on energy imports and support the uptake of renewable energy systems as energy producers in the islands.

Concerning the European Parliament's "Resolution on the special situation of islands" (2015/3014(RSP)), Malta's resolution confirmed the islands' potential to contribute to the EU's energy transition and the Member States expressed their *"determination to further promote and support tailor-made clean energy transitions for islands, while preserving the security of supply (…), to share best practice in financial and regulatory tools and promoting best available technologies, with the aim to take action on the ground (…)and to support the Clean Energy for EU Islands Initiative"* (Valletta 18 May 2017, Political Declaration on Clean Energy for EU Islands).

As a follow-up, during the Croatian Presidency of the Council of the European Union, the parties also signed a "Memorandum of Understanding Implementing the Valletta Political Declaration on Clean Energy for European Union Islands" also known as the **"The Memorandum of Split"** (European Commission, 2020) in order to establish a long-term framework advancing the islands' energy transition. From the operative side, the signatories agreed to cooperate on the below-mentioned work areas:

[3] Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Malta, Portugal, Spain, and Sweden

- *"**Work area 1:** Development of specific solutions for islands (technical assistance, capacity building, implementing transition agendas and concrete pilot projects, developing studies and identifying decarbonization challenges),*
- ***Work area 2:** Enabling environmental, legal, and regulatory aspects (exchange of best practices, evaluation of existing policies, identification of legal, regulatory, and other barriers and solutions for tacking these barriers, identification of horizontal aspects that affect the preparation and implementation of transition plans),*
- ***Work area 3:** Support framework and finance (identification of possible financing models, optimization of islands' access to sources of financing, facilitation of local participation models (i.e. Citizen and Renewable Energy Communities), etc.)"* (European Commission, 2020, p.7)

The selected social innovations that will be presented in this thesis as the potential contributions to the islands' energy transitions very much correspond to the work areas enlisted in the abovementioned Memorandum of Split supporting clauses.

Based on the conclusions of the Valetta Declaration, the European Commission in 2018 set up the **Clean Energy for EU Islands Secretariat** whose goal was to deliver the objectives of the clean energy for EU Islands initiative. The Secretariat's pilot phase of the operation was executed in the period from 2018-2020. Following the conclusions of the Memorandum of Split to support a long-term framework to accelerate islands' energy transition, the second phase of the CE4EUI was launched at the beginning of 2021 and will be operational in the next two years.

Furthermore, in 2019 the European Commission launched the **RESponsible Island Prize** (European Comission, 2021), intending to award islands with demonstrated RES energy production for use in electricity, heating, cooling, and transport. The first three islands to receive the Award were the Danish island of Bornholm, the island of Samso (also in Denmark), and the Orkney Islands in the United Kingdom. Together with Tilos (Greece) which is considered to be the first zero-energy island in the Mediterranean, the island of Samso and the Orkney Islands will also be taken as examples (or best practices) in this thesis, and their experiences analyzed with the aim of possible replication on the Croatian island of Unije.

Apart from the European Commission's efforts, another initiative appeared in 2017, important for its bottom-up approach– the **Smart Islands Initiative**, created also in support of the islands' energy transition. During the Smart Islands Event held in Brussels on the 28th of March 2017, more than 30 island representatives[4] signed the Smart Islands Declaration. This time it was not

[4] From Croatia, Cyprus, Denmark, Estonia, France, Germany, Greece, Italy, Ireland, Malta, Portugal, Spain, Sweden, the Netherlands and the UK

the MS's ministers, but the European islands' local and regional authorities themselves who committed to (cited from Smart Islands Initiative, 2021):

1. *"Take action to mitigate and adapt to climate change and build resilience at a local level*
2. *Trigger the uptake of smart technologies to ensure the optimal management and use of our resources and infrastructures*
3. *Move away from fossil fuels by tapping our significant renewables and energy efficiency potential*
4. *Introduce sustainable island mobility including electric mobility*
5. *Reduce water scarcity by applying non-conventional and smart water resources management*
6. *Become zero-waste territories by moving to a circular economy*
7. *Preserve our distinctive natural and cultural capital*
8. *Diversify our economies by exploiting the intrinsic characteristics of our islands to create new and innovative jobs locally*
9. *Strengthen social inclusion, education, and citizens' empowerment*
10. *Encourage the shift towards alternative, yearlong, sustainable and responsible tourism"*

The national promotor of the Smart Islands Initiative in Croatia was the Regional Energy Agency Kvarner, motivating several Croatian island authorities to sign the commitment.

Finally, the **BRIDGE initiative** launched in 2016 and supported by Horizon 2020, unites R&I projects in the areas of Smart Grid, Energy Storage, <u>Islands</u>, and Digitalisation (BRIDGE Brochure June 2020) to motivate the knowledge-sharing between the projects, increase their visibility and impact in the communities, contributing also to speeding up the energy transition and repairing the negative consequences of COVID-19 pandemic. The initiative (data from June 2020) brings together 64 projects involving 713 organizations from 38 countries.

One of the relevant projects under this initiative is **NESOI: New Energy Solutions Optimized for Islands –** grant agreement ID: 864266, grant value: 10 million EUR (H2020 NESOI, 2021). Starting in 2019 and ending in 2022, EU Islands Facility NESOI aims to fund, support, and monitor energy projects implemented on islands. The first NESOI Call for proposals was open from October 2020 to December 2020, with over 3 million EUR available to support the islands' energy transitions. A total of 28 islands from 10 different countries were shortlisted to receive the NESOI grant (worth up to 60.000 EUR), starting in May 2021, and a second call for applications is expected to be announced in autumn 2021 (H2020 NESOI, 2021).

Another project of importance for this thesis is the H2020 **"INSULAE - Maximizing the impact of innovative energy approaches in the EU islands"** (2019-2023) that has selected the Croatian island of Unije (a case-study island in this thesis) as one of the project's pilot islands, investing significant resources in energy transition activities and investments on the island (H2020 INSULAE, 2021).

This section demonstrated the European Union's strategic affiliation and support towards the islands' energy transition. Next, the position of social innovation in local energy transition processes will be demonstrated, stressing the role that social sciences have in the decarbonization agenda.

2.3 Social innovation in local energy transition processes

Back in 1915 the famous phrase "Think globally, act locally" appeared, attributed to the Scottish regional planner Patrick Geddes (Groom, 2012)[5], but made popular in the 1990s before the UN Rio de Janeiro Conference on Environment and Development. Since then, it has been used in various discourses connected to globalization and sustainable development. Its variation has been coined also in relation to local energy transition processes: Act locally, transition globally! (Adesanya, Sidortsov, & Schelly, 2020). In other words, activities that happen at a local level are considered key to reaching the national and global energy transition goals. However, they require supportive national renewable energy policies to be successful (Brugger & Henry, 2021).

„Bottom-up approaches to energy transition are anchored in decentralized, community-based solutions, innovative tailor-made municipal models promoting broad citizen participation, and community co-creation and co-ownership" (Young & Brans, 2020, p.224).

The latter very well describes the position taken also in this thesis that will offer further evidence to the importance of bottom-up approaches, citizen engagement, and implementation of community energy projects. The second claim to be supported is that the energy system transitions are not to be considered strictly technical. Instead, they are to be seen as "socio-technical transitions" since they influence the technological regimes and the organization of societal systems, being comprised of *"technologies, policies, politics and other artifacts"* (Selvakkumaran & Ahlgren, 2021, p.1).

Social innovation is, according to research (Selvakkumaran & Ahlgren, 2021; Gjørtler Elkjær, Horst, & Nyborg, 2021), closely linked to the already mentioned concept of co-creation. In simple words, co-creation means doing something together with another person or entity

[5] There are certain disputes on the origin of the phrase, but most of the research literature consulted during this research was in favour of attributing it to P. Geddes.

(Selvakkumaran & Ahlgren, 2021), having in mind the following four aspects (W.H. Voorberg, 2014, as cited in Selvakkumaran & Ahlgren, 2021, p.2):

1. The objective of co-creation is to provide long-lasting solutions to society;
2. Co-creation "changes the social relationships between the stakeholders" as well as the context in which the existing practices are happening;
3. "Relevant stakeholders are involved in the design, implementation and adoption" of certain innovation, which adds to its relevance;
4. It is not only about producing innovations, but also about the innovation processes.

In a more elaborated approach, co-creation is seen as a process in which actors come together despite their organizational and institutional boundaries, to jointly create innovations that are of mutual benefit (Gjørtler Elkjær, Horst, & Nyborg, 2021). This approach further distinguishes three different understandings of co-creation, namely: 1) "Co-production of identities and representations, 2) Co-creation of innovation in socio-technical systems, 3) Co-creation as participatory governance" (Gjørtler Elkjær, Horst, & Nyborg, 2021, p.1).

The co-creation aspect is important for local energy transitions because only a citizen-oriented approach can ensure the avoidance of the NIMBY (Not in My Back Yard) syndrome and a successful uptake of the new technology and is, claimed by Selvakkumaran & Ahlgren (2021) mostly led either by municipal actors (MA) or civil society players. Although the new renewable technology may be the core of energy transition, the local energy transitions are to be foreseen primarily as "socio-technical" and "actor-centered" transitions, rather than as "pure technological" transitions (Selvakkumaran & Ahlgren, 2021, p.2). Another argument (Fri & Savitz, 2014) counts on the fact that decarbonization and climate change mitigation are a public good, so probably the private markets will not be interested in developing innovations needed to respond to these challenges. Instead, social sciences should influence the consumer choice (by leading the consumers not to take only the price into account) and support the governmental institutions in developing adequate frameworks and policies for the energy transition.

Yet it remains unclear how to assess the impact of co-created social innovation on local energy transitions. Selvakkumaran & Ahlgren (2020) use the Transformative Social Innovation (TSI) framework to explain different social innovations present in the different cases analyzed. In their understanding, the TSI consists of four different elements (also called "shades") which sometimes overlap (Table 3):

TSI elements	Description
Social innovation	*"The change in social relations, involving new ways of doing, organizing, etc."*
System innovation	*"The change at the level of societal sub-systems, including institutions, social structures, and physical structures."*

Game changers	*"The macro-developments that are perceived to change the playing field."*
Narratives of change	*"The overall discourses on changes that come about, with changes in sets of ideas, concepts, etc."*

TABLE 3: FOUR ELEMENTS OF TSI, SOURCE: SELVAKKUMARAN & AHLGREN (2020, P.3)

The authors (Selvakkumaran & Ahlgren, 2021, p.3) however point to the fact that *"game-changers and narratives of change take time to manifest and to be observable"*, so when analyzing recent local energy transition processes it is hard to detect any game-changers or narratives of change, so one can only hypothesize on what they could be at some point in future. They analyze and compare three different cases, not the overall energy transition, but some elements of it, namely:

- "The diffusion of household solar PV panels in Skåne, Sweden" case
- "The transition from fossil fuel cars to alternative fuel vehicles in Dalsland, Sweden" case
- "The oil-burner phase-out in Hjørring, Denmark" case

The results are shown in Table 4 and are used to better illustrate the TSI framework.

Cases	**Social innovation**	**System innovation**	**Game-changers**	**Narratives of Change**
"The diffusion of household solar PV panels in Skåne", a case in the county in southern Sweden, with the highest solar electricity potential in the country	"The method of information dissemination is new, with the establishment of study circles. The MAs also have a new role as facilitators of solar PV diffusion."	"The relationship between the residents and the MAs has changed. The residents have access to the MAs and can request help with technical and other doubts over solar PV installation."	"No observed game-changers yet."	"Narratives of change have not been observed yet."
"The transition from fossil fuel cars to alternative fuel vehicles" (AFVs) case in Dalsland (five municipalities	"The method of information dissemination is new with organizing meetings and demonstration meetings.	"Clearly, the physical charging stations have brought about a system innovation, with the town	"No observed game-changers yet."	"Narratives of change have not been observed yet."

in the county of South-Western Sweden)	The method of trialability is also changing, with the availability to try EVs and biogas cars."	centers having charging-while-parking stations."		
"The Oil-burner phase-out in Hjørring", Northern Denmark case (phase-out of 500 household oil-burners, that was 10% of the existing oil-burners, between 2016 to end of 2018.)	"The method of information dissemination is new, with town-hall meetings and focus groups."	"No system innovation seen yet."	"No observed game-changers yet."	"Narratives of change have not been observed yet."

TABLE 4: THE BRIEF OVERVIEW OF THE THREE TRANSITION CASES USING THE TSI FRAMEWORK, SOURCE: SELVAKKUMARAN & AHLGREN (2021, P.8)

Potential critique to TSI may come from the fact that, due to time constraints (time needed for game-changers and narratives of change to be developed), it mostly portrays only social innovations and system innovations. However, it can be a nice tool to visualize the transformative element of social innovation and the progress of its acceptance in the community. Not every social innovation is, of course, expected to become a game-changer nor to contribute to narratives of change, but it would be interesting to see how different actors perceive and assess certain social innovations and also to analyze what can be done to enable the development of system innovations.

Low-carbon innovations, defined by Geels & et. al. (2018, p.23) as *„new technologies, organizational arrangements and modes of behavior (or social practices) that are expected to improve energy efficiency and/or reduce energy demand"* can also be classified *„by their degree of technical or social novelty" (*Geels & et. al., 2018, p.23). Most policy efforts so far were focused on the technically and socially incremental innovations, but the expected more radical demand reduction will require also more radical innovations and substantial change in social and user practices (Geels & et. al., 2018). Figure 4 shows some relevant examples of energy field segments in which more substantial innovations are expected.

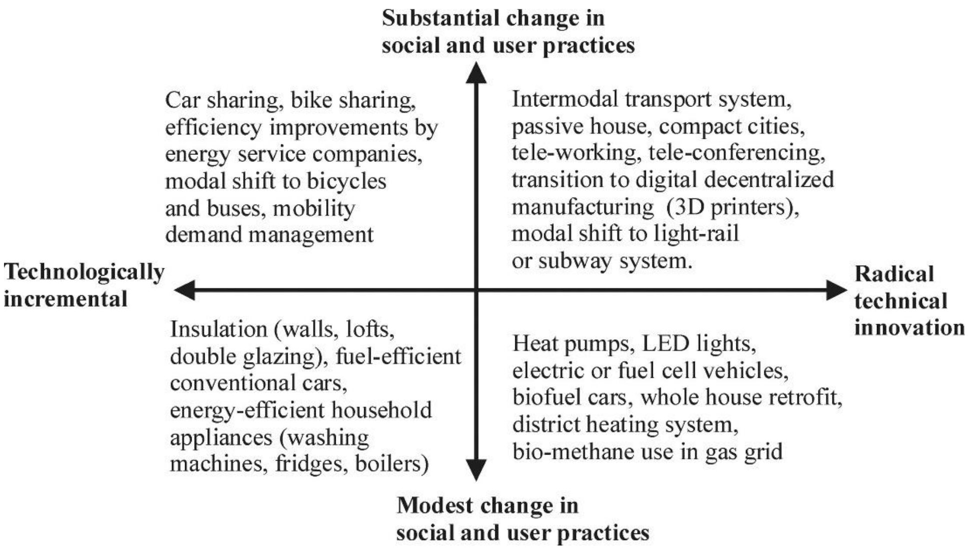

FIGURE 4: VARIETY OF LOW CARBON INNOVATIONS WITH DIFFERENT DEGREES OF SOCIAL AND TECHNICAL NOVELTY, SOURCE: GEELS F.W. ET.AL. (2018)

This is a non-exhaustive list yet since many examples are missing. In their editorial to the 11th edition of Sustainability Journal, Hoppe T. and de Vries G. (2019), based on the article contributions to this special issue dealing with social innovation in energy transition, list the following areas as fertile ground for social innovation:

- “social incentives (including ‘green nudges’) to stimulate behavioral change (e.g. to lower energy consumption),
- new social configurations (e.g. using social entrepreneurs or intermediaries to build social networks supportive to renewable energy),
- new organizational forms to stimulate low carbon energy services (e.g. renewable energy cooperatives),
- new forms of governance to stimulate transitions to low carbon economy (either at the local or regional scale; e.g. citizen self-governance or co-creation to co-design low carbon policy),
- novel policies and regulations to empower social groups to engage in low carbon energy activities.” (Hoppe T. and de Vries G., 2019, p.3),

In the words of Hoppe T. and de Vries G. *“social innovation seeks to attain particular social goals, like community empowerment, alleviating (energy) poverty, (energy) justice, social equality, and increasing the wellbeing of local communities”* (2019, p.9) and it is expected to have the capability to address the above mentioned social challenges (Selvakkumaran & Ahlgren, 2020).

Even though it is mostly being perceived positively and gaining more and more attention from researchers, the role of social innovation in local energy transitions is still under-studied (Selvakkumaran & Ahlgren, 2020 & 2021) or it is considered in narrow instrumentalist terms, being analyzed mostly as a tool serving particular policy objectives (Wittmayer, 2020). As a consequence*, "the impact of social innovation on energy transitions is not clearly defined or articulated"* (Selvakkumaran & Ahlgren, 2020, p.99) and there is also a need to *"develop an empirically robust record of the benefits of social sciences in facilitating the energy innovation process"* (Fri & Savitz, 2014, p.187).

Therefore, this thesis intends to expand the research on social innovation in local energy transitions and, by analyzing the examples of different EU islands, offer a list of social innovations that could support the local energy transition of the Croatian island of Unije.

3 METHODOLOGY

The theoretical framework is presented in the early section of this thesis and provides the rationale for conducting this research. The theoretical analysis is based on findings from national and international scientific literature and current political agendas. This chapter explains "step-by-step" how and why certain methods and instruments were employed at each stage of the research.

3.1 Research questions and approach

The selection of a research approach is, among other factors (such as the researchers' personal experiences or the research audience) based on the nature of the research problem (Creswell & Creswell, 2018), or the issue that is to be addressed. The research question to be addressed in this thesis is the following: *What is the role of social innovation in energy transition and can social innovation be considered a success factor in the island of Unije energy transition process?* There are also a number of sub-questions involved, related to the social innovation types and identification, the foreign islands' best practices, the recognition of actors that need to address the social side of technical zero-energy innovations, and the potential role of governments in social innovation design and implementation. We differentiate three research approaches: quantitative, qualitative, and mixed (Creswell & Creswell, 2018). Creswell & Creswell (2018) claim that the line between qualitative and quantitative approaches is not so rigid and that research sometimes *tends to be* more qualitative or more quantitative.

This master research tends to be more qualitative, by using the *case study* as the most suitable research strategy. According to Yin (2013, p.1) when the research focus *"is on a contemporary phenomenon with some real-life context"* and when *"there is a need to obtain an in-depth appreciation of an issue, event or phenomenon of interest"* (Crowe. S. et. al., 2011, p.1) it is useful to make a case study. In this case, the real-life context - the case of Unije island will be contrasted to other EU islands' best practices, to see how the existing foreign socially innovative practices can affect the ongoing energy transition process on Unije. However, the main research method is the survey, a form typical for qualitative research which *"provides a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population (…) with the intent of generalizing from a sample to a population"* (Fowler, 2008, in Creswell & Creswell, 2018, p. 49-50). More details on the survey are provided in section 3.3.

3.2 Research design

As defined by Creswell & Creswell (2018, p. 49), *"research designs are types of inquiry within qualitative, quantitative, and mixed methods approaches that provide specific direction for* *procedures in a research study"*. Combining the quantitive and qualitative approaches, the objective of this thesis is to analyze whether social innovation can be considered a success factor in the energy transition process of Unije, and thus the research design involves several steps that will lead to answering this question. This includes researching not only the situation on the island of Unije but also on some other EU islands that are considered as front runners in the energy transition and have already implemented different social innovations.

The island of Unije is on a path to become the first small carbon-neutral island in Croatia.[6] With the support of the Primorje Gorski Kotar County (regional government) and Regional Energy Agency Kvarner (as local transition coordinator), the energy transition of the island of Unije is being implemented as part of the wider "Unije: Self-Sufficient Island" policy framework that, apart from energy independence, also promotes measures in the area of water supply and drainage, agriculture and mariculture, transport infrastructure and tourism. Energy developments on Unije were, however, given a significant boost in 2018 when the H2020 project "INSULAE - Maximizing the impact of innovative energy approaches in the EU islands" (Grant agreement ID: 824433), with the island of Unije as one of the pilot islands, was selected for funding (H2020 INSULAE, 2021).

The island of Unije case study will present the relevant information related to:

- Unije's geographical position, demographical situation, and economy, to provide context to the energy transition issues;
- Unije Self-Sufficient Project, initiated by the regional government, that should contribute to the overall island sustainability, not only from the energy point of view;
- Developments in the field of Unije's energy transition, mostly connected with the implementation of the H2020 INSULAE project, and the socio-economic aspects of this transition;
- Local perception of the energy transition developments on the island.

The energy transition of Unije is still in the beginning phase and can benefit a lot from the research on best external practices – other EU islands that are at more advanced energy transition stages - learning from them by replicating their results.

The initial desk research on the front-runners in decarbonization among the European islands, based on the available research papers' analysis as well as the project database of the EU's

[6] Yet another island in the Kvarner Bay is famous for its zero-energy agenda, and that is the island of Krk, but these two islands are not really comparable since Krk is connected to the mainland with a bridge and only 25 km away from the City of Rijeka as the regional centre.

Horizon 2020 programme, resulted in a list of fewer than ten islands being widely acknowledged for their efforts in becoming carbon neutral. The islands that stood out were the following (in alphabetical order): Aran Islands (Ireland), Borkum (Germany), Bornholm (Denmark), Madeira (Portugal), Orkney Islands (Scotland), Reunion (overseas department of France), Samso[7] (Denmark) and Tilos (Greece).

Out of those eight islands, in collaboration with energy experts from the Regional Energy Agency Kvarner, three islands were selected to be scrutinized - Aran Islands, Samso, and Tilos, based on the estimated replicability of their best practices to the island of Unije. In other words, the task was not to evaluate whose transition methods were the best, but from which islands Unije can learn the most and replicate their methods.

Since citizen engagement is quoted as the main ingredient of successful islands' energy transition (Heaslip & Fahy, 2018; Selvakkumaran & Ahlgren, 2021; Sperling, 2017), in the central part of this research the local community on Unije was given an opportunity to express their views on island's self-sufficiency and decarbonization tendencies, by taking part in a community survey.

Experiences of three different EU islands (Samso, Aran Islands, Tilos), gathered from secondary data and lessons learned from the H2020 project INSULAE, were then put in correlation with the primary data resulting from the survey among the residents of Unije, leading to conclusions and practical recommendations for the local/regional government.

3.3 Research methods and instruments

To answer the research questions, both qualitative and quantitative methods were used, as well as the combination of primary and secondary sources. Desk research was used to collect qualitative data from different secondary sources. Apart from research databases (for theoretical framework elaboration) and the European Commission's official website (for the information on relevant political agendas), an important source of data were the archives of the Regional Energy Agency Kvarner, a public organization that coordinates energy transition activities on the pilot island of Unije. An in-depth literature review and analysis of strategic documents were undertaken to critically assess the context for the local energy transition. On the other hand, the empirical part of research relies both on secondary sources and primary data gathered via a local community survey.

[7] For the purpose of this paper, anglicized version "Samso" is used instead of version Samsø.

The main research method used was the survey conducted among the residents of Unije. Ethical clearance was obtained beforehand from the Institutional Review Board at Modul University Vienna. The survey was intended for:

- **Permanent residents of Unije island** (living full-time on the island, throughout the whole year), and
- **Occasional residents with property on the island** (i.e. staying with family or in their own weekend houses in some periods of the year, but not the whole year).

The survey was conducted during June 2021, door-to-door in paper format, and online via a digital format questionnaire. The participants in the online survey were initially approached by either phone, e-mail, or social networks. The chain-referral sampling technique was used since the participants were asked to propose future participants from among their acquaintances. The same questionnaire was used for both groups of participants. It was structured as a combination of closed-type and open-type questions, focusing on:

a) **Public attitudes towards the current „Unije Self-Sufficient Island“ action plan** listing all of the Plan's measures (in different areas – agriculture, energy, transport, tourism…) and aiming to find out which measures the locals consider as most important, what is the status of Energy measures in this ranking, and what is the level of their support towards some concrete measures (questions no. 1, 2, 3 and 4);
b) **Willingness for a more active personal engagement,** in terms of either financial investments, change of energy-consumption habits, or engagement in the work of a potential island energy cooperative (questions no. 5, 6, 7 and 13);
c) **Actions that could increase the overall public support towards the island energy transition**, which at the same time detect possible flaws in the current transition project implementation (questions no. 11 and 12);
d) **Level of familiarity with the "social innovation" concept** and its role in the energy transition (questions no. 8, 9, 10, and 14).

The collected data were analyzed using standard descriptive analysis and statistical analysis. The analysis showed that the permanent and occasional residents share similar opinions and experiences across almost all questions, which is not unexpected, given that the majority of the occasional residents of Unije originate from the island and thus know the Unije's history and challenges.

The survey was chosen as a method over interviews since the aim was not to gain what Geertz has called "*thick descriptions*" (Geertz, 1973), the detailed interpretations and subjective understandings of individual islanders, but to have an overall understanding and numeric assessment of the EE and RES actions that are being implemented or are planned to be implemented on the island. The majority of questions were thus of a closed-ended type and participants were asked to assess certain claims and actions on a Likert scale. However, there were also a few open-ended questions asking for further clarifications or suggestions. As expected, the feedback from the open-ended questions was not always in close relation to the question. Instead, the participants used the opportunity to express their current issues and concerns related to living on the island in general. This way, some thick descriptions were also collected in the end but serving more as descriptive interpretations of complex island living conditions, rather than providing background information on the energy transition processes. Nevertheless, some very relevant and interesting comments provided valuable inputs to the research.

In addition, secondary data from the H2020 INSULAE survey was used, that involved the residents – participants of the INSUALE Focus group meeting, held in the summer of 2019 on the island of Unije, organized by the Regional Energy Agency Kvarner to obtain the locals' perceptions on the energy developments on the island.

Finally, this research will merge the gathered qualitative and quantitative data to make a comprehensive analysis of the research problem, and integrate all the findings in the final elaboration of results.

4 EMPIRICAL PART

The empirical part of the research consists of two main sections – the case study of Unije, a small island that intends to become the first energy-independent island in Croatia, and the analysis of best practices and social innovation examples in the islands' energy transition focusing on three European islands that are in the more advanced transition stage than Unije and whose experiences could be replicated to Unije island.

The islands to be analyzed in this thesis are (Table 5):

EU islands in the energy transition – best practices (Country)	Surface area (m2)	Population	Short description
Samso (Denmark)	114 m^2	3.724	Danish island located in the Kattegat, 15 kilometers off the Jutland Peninsula.
Aran Islands (Ireland)	46 km^2	1.200	An archipelago of three islands located in Galway Bay, on the west coast of Ireland.
Tilos (Greece)	64 m^2	780	A small island in the Aegean Sea, part of the Dodecanese group of islands.
Case study island	**Surface area (m2)**	**Population**	**Short description**
Unije (Croatia)	17 km^2	88	A small island just west of the larger Losinj in Kvarner bay of the Adriatic sea.

TABLE 5: ISLAND COMMUNITIES TO BE ANALYZED IN THIS THESIS, SOURCES: CE4EUI, 2019; NOTTON, G. ET.AL., 2017, STARC, 2011, ADAPTED BY THE AUTHOR

These islands, being quite different in terms of location, distance from the mainland, surface area, population size, level of transition advancement, and technology used will offer different perspectives and experiences to learn from.

Papazu (2016) emphasizes the centrality of "the social processes" to community-based transition processes, stating that the emphasis accent should not be on technological innovations. She believes that in the process of the island's energy transition, project developers create something new (that is: the renewable energy island) out of three different elements that are now new*: "1) Well-tried renewable technologies, 2) community-ownership and 3) citizens' meetings"* (Papazu, 2016, p-17). The following analysis of the three observed islands (best-practices) confirmed this argumentation.

4.1 EU islands in the energy transition – best practices

The experiences of the three selected EU islands (Samso, Aran Islands, and Tilos), although similar in their final goal and ambitions, are quite different.

Samso's energy transition story dates back to the 1990s, while in 2007 the island was declared 100% energy self-sufficient (Papazu, 2016) and set a new target – to become completely independent of fossil fuels before 2030 (Mathiesen et. al., 2015). Thus, Samso has more than 20 years of experience in energy transition processes, led by Samso Energy Academy, and has many aspects to learn from and replicate even on significantly smaller islands like Unije.

The Aran Islands were chosen in 2012 by the Sustainable Energy Authority of Ireland (SEAI) as the ideal location to study how the reliance on imported energy from the mainland could be reduced by energy efficiency and renewable energy measures (Pleijel, 2015). This was the turning point, leading towards the foundation of an energy cooperative on the Aran Islands whose goal is to *"make Aran islands energy independent and carbon neutral by 2022"* (CE4EUI, 2019, p.4).

The energy transition of the Greek island of Tilos is a process that started most recently, to a large extent connected with the realization of the H2020 project TILOS (2015-2019).

Finally, commissioned by the regional government, the first REI energy scenarios for Unije were prepared in 2011, while in 2015 a wider "Unije: Self-Sufficient Island" project was started, led by the Regional Energy Agency Kvarner, and its energy-related activities were given a significant boost with the H2020 project INSULAE (2019-2023).

Apart from only a brief technical description of the islands' energy systems, the focus will not be on analyzing the energy infrastructure nor the energy systems' functionality, but on the social aspects of their energy transitions.

4.1.1 Island of Samso (Denmark)

4.1.1.1. Background

Samso is an island of around 3.600 inhabitants, located 15 kilometers off the Jutland Peninsula (Figure 5), governed by the Samso municipality, Denmark (CE4EUI, 2019).

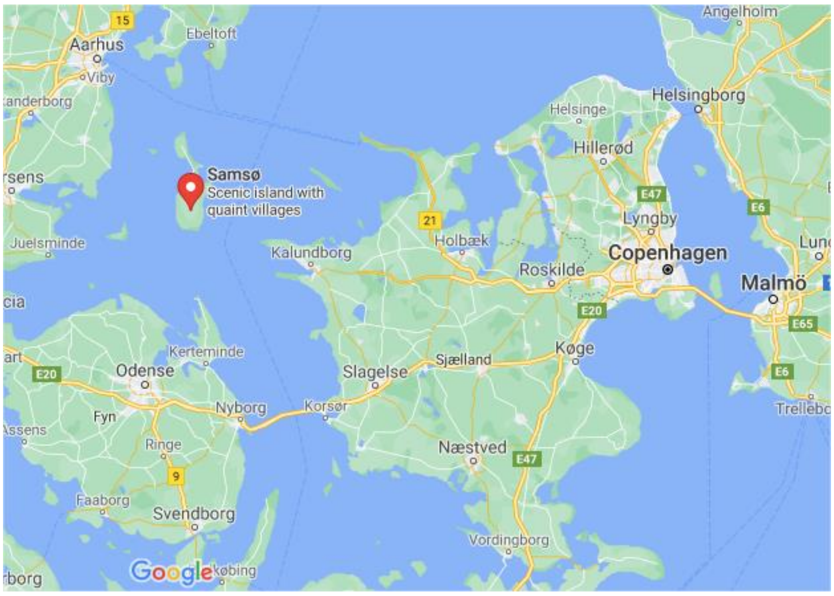

FIGURE 5: SAMSO IS LOCATED 15 KILOMETERS OFF THE JUTLAND PENINSULA, SOURCE: GOOGLE MAPS

In 1911 the island had 7500 inhabitants, while in 2018 according to the AdminStat DANIMARCA the population declined to 3.684. The distribution by age shows the prevalence of older generations with more than 50% of inhabitants being over 55 years of age (Table 6).

POPULATION BY AGE (THE YEAR 2018)		
Classes	**(n.)**	**%**
0 - 2 age	87	2.36
3 - 5 age	69	1.87
6 - 11 age	196	5.32
12 - 17 age	197	5.35
18 - 24 age	121	3.28
25 - 34 age	220	5.97
35 - 44 age	359	9.74
45 - 54 age	458	12.43
55 - 64 age	712	19.33
65 - 74 age	719	19.52
75 or more	546	14.82
Total	**3,684**	**100**

TABLE 6: POPULATION BY AGE, 2018, SOURCE: ADMINSTAT DANIMARCA, ADAPTED BY THE AUTHOR

The out-migration to other parts of Denmark is larger than in-migration (partially due to young people who leave the island at 16 or 17 to continue education), however, there is a positive net inflow from foreign countries due to workers from Eastern Europe as well as the increase in the number of refugees who may decide to settle permanently on the island, so the Statbank Denmark forecasts (Figure 6) show the potential for population growth by 2040 (Jantzen, Kristensen, & Haunstrup Christensen, 2018).

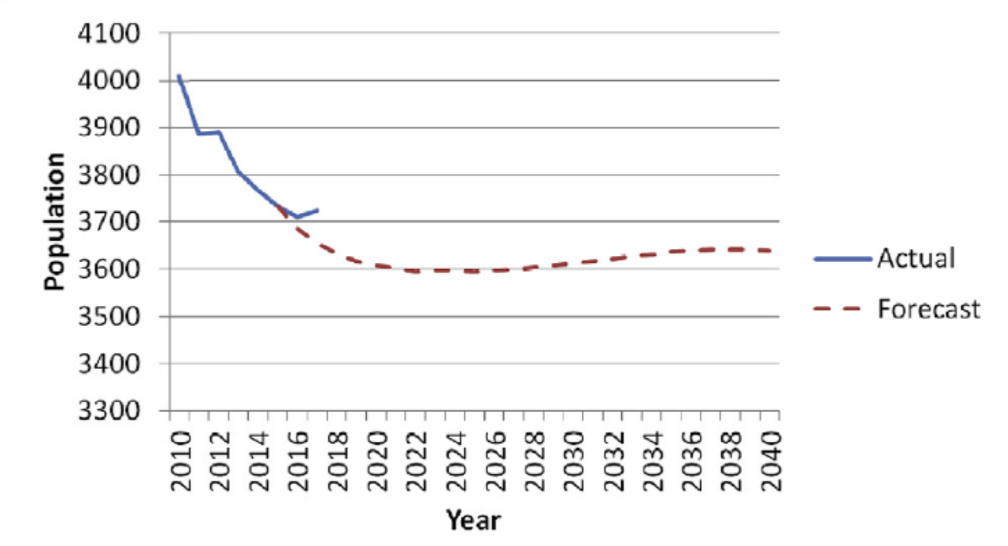

FIGURE 6: STATBANK DENMARK POPULATION FORECASTS UNTIL 2040, SOURCE: STATBANK DENMARK

Some of the interesting government measures that may have contributed to the attractiveness of settling at Samso may be their ferry policy stating that *"ferry access to the islands should cost the same as driving the same distance by roads"* (Jantzen, Kristensen, & Haunstrup Christensen (2018, p.23). The government offered subsidies to small municipalities to lower the ticket prices which both increased the number of passengers to the island and made the transport of goods less expensive.

Samso's economy traditionally relied on agriculture and tourism, with fewer labor opportunities for highly educated professionals. The county expressed interest in keeping them on the island by promoting new industry and more graduate jobs, and the renewable energies island programme is considered to have contributed to this tendency (Halkier, 2007).

The purpose of this thesis is not to assess to what extent the decarbonization project also contributed to the moderate rise in population numbers. That was surely a result of a nexus of different policy measures. Yet, it is encouraging to observe that the island that is the front runner in energy transition also demonstrates success in reversing the depopulation trend.

4.1.1.2. Energy transition

As described in the Samso Energy Vision 2030 document, Samso started its first RES projects in the late 1990s with the installation of 11 wind turbines that were primarily owned by local inhabitants (Mathiesen & et. al., 2015). In 1997, the island was nominated in a national competition to become a model RES island. In the early 2000s, a district heating system was built, integrating biomass in the heating system, and several public building renovations were carried out to reduce heating demands. Also, several offshore wind turbines were built. In 2006 Samsø Energy Academy was founded to carry out future energy transition projects and in 2007 Samso started producing more energy than it was using (Papazu, 2016).

The current island's energy system is specific for its large share of wind power from 11 onshore and 10 offshore wind turbines, as well as the 75% share of district heating supplied households, fueled mainly with woodchips and straw, both harvested locally, while the individually heated buildings are supplied by biomass boilers, heat pumps, electric heaters, oil boilers and a few solar thermal collectors (Marczinkowski & Ostergaard, 2019, CE4EUI Catalogue, 2019). Some households that are "outside of the heating districts have replaced old oil furnaces with biomass boilers and solar or heat pumps" (CE4EUI, 2019, p.11), while the electricity is supplied by household PV panels (to a smaller extent) or imported by a power cable from the mainland (Marczinkowski & Ostergaard, 2019, CE4EUI Catalogue, 2019).

With its 2030 strategy vision, the island wants to make a step further, going from a net renewable energy island where some sectors are offset by RES production towards a 100% renewable energy island supplied only by renewable energy in all sectors. According to the CE4EUI Catalogue presented in December 2019, this includes switching all transportation means to electricity or biogas for which the electric cars' union was founded, as well as the installation of a multifunctional biogas plant to produce biogas for transportation. Also, measures for lowering the need for heating in homes will be introduced.

Speaking about the Island of Samso energy transition, one of its key leaders (Hermansen, S., 2013, In: Papazu, 2016, p. 10) stressed the fact that "the Renewable Energy Island project wasn't new. It was built on well-known principles of self-sufficiency, good housekeeping, harnessing local resources. It wasn't wave technology!" This statement summarizes the nature of Samso's transition very well. As reported (Papazu, 2016), the local energy transition was not seen nor presented as a climate or energy project, but rather as means to create a platform of active and responsible citizens who would take care of their community. Even though the idea was to reorganize the island's energy system, RES technology nor CO_2 emissions were not in the center of discussion and it was unclear whether Samso's REI project is actually *"a climate or energy project, a project in community-building or local development or something else"* (Papazu, 2016, p.13). As the same author further argues, Samso did not become a leading example of zero-energy islands due to technological innovations, but rather due to *societal* or *participatory* innovation that was built into its local energy transition.

What is usually not described in numerous reports written on Samso, is the actual human side of the story that was analyzed in-depth in the Ph.D. research carried out by Papazu (2016) who spent five months on Samso (2013-14), living on the island, joining the daily work at the Samso Energy Academy and conducting numerous interviews and background stories.

In April 1996, Papazu reports, an article was published in the local newspaper stating a triumph over the fact that the regional government has decided not to build any large wind farms on the island. Only half a year later, the municipal council was examining the possibility of applying to the national (government) competition to become a model renewable energy community. The head of the business council on Samso (gathering representatives of the island's businesses who used to meet each month) got a call from Samso's energy supplier company with information about the national public call for islands. It was at this time that one of the largest employers on the island (the island's slaughterhouse) was closed and hundreds of people became unemployed (Papazu, 2016).

"I [head of the business council] went straight to the council and said: 'Friends, we are going to make Samso self-sufficient with renewable energy!' The manager of the slaughterhouse said, 'The smith is going crazy, we could never do something like that!' But the mayor, who was also a part of the council, was quick to see the possibilities for local job creation, which was also my sole interest as head of the business council and master smith." (Papazu, 2016, p.33)

Samso did apply, and it won the competition in 2007, being appointed the Danish Renewable Energy Island and awarded with 17.000 EUR to develop a pre-study. Samso Energy Company (in Danish: Samso Energiselskab) was established to facilitate the REI project, having all Samso's key stakeholders involved in its work. The company hired an engineer to further coordinate the technical aspects of the REI project, while a farmer and teacher took the role of the island's "energy counselor"[8] in charge of managing the social aspects of the project, i.e. getting the islanders to embrace it.

From 1997 to 1999, Papazu (2016) reports, technical calculations, and activities were made, preparing the ground for RES installations, but with no communication activity towards citizens. This lead to people's discouragement and resistance, coupled with the fear that something important for the island is happening behind their backs. That was one of the rare mistakes in Samso REI project implementation.

[8] This person is today the director of the Energy Academy, Mr. Soren Hermansen

The "Ten-year plan: First energy plan for Samsø", referred to in the literature as "the Masterplan", prepared in 1997 by Samso Energy Company (assisted with relevant stakeholders) *"proposed the installation of different technologies: four district heating plants, 15 land-based wind turbines, 15 offshore wind turbines (to offset fossil fuel-based transportation), 15 household wind turbines, two large biogas plants, five farm-based biogas plants and 70 smaller solar cell plants"* (Samsø Energiselskab et al. 1997, In: Papazu, 2016, p.37).

The master plan was presented to the locals in several meetings during 1999 and at first, faced rejection. Then the manager held individual meetings with the key influencers, convinced them of the benefits, and at the following meeting the whole community embraced the ideas. The novelty was also in the fact that the Plan was prepared by a dedicated organization, and not by the municipality, which was different from Denmark's usual practice.

It is worth mentioning that apart from being appointed the Danish Renewable Energy Island (REI), and the small initial grant, no more funds were promised by the state. However, this nomination enabled Samso to compete in other calls for funding. Samso Energy Academy estimated that in the first ten years, around 53.3 million EUR were invested in the island, and each islander on average invested 14.000 EUR, which was assisted by the island's banks that offered affordable loans to everyone, even the ones with lower financial capacity, so everyone could afford buying shares in collaboratively owned RES technology (Papazu, 2016, p.38).

This is where Samso was well ahead of its time. First, they realized the importance of "key influencers" in the case of low carbon energy transitions, or the *"people who already have the attention of the community as a whole"* (Heaslip, 2017, p.37). Second, they understood the importance of taking care of both technical and social dimensions in parallel. Third, they promoted the development of community-led renewable energy projects (wholly or partially owned and/or controlled by communities) long before that became a recognized practice that is currently supported by the EU in different relevant energy strategies.

In their (Samso Energy Academy's) own words, *"the willingness to take risks, push local investments and build trust among the local community were the main ingredients of Samsø's groundbreaking success"* (CE4EUI, 2019, p.11) and an example of how the community can take good care of its future.

Some external conditions favored the Samso project, for example, the supportive national energy strategy with clear guidelines for REIs on the need for local participation, which influenced the holistic approach taken by Samso, together with the existence of various funding programmes for local activities (Sperling, 2017).

Internally, the unemployment crisis, depopulation issues, and rural development problems motivated people to act, and an experience with local (agricultural) cooperatives provided the organizational framework (Sperling, 2017). Finally, according to the same author, dedicated individuals were identified and supported to mediate between the project and the community. Finally, by enabling the growth of community energy, supported by financial instruments from the banks, no one was left behind. In other words, public participation was not just an add-on to a top-down development process, nor was it there just to avoid public controversies (Papazu, 2016).

4.1.2 Aran Islands (Ireland)

4.1.2.1. Background

Aran Islands are a group of three islands - **Inis Mór** (referred to in the literature also as Árainn), **Inis Meáin** and **Inis Oírr** - located in the Galway Bay, on the west coast of Ireland (Figure 7), with a total area of around 46 km^2. Aran Islands have a total of 1,200 inhabitants and are governed by Galway County Council (CE4EUI, 2019). The number of people however triples in the summer period due both to tourist and local population that returns from working or studying on the mainland. Each island has its own development company or co-operative in charge of different public functions but with no jurisdiction (Aran Islands Energy, 2019).

FIGURE 7: LOCATION OF ARAN ISLANDS IN GALWAY BAY ON IRELAND'S WEST COAST, SOURCE: GOOGLE MAPS

Inis Mór is the largest of the three Aran islands with an area of 31 km^2, second-largest is Inis Meáin (9 km^2) and the smallest is Inis Oírr (8 km^2) (CE4EUI, 2019). Same as many other European islands, Aran islands also face depopulation issues, with the population being cut to half in the last 100 years (Table 7).

Islands/Year	1841	1851	1901	1951	1996	2002	2006	2011	2016	Index
Inis Meáin	472	503	421	361	191	187	154	157	160	33,90
Inis Oírr	456	518	483	338	274	262	247	249	260	57,02
Inis Mór (Árainn)	2592	2312	1959	1016	838	831	824	845	840	32,41
Total	3520	3333	2863	1715	1303	1280	1225	1251	1260	35,80

TABLE 7: ARAN ISLANDS - CHANGE IN POPULATION 1841 – 2016, SOURCE: IRISHISLANDS.INFO/CENSUS & CENTRAL STATISTICS OFFICE, ADAPTED BY THE AUTHOR

The main economic branch is tourism, followed by farming, small-scale fishing, and food production. Unfortunately, many young people with higher education have few work possibilities on the islands so they choose to work on the mainland or abroad. Seasonality is also an issue since in the summer period the number of people on the islands rises from about 1.200 to 2.700. Islands can be accessed by either ferry or plane (approx. 1.5h journey duration by ferry, 10 min by flight) but the reduced service is offered between November and March (Pleijel, 2015).

The Aran Islands faced depopulation issues, aging population, energy over-use, economic over-dependency on tourism and were - same as many other small EU islands – 100% dependent on imported energy, with a political will to decarbonize by 2022 expressed in their energy independence roadmap.

4.1.2.2. Energy transition

The first RES technology installed on Aran islands was the wind. Back in 2002, "three wind turbines were installed on Inis Meáin covering almost 40% of the three islands' annual electricity consumption", but being decommissioned in 2011 (CE4EUI, 2019, p.4).

In 2012 Aran Islands Energy Cooperative, with the support from the Sustainable Energy Authority of Ireland (SEAI), and the involvement of commercial companies and the local community started a pilot project for increasing the energy efficiency of public buildings (Pleijel, 2015). A study was prepared to show how the reliance on imported energy could be reduced by investments in energy efficiency measures and renewable energy systems since the energy was being imported via under-sea cable from the mainland first to Inis Mór and from there to the other two islands. It was concluded that the Aran Islands could reduce their energy imports by 84%. Based on these conclusions, in 2014 the local energy cooperative designed the energy independence 2022 roadmap and commissioned a feasibility study for the installation of a wind turbine on Inis Mór, and the Galway County development plan for 2015---2021 supported this ambitions by putting energy independence of Aran Islands as one of the objectives (Pleijel, 2015). This proved to already be a good strategic objective in 2016 when the power cable to the mainland was cut, "leading to a general power outage in the archipelago" (CE4EUI, 2019, p.4).

In 2018, two consulting companies were commissioned by Aran Islands Energy Co-Op to develop an Energy Master Plan (EMP) for Inis Mór and Inis Meáin. The third island, Inis Oírr, was not included since the island was developing its plan separately (CE4EUI, 2019). During the data collection process, private and public stakeholders were contacted to provide information on energy consumption. The EMP suggested the installation of different RES technologies: onshore wind turbines, solar farms, wave and tidal energy systems, installation of residential and non-residential biomass boilers, anaerobic digestion, and heat pumps. Also, the EMP presented different renewable energy proposals for transportation (personal transport electrification, electric or hydrogen-run ferries) as well as the evaluation of a hydrogen production facility on the island, deployment of smart micro grids, and battery storage (Rivas, Stanley, & Forkan, 2018). The EMP also suggested closer collaboration between the Aran Islands energy cooperative and the three development cooperatives – the Árainn development cooperative, Inis Oírr development cooperative, and the Inis Meáin development company. However, it is not clear from the EMP why this document excluded the Inis Oírr island.

In 2019, the Aran Islands were selected by the EU Islands Secretariat as one of the pilot islands that were to develop the islands' transition agenda which was a highly participatory process and a local transition team was aware from the start that "to reach the islands' transition goals, the active contribution and consideration of the needs of all island stakeholders will be key" (CE4EUI, 2019, p.4). Given the high energy consumption by the transport sector, "engaging the local ferry companies and the local authority in the transition process" (CE4EUI, 2019, p.4) was considered imperative.

The Clean Energy Transition Agenda of Aran Islands (2019) was again focused more on the Inis Mór and Inis Meáin while it is said in the Agenda that the energy consumption emissions for Inis Oírr will be included once its energy master plan is finalized. The Agenda focuses strongly on the stakeholder mapping or the identification of local actors relevant for the energy transition process. First, those are the civil society organizations (citizen co-operatives), then the businesses networks and ferry companies, public sector actors, schools, and academia. Also, it underlines the importance of empowering the energy communities as „groups of citizens, social entrepreneurs, public authorities and community organizations participating directly in the energy transition by jointly investing in, producing, selling and distributing renewable energy" (Aran Islands Energy, 2019, p.19).

It is also noted that the governance of the clean energy transition is shared between the local energy and development cooperatives on both islands, with a significant role of schools as the key catalysts for change. The 1st pillar of energy transition listed in the Agenda is Community engagement since *"the Aran Islands' communities lie at the heart of its clean energy transition.*

Providing benefits to the islands by bringing jobs, income and a sustainable and clean environment are the principal aims of this transition” (Aran Islands Energy, 2019, p.26). Thus, the Agenda coordinator intends to reach out to the island community and seek broad support, while the *„joint decision-making based on the acceptance of a large majority of the island community (*over 75%) makes sure that the cooperative’s actions reflect the island community’s perspective“ (Aran Islands Energy, 2019, p.26).

While the focus of both the EMP and the transition agenda was on the islands of Inis Mór and Inis Meáin, the energy developments on Inis Oírr were in the center of one university research project, with a strongly participatory approach.

According to researchers Heaslip & Fahy who did a study on Aran Islands' transition taking Inis Oírr as the case study*, “the community energy planning is understood as the range of methods used to define the priorities of a community around energy provision and energy use with a view to improving efficiency, cutting emissions, and driving economic development”* (2018, p.2), ranging from technical planning to assessing energy practices and cultural norms and values. In their field research on Inis Oirr island, Heaslip & Fahy (2018) used surveys, focus groups, individual interviews, and workshops as instruments to learn about the participants’ perceptions of Inis Oírr’s energy transition. After examining community low carbon energy transitions in the Irish context, and based on the Inis Oírr case study, Heaslip (2017) concluded that:

Energy transition project objectives need to be shared with the local community as early as possible;

- Meetings in person with the locals are the best communication method;
- It is preferred to use the existing organizational structures or networks whenever possible;
- It is important to detect a „key influencer“ in the community and get him/her to support the project publically;
- Mixed methods of funding are preferred (including also private funding from citizens themselves);
- It is important to inform the community as early as possible about any potential risks or drawbacks;
- It is advisable to make use of the local energy knowledge;

The study results further showed that “the top 5 desired characteristics for a community energy project” (Heaslip, 2017, p.390), ranked in descending order of popularity, for the locals at Inis Oírr are the following: *“1) Affordable energy, 2) Energy independence, 3) Energy that is good for the environment, 4) Local people involved in the project and 5) Renewable energy”*

In other words, locals at Inis Oírr want to save money while saving energy, prevent further electricity blackouts caused by problems with the undersea cable, save the island's natural environment, be actively involved and promote the use of renewable energy.

What is interesting in the case of Aran Islands is precisely the element of citizen engagement through co-operatives, being funded and running way before the EU started promoting it as a viable concept for local communities.

Aran Island Energy Cooperative was first a project of Aran Development Co-Operative (1990-2003), then it became a sub-committee of the same development cooperative and finally, in 2012 it was registered as a separate legal body. Every resident (or business) of the Aran Islands may become a cooperative member and shareholder. However, it is forbidden to distribute any profit to the shareholders. The cooperative aims to have at least 50% ownership of RES installations on the islands and to further drive the transition on the Aran Islands to carbon neutrality (Aoidh, 2019).

Looking at the European level, it is believed that Denmark as a nation is a front-runner in wind energy precisely due to the cooperative nature of its wind farms (Meyer, 2004, Christensen and Lund, 1998, In: Heaslip, 2017, p.55). Also, as pointed out by Heaslip (2017, p.58) *"almost half of Germany's renewable energy capacity is owned by individuals and local or regional community groups"*. Thus, it is plausible to assume that the cooperative organization on the Aran Islands will be crucial for meeting the objective of becoming carbon neutral by 2022.

4.1.3 Island of Tilos (Greece)

4.1.3.1. Background

Tilos is a small Greek island and municipality (Figure 8) with an area of 64 km2, located in the Aegean Sea, midway between the more popular islands Kos and Rhodes (Notton, G. et.al., 2017). According to the 2011 census (ELSTAT, 2020), it has a population of 780 inhabitants.

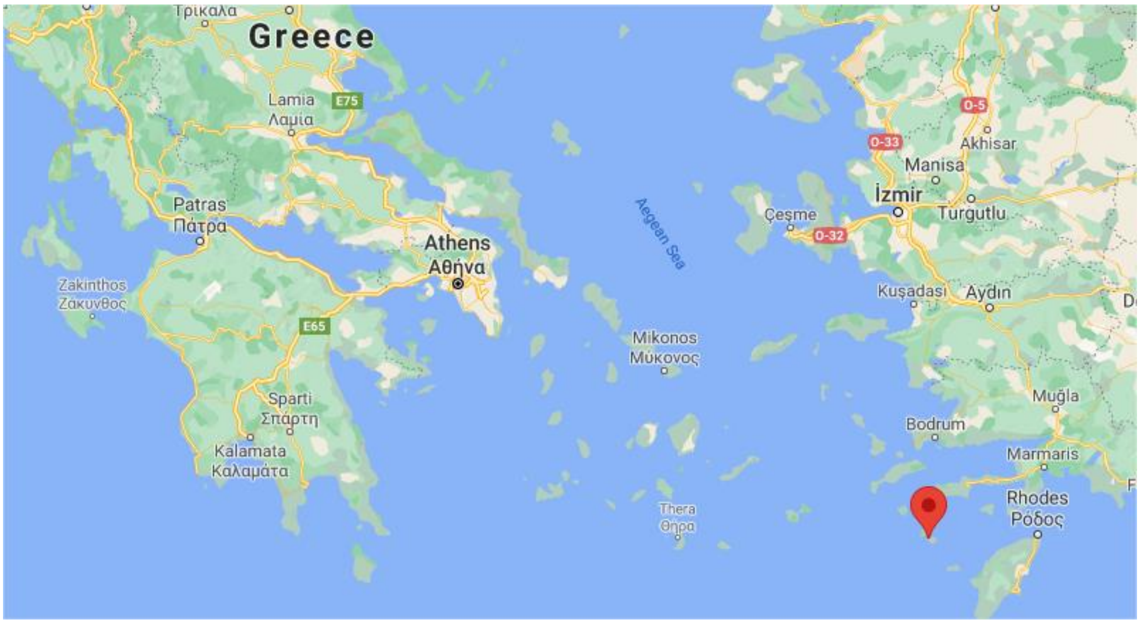

FIGURE 8: TILOS ISLAND IS LOCATED IN THE AEGEAN SEA, SOURCE: GOOGLE MAPS

Similar to many other islands, Tilos had faced a population decrease, with numbers going significantly down from 1951 to 1991 (Table 8). Hower, since 1991 the population is steadily increasing which is due to the creation of appropriate conditions for the general development (creation of infrastructure, improvement of transport, etc.) and the development of tourism (South Aegean Region , 2014).

Island / Year	1951	1961	1971	1981	1991	2001	2011
Tilos	1.052	789	349	301	279	533	829

TABLE 8: TILOS ISLAND - CHANGE IN POPULATION 2001 – 2011, SOURCE: ELSTAT

The official ELSTAT (Hellenic Statistical Authority) data on the age distribution is available only in a consolidated manner for the island of Tilos and the close-by Halki island and does not allow for a safe conclusion to be drawn. However, the report (South Aegean Region , 2014) states that the population growth comes mainly from young people employed in tourism who decide to settle on the island. Despite the positive demographic trends, the officials at Tilos recognized the need to take a step further to ensure the island's sustainability, and the island's energy transition was one of the pillars of its long-term sustainability.

4.1.3.2. Energy transition

Tilos island imports electricity via a submarine cable that first goes to Kos and Nisyros island, making Tilos the last island in line, experiencing frequent power cuts lasting from few minutes to several hours. In 2010, a visionary former mayor of Tilos, Mr. Tasos Aliferis, in cooperation with experts from the Athens-based University of West Attica decided to introduce RES on the island (WWF, 2019). The University prepared a project proposal and applied for a Greek

National grant, but was not selected for funding. However, they did not give up and in 2014 the proposal was re-submitted and won the H2020 call.

The EU project "TILOS - Technology Innovation for the Local Scale, Optimum Integration of Battery Energy Storage" (project reference no. 646529), worth almost 14 million EUR, started in February 2015 with a four-year duration, 13 participating enterprises, and institutes from 7 European countries (DE, FR, EL, UK, SE, IT, ES), with the Greek University of West Attica as the leading partner (INEA, 2021).

Eliminating the problem of power outages by power produced locally from renewables was thus a number one priority for Tilos, reports Zafirakis (2017), the H2020 TILOS project coordinator, combined with *„a strong environmental culture amongst the people of Tilos… [who] always had an open mind when it comes to innovative ideas, such as the implementation of the TILOS project on their island. This is largely thanks to the former mayor, Mr. Tasos Aliferis, who loved the island and fought for the protection of the local environment“* (Zafirakis, 2017) and who had no hesitation in supporting the renewable energy initiatives on Tilos.

Project relevance was confirmed in 2016 when the subsea cable was severely damaged and the island was completely cut off for two weeks (Kaldellis & Zafirakis, 2020). The main objective of the TILOS project was *"the development and operation of a prototype battery storage system, based on NaNiCl2 batteries, provided with an optimum, real-environment smart grid control system and coping with the challenge of supporting multiple tasks, ranging from microgrid energy management, maximization of RES penetration and grid stability, to export of guaranteed energy amounts and provision of ancillary services to the main grid"* (H2020 TILOS, 2019).

In more simple words, the TILOS project was set to develop a new system of energy production combining different RES (specifically wind turbines and solar plants) which due to fluctuating productivity had to be combined with a battery storage system to meet the island's energy requirements at any time of the year.
The smart microgrid and hybrid power station introduced consisted of the following main technological components (Kaldellis & Zafirakis, 2020):

- A wind turbine with a nominal power of 800 kW;
- A photovoltaic power station (solar park) of 160kW, comprising of 592 solar panels;
- An advanced Battery Energy Storage System (BESS) for storing excess energy generated, able to provide 12h of energy autonomy for the island without external support;
- Smart meters and Demand Side Management (DSM) system which in cooperation with consumers/citizens aims to achieve a better balance between production and demand. When there is high demand and low production the consumers receive a notification, to avoid using energy-intensive appliances

- An Energy Management System (EMS) that would coordinate the work of the entire RES system on Tilos

A microgrid was intended to control the power supply of households and the municipality would receive a 3% share of revenues from the power station. Free charging stations for hybrid vehicles were also introduced and the municipality is considering introducing the electric power ferry to the island (Atherns Insider , 2021).

The current Mayor of Tilos Municipality, Ms. Maria Kamma, highlighted the following main benefits of this technology (WWF, 2019): Once the TILOS project is implemented, the quality of electricity will be improved, and power failures (which are often and last for long) would be eliminated, same as the severe damages of electric appliances in households and businesses due to voltage fluctuations. Second, it will contribute to the protection of the environment (by reducing the use of oil as a fuel) and third, Tilos would be able to export clean energy to other islands. From the citizens' point of view, there was also hope that if the island manages to sell the excess electricity that could lead to lower electricity rates for the locals. Also, a large portion of the energy consumed will be green, enabling the development of green tourism.

An important part of the TILOS project activities dealt with social engagement, developing new business models and policy instruments, while one of the goals was to transfer the project knowledge and know-how to other Greek islands. Two surveys were undertaken, targeting the islanders.

The first one, implemented on Tilos at the end of 2016, involving a sample of 226 inhabitants, demonstrated a widespread local acceptance of RES solutions but also the unwillingness of a large part of the community (nearly equal levels of support and opposition) to engage personally in the local energy transition, as prosumers. What's interesting, some differences were observed on the gender level, with female respondents being more willing to “green” their personal energy consumption (UEA, 2018). Thus, the survey validated the co-existence of two clusters: a) locals who are supportive of a green energy transition but unwilling to make engage personally, and b) locals who are supportive, but also willing to take concrete personal steps or investments. The final study conclusion was that *„the more an individual perceives to have been exposed to the problematic elements of energy supply in non-interconnected islands, the more likely (s)he is to accept an energy prosumer role in the future“* (UEA, 2018).

Kaldellis & Zafirakis (2020) added that the social acceptance of technologies introduced by the TILOS project depended on several elements, such as proper fitting in the island's landscape, demonstrated potential for new economic activities (i.e. green tourism), energy security benefits, local development schemes and implementation of similar technology systems, and replication potential. Social acceptance of proposed technological interventions is *„a major determinant of planned transitions…“* and thus it is of extreme importance to *„provide a better* *understanding of energy-users perceptions vis-a-vis novel smart island proposals"* (Stephanides, 2019, p.249).

The second survey was implemented in September 2017, based on a sample of 1001 households across 15 different Aegean Sea islands, investigating the willingness of people to accept the TILOS model and make similar interventions on their islands. Again, it has been confirmed that general acceptance of the project values does not translate into the actual acceptance of concrete technological solutions, especially the ones that directly affect the locals as end-users. A general lack of understanding of new technology such as smart meters was considered as one of the major reasons for rejecting it. The study reached two important conclusions: First, to stimulate the support to RES there is a need to clarify all the uncertainties the locals may have and to demonstrate the positive technological impacts. Second, the researchers and/or the project leaders should try to understand how the locals form their opinions on RES technologies since that would help tailor the approach and communication. In other words, more research should be devoted to *"understanding of the socio-psychological and contextual determinants of public acceptability"* (UEA, 2018).

Apart from the research on social acceptance, the TILOS project also examined the economical side of RES investments, focusing on battery storage solutions (that are also the backbone of the Unije island transition). A life-cycle cost-benefit analysis model was developed to evaluate the economics of battery storage system implementation, concluding that despite the obvious positive benefits (improved energy system flexibility and supply security) the installation of such systems is still economically feasible only with the existence of governmental support or subsidies (UEA, 2018).

The H2020 TILOS project also proposed the setting up of a joint master programme (JMP) "RES Hybrid Energy Solutions and Clean Energy Islands" that would deepen the future engineers' understanding of the renewable energy applications in remote areas and islands, in combination with summer schools, research mobility projects and similar. These kinds of activities could have multiple benefits – by increasing the specific knowledge of young professionals, bringing researchers and students to the island as a test-bed outside the tourist peaks and thus prolonging the season, and also maybe making some of them return to the island again as tourists or future residents. It has been noted by the project that the increased visibility related to the H2020 TILOS project already positively influenced the tourist numbers of the island.

Furthermore, in 2017 Tilos was appointed double EU Sustainable Energy Awards winner, stating that in the long term its ambition is to create an energy cooperative and reach 100% energy autonomy for the entire island (Zafirakis, 2017). The two awards have made Tilos famous across the EU, being an acknowledgment of joint efforts with the citizens. In the words of EU Sustainable Energy Awards judges, the island sent *"a very strong message that alternative,* *community-level schemes that foster energy storage are becoming a viable reality and a way to address energy security for islands"* (European Commission - DG Energy, 2017).

H2020 TILOS project ended in 2019, after successful implementation of the planned activities and investments in RES. Today, Tilos is the first island in southern Europe that has a hybrid power station with battery storage (WWF, 2019) which influenced the preparation of the New Development Law of Greece (4399/2016) and the development of *"novel business models and policy instruments"* (Boulogiorgou & Ktenidis, 2020, p.402).

Also, it is the first Mediterranean island to cover more than 70% of its electricity needs (in summer) by renewable sources with a surplus in winter, and an inspiration to other islands, including the Croatian Island of Unije since exactly the story of Tilos inspired some of the RES developments on Unije that will be described in the next session.

4.2 Socially innovative aspects of the selected EU islands' energy transitions

As it can be seen from the brief description of three distinct energy transition cases (Samso, Aran Islands, and Tilos), there are some similarities (e.g. the importance of energy cooperatives on Samso and Aran Islands) as well as some differences (e.g. forming a new organization for energy transition management on Samso versus managing the transition within the EU-funded project, by the international consortium) in how they approached energy transition issues. What is of interest for this thesis are the two segments of information presented: first, which were the social aspects of their transitions, and second, which of those aspects can be considered socially *innovative*. Finally, in chapter 5, lessons learned from these islands that could be of interest to Unije will be scrutinized.

To select socially innovative aspects of the selected EU islands' energy transitions, a two-step procedure was introduced. Based on the consulted literature (H2020 TILOS, 2019; Notton, G. et.al., 2017; Boulogiorgou & Ktenidis, 2020 – for Tilos; Heaslip, 2017; Aran Islands Energy, 2019 – for Aran Islands; Papazu, 2016; Sperling, 2017 – for Samso, etc.) an overview of their energy transition processes was created, focusing not so much on technological, but rather on the social aspects that facilitated the successful decarbonization. Second, examples of socially innovative actions they've undertaken were extracted and assessed following the methodology of Selvakkumaran and Ahlgren (2021).

Selvakkumaran and Ahlgren (2021) presented a model of understanding and assessing social innovation in local energy transitions processes. Their TSI (Transformative Social Innovation) approach distinguishes four levels of innovation - Social Innovation, System Innovation, Game-changers, and Narratives of Change. Selvakkumaran and Ahlgren (2021, p.4) provide the following definitions:

- **Social Innovation** is defined as "changes in established social relations, social practices, and new ways of doing things and organizing in societies";
- **System Innovation** is seen more as structural changes, transformations affecting patterns, physical infrastructure, policies, etc.;
- **Game-changers** are "macro-phenomena (events, trends, and developments) that change the 'game' of societal interaction (the rules, fields, and players)";
- **Narratives of Change** are believed to be "sets of ideas, concepts, metaphors, discourses or storylines about change and innovation" that can be "brought forth by social innovation initiatives to counter existing framings and discourses".

Resulting from the literature review of the island of Samso, Aran island, and the island of Tilos cases, a TSI classification of their energy transition-related innovations was conducted (Table 9):

Cases	Social innovation	System innovation	Game-changers	Narratives of Change
Island of Samso (Denmark)	Both technical (engineer) and social (communicator, community facilitator) experts were hired to co-run the project from the very start. "Key influencers" in the community were detected and convinced about the transition benefits, which helped to increase the local acceptance.	The islanders already had examples of solving problems collectively, due to previous long-term engagement in cooperative dairies and slaughterhouses since the end of the 19th century. Island banks offered affordable loans to everyone enabling every citizen to invest in co-owned RES systems.	The decentralization of energy generation through the community-led RES projects was promoted as a concept on Samso long before it became the EU's best practice. The RES projects however were promoted as development or community projects rather than energy. Thus, the community was engaged over the idea of general local well-being, decarbonization was named as a final goal.	The effective transition storytelling built by Samso Energy Academy around the Samso case enabled Samso's narrative to travel widely, making it a world-famous pioneer of the island energy transition.
Aran Islands (Ireland)	The method of information	Cooperatives as the	High energy capacities	Not observed yet.

	dissemination was new since the conducted survey and firsthand experience showed that regular direct meetings with the locals provide the best results. Same as in the Samso case, key influencers were used to spread the message and promote the project within the community.	organizational model were one of the most important success factors.	owned by individuals and local/regional groups enabled the game change also on Aran islands. The cooperative organization on the Aran Islands is considered to be crucial for meeting the objective of becoming carbon neutral by 2022.	
Island of Tilos (Greece)	Two community surveys were undertaken to better understand the energy users perceptions towards the proposed technology and achieve the highest public acceptance and support.	A production license for the hybrid RES battery power station was the first such system in Greece and among very few in Europe.	The installation of the first hybrid RES battery power station motivated the adoption of the New Development Law of Greece (4399/2016).	Not observed yet.

TABLE 9: OVERVIEW OF THE THREE ISLAND CASES USING THE TSI FRAMEWORK, SOURCE: OWN CONCEPT BASED ON THE CLASSIFICATION OF SELVAKKUMARAN AND AHLGREN (2021:4)

"Narratives of change take time to manifest and to be observable, especially in the fields of practice of social innovation" (Selvakkumaran & Ahlgren, 2021, p.3), therefore, in this example narratives of change are detected just in the case of Samso, since its transition story started in the late 1990s.

Information from this Table will be further commented in Chapter 5, as a basis for articulating the lessons learned from selected EU islands and forming practical recommendations for the local/regional government on what actions could be introduced to speed up the energy transition of Unije island.

4.3 The Case of the Island of Unije (Croatia)

The island of Unije is a small Croatian island in Kvarner Bay, in the North part of the Adriatic Sea. It belongs to the Cres-Lošinj archipelago (Figure 9) and it is one of the islands situated furthest to the west of all small open-sea Adriatic islands (Starc, 2011).

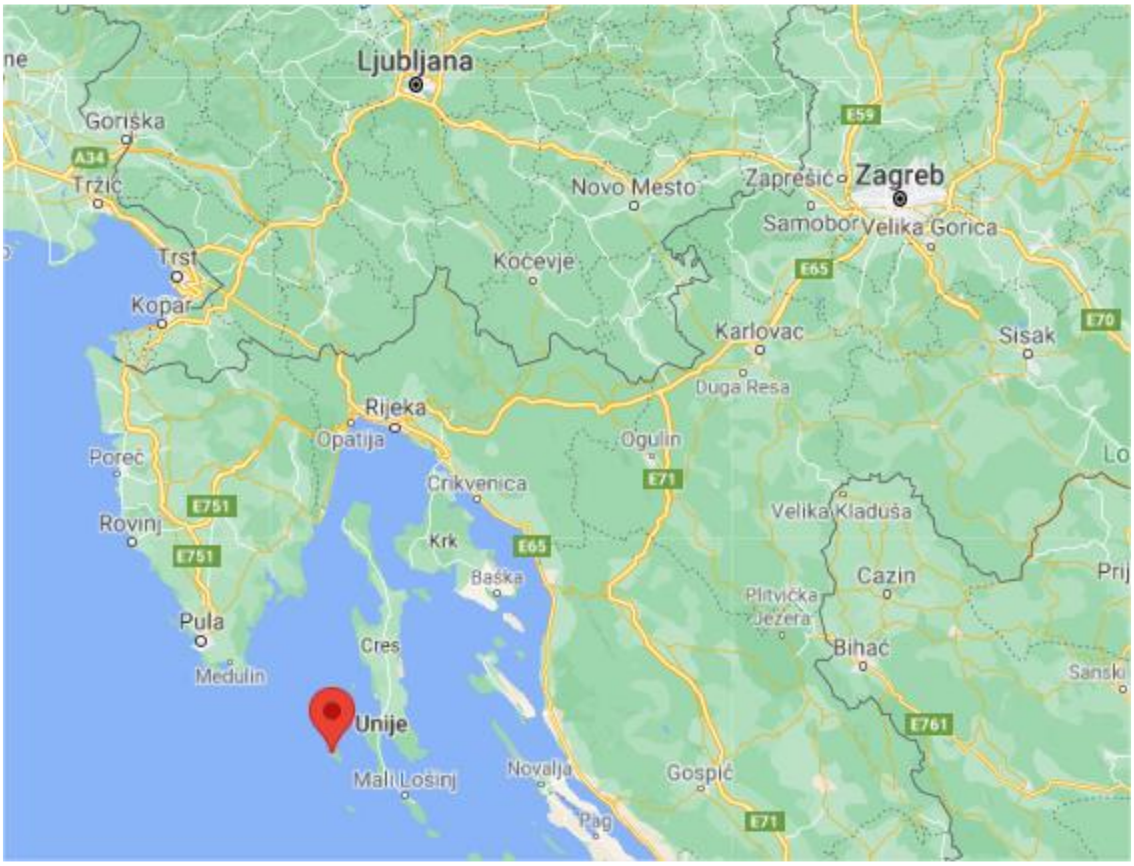

FIGURE 9: THE ISLAND OF UNIJE IS LOCATED IN THE KVARNER BAY OF THE ADRIATIC SEA, SOURCE: GOOGLE MAPS

The Cres-Lošinj archipelago is the largest archipelago in the Adriatic Sea which includes two major islands, Cres and Lošinj, several smaller islands such as **Unije**, Ilovik, Susak, Vele Srakane, Male Srakane, and also a number of small islets (Starc, 2011).

Together with the adjacent islets Samunčiel (0.034 km2), Mišnjak (0.017 km2), Školjić (0.005 km2), and Galiola (0.019 km2), Unije form a small archipelago with a surface of 16.95 km2, and 39.388 km of coastline, being the twentieth-largest Croatian island and the third out of seven inhabited islands that administratively belong to the City of Mali Lošinj (Magas, Faricic, & Loncaric, 2006).

The name Unije derives from the Greek word *heneios (neios, nia)*, meaning “field” and refers to large fertile areas for agricultural production that used to represent the main source of income for the domicile population (Starc, 2011). There is only one settlement on the island – the village of Unije (Figure 10).

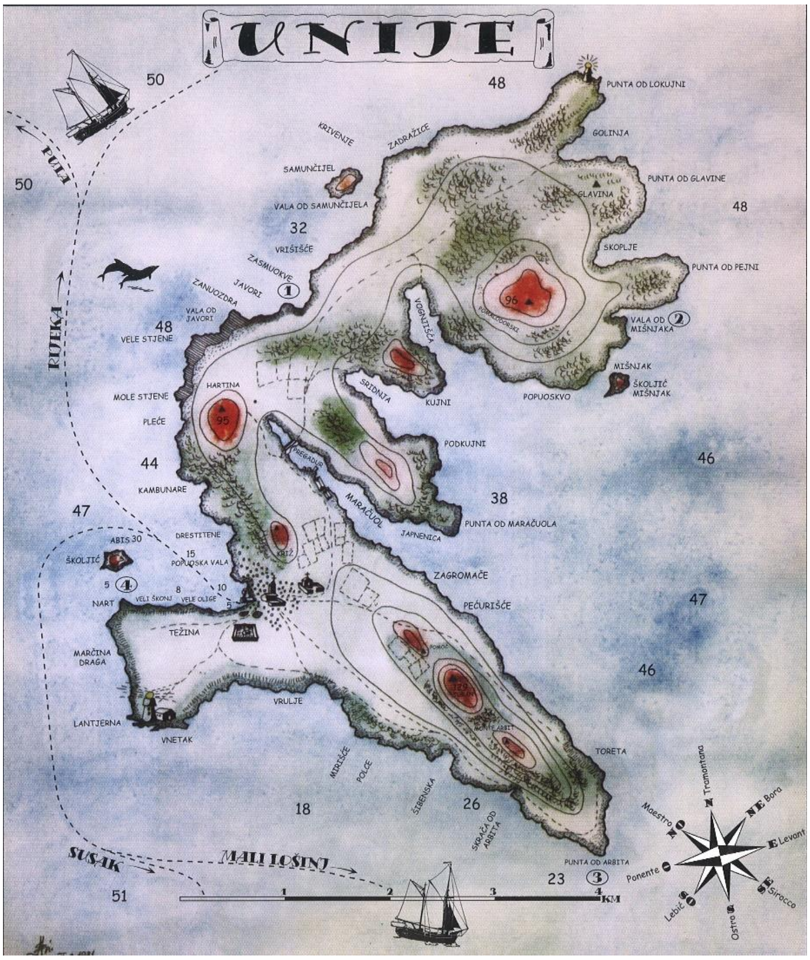

FIGURE 10: MAP OF UNIJE, SOURCE: MALI LOSINJ TOURIST BOARD

4.3.1 Demography and Economy

In the second half of the 20th century, most of the smaller Croatian islands faced depopulation (Magas, Faricic, & Loncaric, 2006), including Unije, which can be seen from Table 10.

Year	1900	1910	1921	1931	1948	1953	1961	1971	1981	1991	2001	2011
No.	696	758	783	717	457	402	273	113	85	81	90	88

TABLE 10: NUMBER OF INHABITANTS OF UNIJE 1900-2011, SOURCE: KORENCIC, 2011

The highest number of inhabitants was recorded in 1921, and since then that number decreased so that 2011 Unije had only 11.2 percent of the population recorded on the island in 1921. The next national census will take place at the end of 2021. However, the data available from the Unije District Council state that currently there are 50 people officially registered on the island, but some of them spend the winter period on the mainland and spring-autumn on the island. Also, some are registered on the island to be able to receive some subsidies intended for islanders (such as the free annual boat tickets to Unije) but do not live there. It is estimated that about 40 people reside on Unije throughout the whole year.

The last available data on the population age and gender distribution (from the 2011 census) shows the prevalence of the elderly population (Table 11).

Sex	Total	Age								
		0-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85+
	1	2	3	4	5	6	7	8	9	10
All	**88**	10	4	7	7	9	21	11	16	3
M	**38**	3	2	2	4	5	11	4	7	-
W	**50**	7	2	5	3	4	10	7	9	3

TABLE 11: UNIJE POPULATION DISTRIBUTION BY AGE AND SEX, SOURCE: CENSUS OF POPULATION, HOUSEHOLDS, AND DWELLINGS 2011

The media recently reported that the elementary school on the island will soon close because the only pupil (1) will start attending high school on the island of Mali Losinj (Milčić, 2021). Unfortunately, there are no incentives or significant national socio-economic initiatives that would motivate the current island population to remain living on the island or to attract new people to settle permanently on the island, apart from some regional initiatives that will be described further in the thesis, promoting the need for an integrated island revitalization.

In the summer months, there are about 800 people on the island (Starc, 2011), or at least those were the numbers before the COVID-19 pandemics that surely influenced the tourist arrivals on Unije as well. Unfortunately, the more recent tourist arrivals numbers are available only on the municipal level (City of Mali Losinj) and it is unknown precisely how many visitors come to Unije.

Unije can be reached only by catamaran or ferry, however, there is no road traffic on the island, the only exception being the tractors used for goods distribution and the postal service electric vehicle for delivering mail and postal packages.

There are four main directions from which the island of Unije can be reached: a) from the regional capital – the City of Rijeka, b) from the Istria peninsula – the City of Pula, c) from the southern part of Adriatic - City of Zadar and d) from the island of Mali Lošinj - which is the most important route for the locals. The ferry boat from Mali Lošinj is considered to be the most important since it is the only line that accepts not only passengers and passengers' luggage but also pets, all kinds of goods, furniture, construction material, whatever needs to be transported to the island by natural or legal persons.

Unless you are already on the adjacent island of Mali Lošinj, it is impossible to make a one-day return trip to Unije from any of the biggest regional centers, which further complicates life on the island. For example, if a person has a doctor's appointment at the Clinical Hospital Center of Rijeka (one of five clinical hospital centers in Croatia and the central hospital for this part of Croatia) he or she needs to stay in Rijeka overnight. The durations of traveling to Unije on all the above-mentioned lines are shown in Table 12:

Boat line connection to Unije	**Travel duration**
Ferry line: Mali Losinj – Srakane V.- Unije – Susak – M.Lošinj	
The travel duration from Mali Losinj to Unije	1.5 hours
Catamaran line: Mali Lošinj – Ilovik – Susak – Unije – Martinscica – Cres – Rijeka	
The travel duration from Mali Losinj to Unije	approx. 1 hour
The travel duration from Rijeka to Unije	approx. 3.5 hours
Catamaran line: Pula – (Unije – Susak) – Mali Losinj – (Ilovik – Silba) – Zadar	
The travel duration from Pula to Unije	1.5 hours

TABLE 12: TRAVEL DURATION TO UNIJE, COMPARISON OF DIFFERENT BOAT LINES, SOURCE: SHIPPING COMPANIES' JADROLINIJA AND CATAMARAN LINE LTD. WEBSITES, ADAPTED BY THE AUTHOR

The frequency of ship (ferry) and catamaran connections is also presented, based on the example of one week in the summer season (10-16th of July).

The first table (Table 13) shows the connections from the island of Mali Losinj. As it can be seen, there are 2-3 connections per day, 7 days a week, but none after 1:30 PM.

Departing from **MALI LOŠINJ (Lošinj)**	Arrival at **UNIJE (Unije)**	Line	Ship type	Ship name
Sat 7/10/2021 5:30 AM	Sat 7/10/2021 7:00 AM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Sat 7/10/2021 6:00 AM	Sat 7/10/2021 7:10 AM	(9308) M.LOŠINJ-UNIJE-CRES-RIJEKA	CATAMARAN	DUBRAVKA
Sat 7/10/2021 1:30 PM	Sat 7/10/2021 3:20 PM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Sun 7/11/2021 12:00 PM	Sun 7/11/2021 1:10 PM	(9308) M.LOŠINJ-UNIJE-CRES-RIJEKA	CATAMARAN	DUBRAVKA
Sun 7/11/2021 1:00 PM	Sun 7/11/2021 2:30 PM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Mon 7/12/2021 5:30 AM	Mon 7/12/2021 6:55 AM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Mon 7/12/2021 6:00 AM	Mon 7/12/2021 7:50 AM	(9308) M.LOŠINJ-UNIJE-CRES-RIJEKA	CATAMARAN	DUBRAVKA
Mon 7/12/2021 1:30 PM	Mon 7/12/2021 3:15 PM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Tue 7/13/2021 5:30 AM	Tue 7/13/2021 7:00 AM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Tue 7/13/2021 1:30 PM	Tue 7/13/2021 3:20 PM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Wed 7/14/2021 5:30 AM	Wed 7/14/2021 6:55 AM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Wed 7/14/2021 6:00 AM	Wed 7/14/2021 7:10 AM	(9308) M.LOŠINJ-UNIJE-CRES-RIJEKA	CATAMARAN	DUBRAVKA
Wed 7/14/2021 1:30 PM	Wed 7/14/2021 3:15 PM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Thu 7/15/2021 5:30 AM	Thu 7/15/2021 7:20 AM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Thu 7/15/2021 6:00 AM	Thu 7/15/2021 7:50 AM	(9308) M.LOŠINJ-UNIJE-CRES-RIJEKA	CATAMARAN	DUBRAVKA
Thu 7/15/2021 1:30 PM	Thu 7/15/2021 3:00 PM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Fri 7/16/2021 5:30 AM	Fri 7/16/2021 6:55 AM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Fri 7/16/2021 6:00 AM	Fri 7/16/2021 7:50 AM	(9308) M.LOŠINJ-UNIJE-CRES-RIJEKA	CATAMARAN	DUBRAVKA
Fri 7/16/2021 1:30 PM	Fri 7/16/2021 3:15 PM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT

TABLE 13: BOAT CONNECTIONS TO UNIJE 10-16 JULY 2021, SOURCE: "JADROLINIJA" NATIONAL SHIPPING COMPANY WEBSITE

The second table (Table 14) shows the connections from Unije to Mali Lošinj (and further to Rijeka). There are also 2-3 connections, from 7.00 AM to 8.00 PM. However, if the visitor for example comes to Unije from Rijeka by catamaran, there is no return option on the same day.

Departing from **UNIJE (Unije)**	Arrival at **MALI LOŠINJ (Lošinj)**	Line	Ship type	Ship name
Sat 7/10/2021 7:10 AM	Sat 7/10/2021 9:10 AM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Sat 7/10/2021 3:30 PM	Sat 7/10/2021 5:10 PM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Sat 7/10/2021 8:00 PM	Sat 7/10/2021 9:10 PM	(9308) M.LOŠINJ-UNIJE-CRES-RIJEKA	CATAMARAN	DUBRAVKA
Sun 7/11/2021 2:40 PM	Sun 7/11/2021 4:40 PM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Sun 7/11/2021 7:45 PM	Sun 7/11/2021 8:55 PM	(9308) M.LOŠINJ-UNIJE-CRES-RIJEKA	CATAMARAN	DUBRAVKA
Mon 7/12/2021 7:00 AM	Mon 7/12/2021 9:00 AM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Mon 7/12/2021 3:30 PM	Mon 7/12/2021 5:00 PM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Mon 7/12/2021 8:00 PM	Mon 7/12/2021 9:50 PM	(9308) M.LOŠINJ-UNIJE-CRES-RIJEKA	CATAMARAN	DUBRAVKA
Tue 7/13/2021 7:10 AM	Tue 7/13/2021 9:10 AM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Tue 7/13/2021 3:30 PM	Tue 7/13/2021 5:10 PM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Wed 7/14/2021 7:00 AM	Wed 7/14/2021 9:00 AM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Wed 7/14/2021 3:30 PM	Wed 7/14/2021 5:00 PM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Wed 7/14/2021 7:45 PM	Wed 7/14/2021 8:55 PM	(9308) M.LOŠINJ-UNIJE-CRES-RIJEKA	CATAMARAN	DUBRAVKA
Thu 7/15/2021 7:30 AM	Thu 7/15/2021 9:10 AM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Thu 7/15/2021 3:10 PM	Thu 7/15/2021 5:10 PM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Thu 7/15/2021 8:00 PM	Thu 7/15/2021 9:50 PM	(9308) M.LOŠINJ-UNIJE-CRES-RIJEKA	CATAMARAN	DUBRAVKA
Fri 7/16/2021 7:00 AM	Fri 7/16/2021 9:00 AM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Fri 7/16/2021 3:30 PM	Fri 7/16/2021 5:00 PM	(310) UNIJE-SUSAK-MALI LOŠINJ	SHIP	TIJAT
Fri 7/16/2021 7:45 PM	Fri 7/16/2021 9:35 PM	(9308) M.LOŠINJ-UNIJE-CRES-RIJEKA	CATAMARAN	DUBRAVKA

TABLE 14: BOAT CONNECTIONS FROM UNIJE 10-16 JULY 2021, SOURCE: "JADROLINIJA" NATIONAL SHIPPING COMPANY WEBSITE

This is not the case for arrivals from Pula, but those are not available all days of the week and also, since this line is operated by a private shipping company, it highly depends on the season (Table 15).

PONEDJELJAK / MONDAY ⊳ NEDJELJA / SUNDAY	SRIJEDA / WEDNESDAY ⊳ SUBOTA / SATURDAY	PETAK / FRIDAY	VISOKA SEZONA HIGH SEASON 02.07. - 29.08.	PONEDJELJAK / MONDAY ⊳ NEDJELJA / SUNDAY	SRIJEDA / WEDNESDAY ⊳ SUBOTA / SATURDAY	PETAK / FRIDAY
07:00	07:00	07:00	PULA	22:15	22:15	22:15
08:40 08:50	—	08:40 08:50	UNIJE	20:35 20:25	—	20:35 20:25
09:25 09:35	08:50 09:00	09:25 09:35	SUSAK	19:50 19:40	20:25 20:15	19:50 19:40
10:10 10:25	09:40 09:55	10:05 10:20	MALI LOŠINJ	19:05 18:50	19:35 19:20	19:05 18:50
—	10:45 10:55	—	ILOVIK	—	18:30 18:20	—
11:30 11:45	11:30 11:45	11:30 11:45	SILBA	17:45 17:30	17:45 17:30	17:45 17:30
13:15	13:15	13:15	ZADAR	16:00	16:00	16:00

TABLE 15: CATAMARAN CONNECTION PULA-UNIJE-ZADAR, HIGH SEASON 2021, SOURCE: CATAMARAN LINE LTD. WEBSITE

The island of Unije has had a small airport since 1996 (one runway with grass surface) but it has not been operative since 2013. In cooperation with the City of Mali Lošinj and the Tourist Board of Mali Lošinj, in 1999 the regional government of Primorje Gorski Kotar County organized a pilot airline connection from the island of Lošinj to the island of Unije, making Unije the first small island in the Adriatic with daily air service. The maintenance of the airline until 2005 was performed by the air carrier "North Adria Aviation" from Vrsar, and then the route was taken over by the company Zračno pristanište Mali Lošinj. Since 2013, the airline has not been maintained due to problems with land property relations, which put in question the legitimacy of performing the duties of an airport operator (Primorje Gorski Kotar County, 2020).

If we briefly look at the history and the economy of Unije, the period that is worth mentioning is surely the 1940s when Italy obtained about a third of the Yugoslav territory (Croatia, Serbia, and Slovenia), including the majority of cities along the Croatian coast, and also the island of Unije (Gobetti, 2018).

The most prominent author of the chronicles of Unije (Starc, 2006 & 2011) tells the story of how the Italian administration sought to stimulate economic development on the island. In 1932, the power plant, which provided several hours of electricity a day, started its operation. The plant was also used as a temporary location to pack fish. Somewhat later, a fish processing factory was launched in the bay of Maracol, organized by the company Arrigoni from Trieste. The fish factory employed a large number of islanders, mostly women. At that time, the island was full of life - hundreds of students in primary school, about 30 children in kindergarten, 80 employees in the cannery, and 40 fishermen in the fishing cooperative who hunted for the factory. Two mills, a wheat and corn mill, were operating and cottage cheese, meat, wool, and leather were produced. High-quality wine and olive oil were produced.

World War II marked the start of Unije's economic decrease. Many islanders emigrated due to political reasons, and in 1953 there was almost 50 percent less population compared to 1921. After the Italian capitulation in September 1943, Unije became part of Croatia within former Yugoslavia. A lot of people emigrated, mostly opponents of the communist regime, the Italian population, and their supporters who moved to Italy. In the second big wave of emigration (1961-1971) motives for emigration were both political and existential (Magas, Faricic, & Loncaric, 2006), since most of the production was terminated.

In 1979, Jadranka, the largest tourist company in the archipelago, started operating on Unije, by founding the so-called Complex Organization of Associated Labor (in Croatian: Složenu organizaciju udruženog rada - JUR). JUR began cultivating the fields without agreeing with the landowners. The livestock revival also began, roads were cleared, wire fences were erected, several agricultural buildings were built and agricultural machinery was brought in. The first water supply system was built. This lead to the opening of the grocery store, bakery, and restaurant. However, the production on the island was more expensive than on the mainland, the relations with the islanders were not so good due to many business decisions brought without accordance with the local community and in 1994 Jadranka closed its business on Unije (Starc, 2006 & 2011).

Today, observed during the author's visit to the island, the following facilities operate on Unije: a small grocery store, bakery, confectionary, beach bar, restaurant, postal office, and a small gallery. There is also an equipped infirmary, but with no medical staff, which is considered one of the biggest issues, since any type of medical care can be received only on the island of Mali Losinj, after a not so frequent 1-hour boat ride and in cases of emergency, helicopter for emergency medical services is called to the island. There are no hotels on the island, only private accommodation and one small family-run pension (Unijana) that can provide accommodation for about 20 guests. The most important economic branch is tourism.

As mentioned before, during the summer months, the number of people on the island multiplies, causing issues related not only to the lack of health care but also to the increased pressure on the island's infrastructure and especially in the energy, water, waste, and transport sectors. This high seasonality of the population *"demands innovative solutions in order to alleviate the pressure on the island's electricity grid and reduce energy costs in an environment-friendly way. Such interventions combined with smart water and waste management measures can efficiently reduce the negative consequences of the peak months and also greatly improve the life of the locals"* (RINA-C, 2019).

This was the motive to engage in the H2020 project INSULAE that is boosting the energy transition of Unije island, but which is part of a bigger picture, or one pillar of the wider „Unije Self-Sufficient Island Plan" that includes measures in the fields of energy independence, water supply, and drainage, agriculture and mariculture, transport infrastructure and tourism. Thus, the „Unije Self-Sufficient Island“ project will be presented in the following pages, as a context for the more narrow focus on Unije's energy transition.

4.3.2 “Unije Self-Sufficient Island” project

Back in 2015, the Primorje Gorski Kotar County Administrative Department for Regional Development, Infrastructure, and Project Management recognized the importance of investing in smart and self-sufficient islands by launching a pilot project “Unije Self-Sufficient Island”, led by the Institution Regional Energy Agency Kvarner, as a model of sustainable and self-sufficient life on the island that could then be implemented in other similar island communities (Regional Energy Agency Kvarner, 2021).

The project began with the conclusion of the Project Implementation Agreement between the Primorje Gorski Kotar County, the Diocese of Krk, and the City of Mali Lošinj, who declared a common interest in revitalizing the island of Unije and supporting its long-term demographic, environmental, energy and economic sustainability. To achieve these goals, a Project Team was established consisting of representatives of the Primorje Gorski Kotar County, the Diocese of Krk, the City of Mali Lošinj, the island of Unije District Council, and the Institution Regional Energy Agency Kvarner. The project entails a number of activities in the fields of energy independence, water supply and drainage, agriculture and mariculture, transport infrastructure, and tourism, which contribute to the island's self-sufficiency, not only in terms of energy but also in other aspects of sustainability (Regional Energy Agency Kvarner, 2021).

The Unije Self-Sufficient Island Action Plan was created, with the following measures included:

- **Energy independence**
    1. Energy-efficient public lighting <u>(done)</u>
    2. 1MW PV with battery energy storage system <u>(in progress)</u>
    3. Solar thermal collectors in buildings
    4. Biogas plant – zero-waste system demonstration
    5. Electric bikes and vehicles
- **Water supply and drainage**
    1. Self-powered desalination plant <u>(done)</u>
    2. Municipal potable water storage tanks
    3. Water supply network <u>(in progress)</u>
    4. Public sewage system <u>(in progress)</u>
    5. Wastewater treatment plant with discharge
- **Agriculture and mariculture**
    1. Land consolidation <u>(in progress)</u>
    2. Olive oil production – revitalization and mill construction

3. Growing vegetables in greenhouses
4. Permanent preservation of the Istrian cattle („boškarin“) (done)
5. Sheep and goat farming - increase in herds and cheese production
6. Fish farming

- **Transport infrastructure**
    1. Local airport – putting into action
    2. Breakwater extension (in progress)
    3. Maintenance of field roads
- **Tourism**
    1. Marina in Maračol bay
    2. Green hotel in Maračol bay
    3. Tourist trails and promenades - cycling, ecology, ornithology, archeology

As it can be seen from this list (with the status of activities being enclosed in brackets), some of the measures from this Plan have already been implemented, while others are still pending (Primorje Gorski Kotar County, 2021).

If we look at the measures in the energy field, we see that the replacement of the old one with the new energy-efficient LED street lighting has been conducted, the desalination plant powered by renewable energy has been installed and the installation of a ground photovoltaic power plant (up to 1 MW) is under preparation, expected to be realized in 2022. The power plant will be connected to a battery system for the storage of produced energy, and this joint RES system is intended to cover the year-round needs of the island for electricity and improve the security of its energy supply. The battery system will be implemented within the H2020 INSULAE project (Primorje Gorski Kotar County, 2017 & 2021).

With regards to the water supply and drainage, the construction of a complete water supply and drainage system is being carried out in stages. In 2017, a desalination unit was built, as a source of drinking water on the island, and in 2019 a solar photovoltaic (PV) power plant was installed on the roof of the desalinator. By the end of 2020, the first phase of the water supply system for about 30 households and the accompanying drainage system with the construction of separators and drains was realized (Primorje Gorski Kotar County, 2017 & 2021).

In the field of agriculture and mariculture, in cooperation with the Agency for Rural Development of Istria and the island of Unije District Council, the existing Istrian cattle (in Croatian: „boskarin“) herd on the island was enlarged. A study of the revitalization of olive trees growing on the island has been prepared, which is based on the re-activation of oil production from the olive trees owned by the Diocese of Krk (Primorje Gorski Kotar County, 2017 & 2021).

The development of transport infrastructure presupposes, above all, the extension of a breakwater in the port of Unije, which will enable a secure docking of ships that connect Unije with administrative centers of Mali Lošinj, Cres, Rijeka, Pula, and Zadar as well as with the less populated islands in the archipelago. The project of breakwater extension began in 2017 and will last until the end of 2021. Finally, a project documentation pack for the construction of the island's promenades has been prepared, with the next step being the realization of works.

Even before the start of the “Unije Self-Sufficient Island” project, a research study entitled “Island of Unije Energy Scenarios“ (Jardas et. al., 2011) was prepared by the Institution Regional Energy Agency Kvarner in cooperation with the University of Zagreb Faculty of Mechanical Engineering and Naval Architecture, examining different energy scenarios for the island until 2030 and proposing concrete RES and EE measures (Primorje Gorski Kotar County, 2017). This document served as a baseline for the energy component of the “Unije Self-Sufficient Island” project and later on for the preparation of the H2020 project INSULAE which is at the core of Unije’s energy transition.

4.3.3 Island energy transition

Energy sector transitions, on the mainland or the islands, regardless, need to be supported by relevant policy and strategic documents. The general framework for the Croatian energy sector development is provided in the Strategy of Energy Development of the Republic of Croatia until 2030 with an outlook until 2050 (Offical Gazette No. 25/2020). Another important document more precisely relevant for islands is the Island Law (Official Gazette, no. 116/18, 73/20, 70/21) that prescribes how islands’ goods can be used and exploited, supports the development of island-based projects, introduces the role of island coordinators employed by development agencies that should support the islands in project development, and defines the need to put together distinctive island development indicators, that should be different than the ones for the mainland. This Act supports precisely the development project such as the project INSULAE on Unije, focused on the island’s decarbonization.

The *energy* self-sufficiency of the Adriatic islands, especially those at a greater distance from the mainland such as Unije, is of utmost importance which was proven in winter 2016 when caused by the storm and inadequate anchoring of larger ships in the archipelago, the submarine power cable was cut, stopping the electricity supply to the island. The absence of electricity on the island was solved by bringing in the mobile power generators that managed to supply the island with electricity until the problem with the cable was fixed. Fortunately, the accident occurred in the winter period when there were fewer people on the island.

A research study “Island of Unije Energy Scenarios“ (Jardas et. al., 2011) prepared by experts from the Faculty of Mechanical Engineering and Naval Architecture in Zagreb and the Regional Energy Agency Kvarner presented a series of solutions for introducing renewable energy sources on the island to ensure energy self-sufficiency of Unije by 2030. The island has a favorable geographical location for the use of solar and wind energy as well as the potential for the use of biomass as a consequence of agricultural activities on the island. Given that the legislation at the time the study was prepared prevented the construction of wind farms on the island, a ground photovoltaic power plant with a capacity of up to 1 MW was selected as the first bigger renewable project on the island. Preparations for the implementation of the solar PV project began in 2014 when the external service provider was commissioned to select the most favorable location for the power plant. However, the preparation of the project documentation and acquiring all the permits proved to be quite complex, so the construction phase will not start before the beginning of 2022 (Regional Energy Agency Kvarner, 2021).

Once operative, the solar power plant will cover the island's year-round electricity needs, and all the surplus will be stored in a battery hybridized with the PV plant so that energy can be used in the evening when the sun sets. This will significantly reduce Unije's dependence on energy imports and the residents and tourists will be guaranteed clean, reliable, and green energy. Although this technology is not new on the EU level, it will be the first such battery storage system installed in Croatia. While the solar PV plant will be built and funded by the national electricity company (HEP d.d.), the battery storage will be acquired with EU funding (CE4EUI, 2019).

From April 1, 2019, Regional Energy Agency Kvarner is implementing the *INSULAE project - Maximizing the impact of innovative energy approaches on EU islands*, funded under the Horizon 2020 program. This 4-year project is not at the heart of Unije’s energy transition. INSULAE seeks to develop new innovative solutions for the decarbonization of European islands, which is key to achieving climate and energy goals as well as increasing the quality of life on the islands (H2020 INSULAE project).

Project activities are focused on the islands of Unije (Croatia), Bornholm (Denmark), and Madeira (Portugal), as pilot islands, and the results of pilot activities conducted on these islands will be used to transfer knowledge and develop energy action plans for Menorca (Spain), Norderney (Germany), Psara (Greece) and Bonaire islands (Netherlands Antilles). The leading partner of the project is CIRCE - Research Centre for Energy Resources and Consumption from Spain, and the Croatian partners in the project along with the Regional Energy Agency Kvarner are the University of Zagreb - Faculty of Mechanical Engineering and Naval Architecture, Ericsson Nikola Tesla Ltd., Water Supply and Sewerage Cres Lošinj Ltd. (VIOCL) and WWF Adria - Association for Nature Protection and Biodiversity Conservation from Zagreb (H2020 INSULAE project).

INSULAE pilot activities on Unije are based on the previous activities of the Primorje-Gorski Kotar County and Regional Energy Agency Kvarner in the field of Unije's decarbonization. Regardless of the project, as mentioned before, a solar power plant with a capacity of up to 1 MW will be built, followed by the installation of an INSULAE battery storage. Apart from the battery storage, under the INSULAE project several other innovations and solutions are to be implemented (H2020 INSULAE project):

- Smart integration and control of water and energy systems: setting up the system of smart agriculture/vineyards (monitoring soil and environmental parameters), smart water use and energy use (optimizing agricultural production), management of the existing desalination system;
- Empowerment of the island's energy communities through 5G and IoT: Smart Energy Boxes connected through 5G will be installed in private households, allowing the inhabitants to monitor and manage their energy consumption.

Once all the activities are conducted, Unije will most likely become the first 100% RES island, but the project leaders hope that this will be one of the triggers for reaching wider good, and that is to stop the depopulation process in the island and give a boost to its economy.

4.3.4 Socio-economic aspects of energy transition

The SWOT analysis (Table 16), prepared by the Regional Energy Agency Kvarner within the INSULAE project (RINA-C, 2019) describes the strengths and weaknesses of Unije's economy, identifies opportunities raised by the INSULAE project's implementation, and defines threats that could be mitigated with the project's implementation.

Strengths	**Weaknesses**
– **The support of relevant stakeholders (Unije population, Primorje Gorski Kotar County, Municipality of Mali Lošinj, Krk Diocese…) to the socio-economic revitalization of Unije;** – Several active entrepreneurs on the island; – Some active NGOs and co-operatives on the island; – Preserved specific agricultural and fishery skills among the islanders; – Strong tourist tradition; – Authentic architecture and preserved natural environment; – Adequate daily connections to the mainland; – Growth in tourist numbers (number of arrivals, consumption, etc.)	– Depopulation process in place; – The elderly population in the strong majority; – Lack of economy of scale; – **The population of Unije is not always united when it comes to important development issues (permanent citizens support development, while weekend guests opt to keep the "status quo");** – **Lack of education / public awareness about the importance and benefits of RES/EE investments;**

supporting the need for increasing the infrastructural capacity;	
Opportunities	**Threats**
– Existing EU/national laws and policies supporting the revitalization of islands; – High solar insulation enables the development of feasible PV projects; – Unije as an energy buffer for the entire archipelago; – A number of domestic storage systems installed in the households and connected to the PV, enabling the exchange of energy; – Smart(er) management of water and energy systems; – Introduction of 5G and IoT in the operation of energy communities; – Inhabitants monitor and manage all their consumption;	– **Inappropriate and inefficient system of state incentives for the realization of EE/RES projects;** – **Long and complicated administrative procedures for the realization of infrastructural projects;** – **NIMBY (Not In My Back Yard) syndrome, resulting in inhabitants' resistance to taking part in some of the activities;** – **"Fear of technology" – elderly citizens' resistance towards the installation of Smart Boxes;** – **5G, IoT, and other complex terminology not properly communicated towards the inhabitants with no technical background and no prior knowledge on the matter;**

TABLE 16: SWOT ECONOMIC ANALYSIS OF UNIJE, SOURCE: RINA-C, 2019

This thesis will further analyze the SWOT entries marked in a bold letter, i.e. it will investigate the level of citizens' support, try to compare the differences (if there are any) in the viewpoints of permanent and occasional residents, and contribute to raising public awareness – primarily via a community survey. Furthermore, it will address all the identified threats, offering some solutions on how those can be overcome.

4.3.5 Local perception of energy transition

Some of the claims from the presented SWOT analysis had already been investigated in a series of different INSULAE surveys, targeting local authorities, local DSO/energy utilities, associations, and stakeholders active on the island on non-energy topics and engaged citizens. In this thesis, emphasis will be given to the INSULAE citizens' survey (Regional Energy Agency Kvarner data), by commenting on its results and trying to compare them with the survey results obtained within this master research.

INSULAE questionnaires were filled in during the Unije local event in July 2019. The response rate was relatively low - a total of 10 persons, six male participants, and 4 women. The age of the participants was high, 3 of them aged between 45 and 64 and the remaining 7 being over 65 years old. In terms of education, 6 participants reported having higher, 3 secondary, and 1 primary education completed. Eight out of 10 participants were already in retirement and 2 were still in employment (DAFNI, 2020).

The participants stated that the electricity cuts on the island are more frequent in the winter period (60%) than in the summer period (30%) which means that the cuts' frequency doubles during wintertime and are a problem that needs addressing. 60% of participants assessed that they are putting substantial effort during their everyday routine to save energy in their home, and even more effort into saving water (90%). From these answers, it is clear that the inhabitants are more sensitive to the issues of water-saving, rather than electricity. Looking into their habits, 60% of them said they would be very willing to switch off some of their home devices during peak electricity times without affecting their house comforts (30% were generally willing, and 10% reluctant). Two questions (Figure 11) dealt with citizens' willingness to monitor their water and energy consumption in real-time and showed high interest in such activities, which was very important for the ISLANDER project, even though the survey sample was quite low.

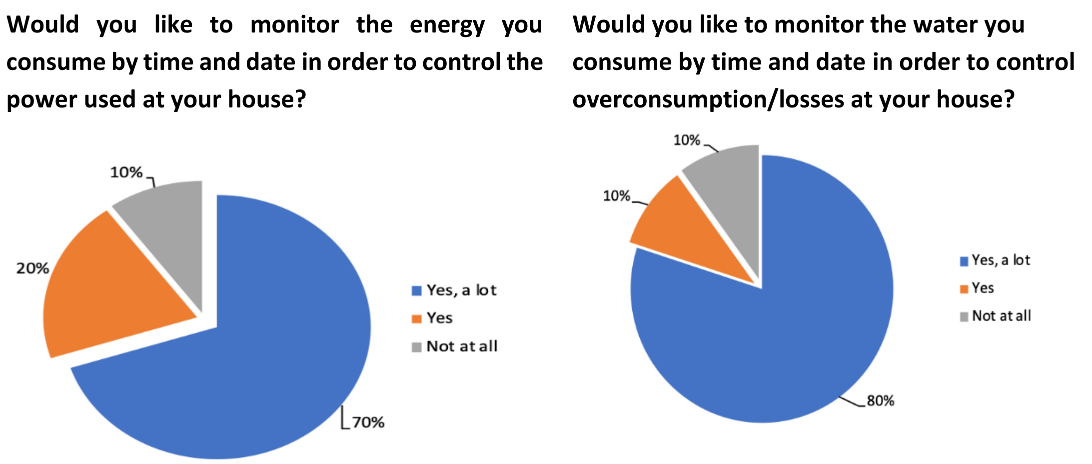

FIGURE 11: RESULTS FROM INSULAE SURVEY, SOURCE: DAFNI, 2019

The master thesis will show whether this willingness has changed over time.

There was another survey implemented on Unije back in 2010, during the preparation of "Island of Unije Energy Scenarios" (Jardas et. al., 2011), with a sample of 32 participants, and focusing on the domestic energy consumption and housing stock characteristics (e.g. surveying when the family houses were built, whether they are insulated, what type of fuel is mainly used for heating during winter, what electric appliances do the households have, etc.). Nonetheless, there was also one question of relevance for this thesis related to energy communities. When asked whether they would be interested to participate in the operation of Unije Energy Cooperative, 78% answered positively, and only 12% gave a negative answer. Ten years after, energy communities are gaining momentum throughout Europe. However, as it will be presented further in the thesis, the support from the locals on Unije towards the energy cooperatives had decreased.

In addition to the survey, the INSULAE project also organized a successful focus group workshop (in July 2019) that gathered a number of local residents, together with the representatives from all the important INSULAE stakeholders: The City of Mali Lošinj (the island of Unije is a part of this administrative unit), HEP ("Hrvatska elektroprivreda" – Croatian national energy company), and OTRA (a local Island Development Agency). The project consortium was represented by the following organizations: Institution Regional Energy Agency Kvarner, Faculty of Mechanical Engineering and Naval Architecture – University of Zagreb, Ericsson Nikola Tesla, VIOCL ("Vodoopskrba i odvodnja Cres Lošinj" – Cres Lošinj water supply and sanitation utility), RINA Consulting S.p.A, and Aegean Energy and Environmental Agency / DAFNI (DAFNI, 2020). It was concluded in the project report prepared by DAFNI (D2.4) that the locals are generally supportive towards the INSULAE project and the energy transition of their island, but what interested them maybe, even more, were some other issues (assessed as more vital), such as water availability, maritime transport, wastewater management, lack of healthcare on the island, etc.). Having different stakeholders in one place made it possible to provide all the needed explanations and answers to the islanders. However, it showed the complexity of living on the islands and the need to examine the energy transition issues from more angles and demonstrate how green energy can trigger positive developments in other areas of concern.

The situation with the COVID pandemics complicated the organization of further INSULAE citizen engagement activities in 2020 and 2021, especially in a fragile location such as the remote island with a majority of the elderly population, which could be a major throwback, not so much for the realization of INSULAE activities, but more for the acceptance of the technological solutions offered and general community support to energy developments on Unije.

The social aspects of the island of Unije energy transition were further tackled in a survey that was prepared as part of this master thesis research.

5 RESULTS AND DISCUSSION

Based on the primary data collected via a community survey conducted on the island of Unije, the presented experiences from other European islands, and the insights from the EU project H2020 INSULAE, this chapter aims to discuss all available findings and present the research results. First, lessons learned from other islands will be summarized, then the survey conclusions will be put in connection with other islands' experiences and finally, some practical recommendations to local/regional government will be provided.

5.1 Lessons learned from the selected EU islands

From the presentation of the selected three island cases using the TSI framework, presented in Table 9: Overview of the three island cases using the TSI framework, Source: Own concept based on the classification of Selvakkumaran and Ahlgren (2021:4), we see that the game-changers (or the social innovations that highly influenced the energy transition on the islands) were the following:

- Samso: The decentralization of energy generation through the community-led RES projects and the fact that the RES projects were promoted as development or community projects rather than energy. Thus, the community was engaged over the idea of general local well-being, and not over decarbonization.
- Aran Islands: High energy capacities owned by individuals and local/regional groups enabled the game change. The cooperative organization on the Aran Islands is considered to be crucial for meeting the objective of becoming carbon neutral by 2022.
- Tilos: The hybrid technological solution developed under the H2020 TILOS project served as a model for local scale RES BESSs and motivated the adoption of the New Development Law of Greece.

In other words, both Samso and Aran Islands heavily relied on community-led projects and energy cooperatives as leaders of decarbonization, with Samso also introducing several innovations in the field of communication with the locals, i.e. emphasizing the importance of general well-being of islanders and island development and not the importance of RES technology introduction. On the other hand, Tilos introduced a new technological solution that served as a model for new business models and influenced the change of law. Those are considered to be the game-changers, while many other social and system innovations implemented were also presented in Table 9.

There are also some other lessons that we can learn from the energy transition literature consulted (H2020 TILOS, 2019; Notton, G. et.al., 2017; Boulogiorgou & Ktenidis, 2020 – for Tilos;

Heaslip, 2017; Aran Islands Energy, 2019 – for Aran Islands; Papazu, 2016; Sperling, 2017 – for Samso, etc.), related to improvements in the fields of islands' accessibility, RES projects ownership, communication towards the islanders, etc.:

Island's accessibility:

- Ferry companies should be engaged since maritime traffic accounts for a majority of CO_2 emissions;
- Ferry/Boat access to the islands should not be more expensive than driving the same distance by road. Government should offer subsidies to small island municipalities to lower the ticket prices which would both increase the number of passengers to the island and make the transport of goods less expensive;

Energy transition management:

- It is good to either appoint or form a new organization that will be dedicated solely to energy transition activities;
- Island communities are characterized by a "feeling of belonging" to their local community that can be stronger than the one in urban areas, thus the project leaders must invest time and effort in meeting this community and understanding how it works, who the key influencers are, which are the major issues and similar.
- Conducting a public perception survey during the preparation phase may be useful to be able to tailor future approaches and communication;

Citizen engagement & co-ownership:

- The islands should be informed about the transition project and be included in its activities from the very start. Every pause in communication could lead to unnecessary conspiracy theories since the islanders might start thinking something is going on behind their back;
- Co-ownership of RES projects is strongly suggested and mixed methods of funding are preferred;
- Project leaders should make use of local knowledge, since the locals know the island best, even though (some of them) may not be engineers;

Communication:

- Project leaders should address the "What is there for me?" issue early on since the locals will be interested in understanding what their benefits from the transition are;
- The local public should be informed about all potential risks that could arise from RES projects' implementation (e.g. any possible infrastructure impact on the environment and similar);

In the next section, the results of the local community survey done in Unije will be presented to see how (and if) they relate to the experiences from other EU islands.

5.2 Community survey results

To examine the local community's perception of the energy transition happenings on the island of Unije, the author conducted a survey intended for both permanent residents of Unije island living there full-time, as the main target group, as well as the occasional residents with property on the island, i.e. staying with family or their own weekend houses[9]. The reason for having two groups of survey participants was to be able to compare the viewpoints of both permanent and occasional residents.

According to the last national Census of Population, Households, and Dwellings (2011), the total population of Unije in 2011 amounted to 88. The new population enumeration will be carried out from September 13 to October 17, 2021 (Croatian Bureau of Statistics, 2021). Based on the data received from the Unije District Council, the numbers from 2011 are no longer valid and the current population on Unije amounts to 50, out of which one person is under 18 years of age, which lead to the overall sample size of 49 islanders that live permanently on the island. All of them have been approached, but 12 refused to take part in the survey. The number of permanent residents that participated in the survey was thus 37, with a ± 8% error margin at the 95% confidence level.

Apart from the permanent residents, the occasional residents, i.e. people who own a house on Unije but do not spend the whole year on the island were also invited to take part in the survey. There is no information on the total number of such individuals (the size of this target population) since there is no data on how many houses on Unije are abandoned and how many are occasionally in use, nor with how many household members. Nevertheless, the collected sample of 43 occasional residents was administered to see whether there are any significant differences in perspectives of permanent and occasional residents.

The demographic overview of the respondents is presented in Table 17 and includes gender, age, education, and type of residence (permanent/occasional).

[9] The questionnaire template used can be found in Annex 1.

		Permanent residents		Occasional residents	
		N	%	N	%
Gender:	Female	12	32.4	21	48.8
	Male	25	67.6	22	51.2
	Total	*37*	*100.0*	*43*	*100.0*
Age:	18-24	1	2.7	3	7.0
	25-44	7	18.9	20	46.5
	45 -64	10	27.0	18	41.9
	65 or over	18	48.6	1	2.3
	Missing data	1	2.7	1	2.3
Highest achieved level of education:	Attended or finished primary school	4	10.8	1	2.3
	Secondary school	16	43.2	6	14.0
	Bachelor degree (In Croatia: VŠS and B.A. degree)	9	24.3	14	32.6
	Master degree (In Croatia: VSS and univ.spec. degree)	5	13.5	17	39.5
	PhD	3	8.1	5	11.6

TABLE 17: DEMOGRAPHIC INFORMATION ON THE RESPONDENTS – PERMANENT AND OCCASIONAL RESIDENTS, SOURCE: AUTHOR

As it can be seen from the table, the permanent residents’ sample included more elderly respondents (48.5% over 65 years of age), mostly with secondary-level education, while the occasional residents’ sample included 53% under 45 years of age and only 2.3% over 65, mostly with tertiary-level education. In terms of their financial capacity compared to other islanders, most of the participants said it “is about the same” as others’ (permanent residents: 73%, occasional residents: 62.8%), with 27.9% of occasional residents (and none from the group of permanent) rating it as “higher” than others’.

5.2.1 Public attitudes towards the current „Unije Self-Sufficient Island“ action plan

The current “Unije Self-Sufficient Island” action plan, prepared in 2015 by the project team appointed by the regional government (Primorje Gorski Kotar County), as already mentioned, contains different measures divided into five thematic groups: (1) Energy independence, (2) Water supply and drainage, (3) Agriculture and mariculture, (4) Transport infrastructure and (5) Tourism. The participants were asked to grade on a scale ranging from 1 (Not at all important) to 5 (Extremely important) **the importance of every individual measure proposed, for the island’s overall sustainability (Q1)**. Average grades given by both groups are ranked from the most important to the least important and are shown in tables 18 and 19.

Thematic group	Measure	Mini-mum	Maxi-mum	Mean	Std. Dev.
WSD2	Municipal drinking water storage tanks	3	5	4,62	0,721
WSD3	Water supply network	2	5	4,57	0,801
WSD1	Self-powered desalination plant	1	5	4,49	0,932
WSD4	Public sewage system	1	5	4,35	0,919
WSD5	Wastewater treatment plant with dis-charge	3	5	4,35	0,824
ENI1	Energy efficient public lighting	1	5	3,95	0,97
AAM2	Olive oil production – revitalization and mill construction	2	5	3,84	1,093
TSM3	Tourist trails and promenades - cycling, ecology, ornithology, archeology	1	5	3,62	1,21
ENI3	Solar thermal collectors in buildings	1	5	3,59	1,235
TIN1	Local airport – putting into action	1	5	3,57	1,444
TIN2	Breakwater extension	1	5	3,57	1,119
AAM3	Growing vegetables in greenhouses	1	5	3,51	1,367
TIN3	Maintenance of field roads	1	5	3,51	1,07
ENI5	Electric bikes and vehicles	1	5	3,49	1,17
AAM1	Land consolidation	1	5	3,43	1,144
ENI2	1MW PV with battery energy storage sys-tem	1	5	3,32	1,107
TSM1	Marina in Maračol bay	1	5	3,19	1,469
AAM5	Sheep and goat farming - increase in herds and cheese production	1	5	3,14	1,251
ENI4	Biogas plant – zero waste system demonstration	1	5	3,03	1,258
AAM4	Permanent preservation of the Istrian cattle („boškarin“)	1	5	2,73	1,239
TSM2	Green hotel in Maracol bay	1	5	2,41	1,554
AAM6	Fish farming	1	5	2,22	1,336

Thematic groups' legend: ENI - Energy independence, WSD - Water supply and drainage, AAM - Agriculture and mariculture, TIN - Transport infrastructure, TSM - Tourism

TABLE 18: RANKING OF THE UNIJE SELF-SUFFICIENT ISLAND ACTION PLAN MEASURES, DONE BY PERMANENT RESIDENTS, SOURCE: AUTHOR

As it can be seen from this table, the highest importance was attributed to measures related to water supply and drainage and the lowest to fish farming and building of the green hotel in Maračol bay. It is interesting to see that the five measures that received the highest grades (Mean > 4) all belong to the Water supply and drainage (WSD) group of measures and that the best rated energy-related measure is the Energy-efficient public lighting, which is also the only energy measure from the list that has already been implemented (Regional Energy Agency Kvarner, 2021).

Looking at the same set of answers from occasional residents (Table 19), we see no major difference, with water-related measures again being assessed as the most important, and green hotel and fish farming as some of the least important, together with the permanent preservation of the Istrian cattle. All the energy measures are assessed quite similarly, with Solar thermal collectors in buildings being considered slightly more important than the Energy-efficient public lighting.

Thematic group	Measure	Mini-mum	Maxi-mum	Mean	Std. Dev.
WSD2	Municipal drinking water storage tanks	1	5	4,74	,727
WSD3	Water supply network	2	5	4,60	,821
WSD5	Wastewater treatment plant with discharge	1	5	4,47	1,032
WSD1	Self-powered desalination plant	1	5	4,16	,949
TSM3	Tourist trails and promenades - cycling, ecology, ornithology, archeology	1	5	4,09	1,130
WSD4	Public sewage system	1	5	4,05	1,479
TIN3	Maintenance of field roads	1	5	3,81	1,118
AAM2	Olive oil production – revitalization and mill construction	1	5	3,79	1,081
ENI3	Solar thermal collectors in buildings	1	5	3,63	1,215
TIN1	Local airport – putting into action	1	5	3,63	1,196
ENI1	Energy efficient public lighting	1	5	3,56	1,053
AAM3	Growing vegetables in greenhouses	1	5	3,44	1,161
TIN2	Breakwater extension	1	5	3,40	1,383
TSM1	Marina in Maračol bay	1	5	3,35	1,412
AAM1	Land consolidation	1	5	3,30	1,081
ENI4	Biogas plant – zero waste system demon-stration	1	5	3,21	1,424
ENI2	1MW PV with battery energy storage sys-tem	1	5	3,14	1,037
AAM5	Sheep and goat farming - increase in herds and cheese production	1	5	3,12	1,219
ENI5	Electric bikes and vehicles	1	5	3,05	1,272
AAM6	Fish farming	1	5	2,74	1,293
TSM2	Green hotel in Maračol bay	1	5	2,72	1,386
AAM4	Permanent preservation of the Istrian cattle („boškarin“)	1	5	2,40	1,094

Thematic groups' legend: ENI - Energy independence, WSD - Water supply and drainage, AAM - Agriculture and mariculture, TIN - Transport infrastructure, TSM – Tourism

TABLE 19: RANKING OF THE UNIJE SELF-SUFFICIENT ISLAND ACTION PLAN MEASURES, DONE BY OCCASIONAL RESIDENTS, SOURCE: AUTHOR

The results from this question also show that some of the measures from the action plan that were first implemented by the regional authority, such as the preservation of the Istrian cattle "boškarin" (Primorje Gorski Kotar County, 2017), are actually at the bottom of the islanders' list, measured by assessed importance. In another survey question that was an open-ended type (Q10), the participants expressed concern that farming cannot be developed along with tourism, one of the two needs to be put aside. Yet, the Aran Islands' experience shows differently, since their main economic branches are tourism and farming (Pleijel, 2015).

Given that the "Unije Self-Sufficient Island" action plan was created ten years ago and can already be considered outdated, it would be advisable to re-examine the measures and its future implementation timeline, considering the islanders' opinion. By doing this, the islanders would feel that they are being consulted, which could (according to best practice examples from EU islands) increase their support towards the plan realization.

Individual items from thematic categories (ENI - Energy independence, WSD - Water supply and drainage, AAM - Agriculture and mariculture, TIN - Transport infrastructure, TSM – Tourism) were further grouped to investigate the effects of five thematic categories and two groups of participants (permanent and occasional residents) on the assessed importance of measures proposed. For each category, the average grade was calculated. The reliabilities (Cronbach's alphas) of the five subscales (categories) are within the range from moderate to high (Table 20). Cronbach's alpha is *"a statistic commonly quoted by authors to demonstrate that tests and scales that have been constructed or adopted for research projects are fit for purpose"* (Taber, 2018). The fact that Cronbach's alpha coefficient ranges from moderate to high (the acceptable values are over 0.6 or 0.7, depending on the literature source, states Taber, 2018) means that formed subscales are reliable and that it is appropriate to use such subscales (grouped data) in further analysis.

Thematic categories:	**N of items**	**Cronbach's Alpha (α):**
ENI - Energy independance	5	,727
WSD - Water supply and drainage	5	,802
AAM - Agriculture and mariculture	6	,813
TIN - Transport infrastructure	3	,603
TSM – Tourism	3	,703

TABLE 20: RELIABILITY TEST OF THEMATIC CATEGORIES, SOURCE: AUTHOR

Next, to examine if the effects of thematic categories and groups of residents (and their interaction) on the assessed importance are statistically significant, a two-way ANOVA with thematic categories (ENI, WSD, AAM, TIN, TSN) as a within-participants factor and with groups of residents (permanent and occasional residents) as a between-participants factor was performed.

The analysis revealed a significant main effect of thematic categories, $F(4, 312) = 44{,}81$, $p < {,}001$. Duncan's post hoc test revealed that participants rated category WSD ($M = 4{,}44$, $SE = {,}08$) as more important than other categories ($M_{ENI} = 3{,}40$, $SE_{ENI} = {,}09$; $M_{AAM} = 3{,}14$, $SE_{AAM} = {,}10$; $M_{TIN} = 3{,}58$, $SE_{TIN} = {,}10$; $M_{TSM} = 3{,}23$, $SE_{TSM} = {,}12$; $ps < .001$). Furthermore, participants rated categories

ENI and TIN as more important than category AAM (ps < .001). Finally, participants rated category TIN as more important than category TSM ($p < .001$). Other differences were not significant.

The analysis also revealed that there was no significant main effect of the group of residents, $F(1, 78) = 0.04$, $p = .849$, and no thematic category × group of residents interaction, $F(4, 312) = 1.34$, $p = .254$.

Descriptive data for the ratings given by two residents' groups to five thematic categories are presented in Table 21 and means are presented in Figure 12.

Thematic categories:	**Permanent residents**		**Occasional residents**	
	Mean	**Std. Error**	**Mean**	**Std. Error**
ENI - Energy independance	3,476	,135	3,316	,125
WSD - Water supply and drainage	4,476	,117	4,405	,109
AAM - Agriculture and mariculture	3,144	,142	3,132	,132
TIN - Transport infrastructure	3,55	,152	3,612	,141
TSM – Tourism	3,072	,176	3,388	,163

TABLE 21: DESCRIPTIVE DATA FOR THE RATINGS GIVEN BY TWO RESIDENTS GROUPS TO FIVE THEMATIC CATEGORIES, SOURCE: AUTHOR

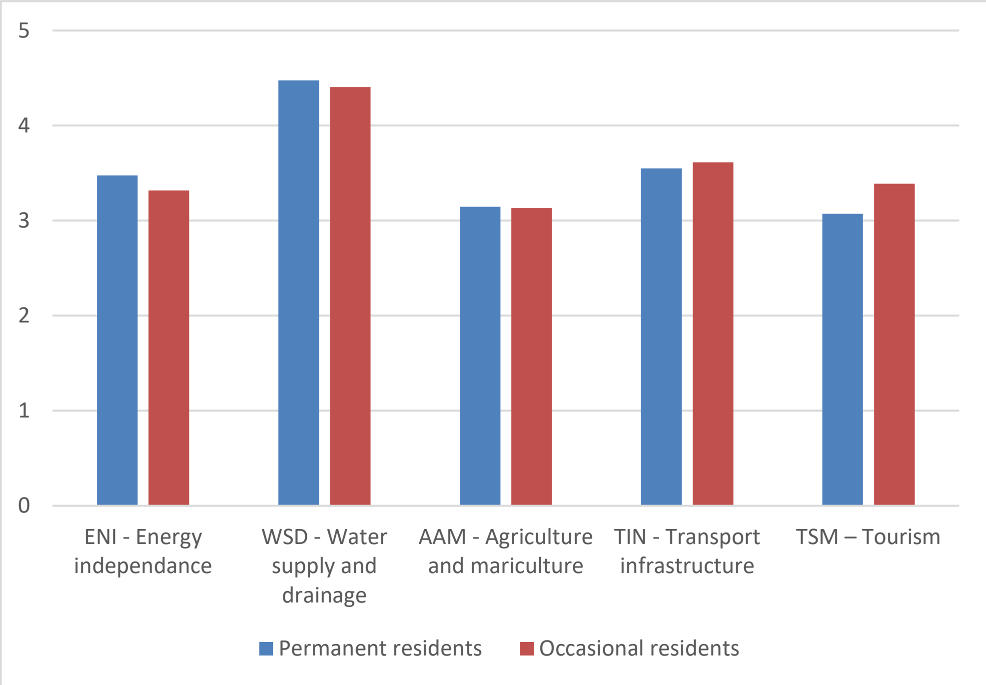

FIGURE 12: ASSESSMENT OF IMPORTANCE PER THEMATIC CATEGORIES, SOURCE: AUTHOR

This data confirms that, in general, permanent and occasional residents assess quite similarly the importance of certain thematic categories of the Unije Self-Sufficient action plan, giving water-related issues a priority over other sustainability issues. This was interesting to see, since one may assume that occasional residents would have different priorities (e.g. wish to develop tourism more strongly or lower sensitivity for the preservation of natural habitat) than the permanent residents, but on Unije that is not the case.

The next question **(Q2)** was **which of the listed benefits to be triggered by the investments in the island's sustainability do the respondents consider as most relevant for the island** (Q2), and participants were asked to rank the options offered from 1-6 (with 6 having the highest importance). Descriptive data are summarized in Table 22 (for permanent) and Table 23 (for occasional residents).

List of benefits	Permanent residents				
	Minimum	Maximum	Mode	Median	Semi-Interquartile Range
Availability of green energy produced from renewable energy sources	1	6	2[a]	4,00	1,5

Improved energy security, not depending on undersea power cable from the mainland	2	6	3	4,00	0,5
Providing drinking water from the desalination plant	1	6	6	5,00	1,00
Introduction of a public sewage system replacing the traditional septic systems	2	6	5	4,00	1,00
Enhancing the resilience of agriculture and food security	1	6	2	2,00	1,25
Supporting the further development of tourism as a major source of income	1	6	1	1,00	/

a. Multiple modes exist. The smallest value is shown

TABLE 22: LIST OF BENEFITS – MEDIAN AND SEMI-INTERQUARTILE RANGE (PERMANENT RESIDENTS), SOURCE: AUTHOR

List of benefits	**Occasional residents**				
	Minimum	**Maximum**	**Mode**	**Median**	**Semi-Interquartile Range**
Availability of green energy produced from renewable energy sources	1	6	1[a]	3,00	1,5
Improved energy security, not depending on undersea power cable from the mainland	1	6	3	3,00	1,00
Providing drinking water from the desalination plant	1	6	5	5,00	0,5
Introduction of a public sewage system replacing the traditional septic systems	1	6	4	4,00	1,5
Enhancing the resilience of agriculture and food security	1	6	2[a]	4,00	1,5
Supporting the further development of tourism as a major source of income	1	6	1	2,00	2,00

a. Multiple modes exist. The smallest value is shown

TABLE 23: LIST OF BENEFITS – MEDIAN AND SEMI-INTERQUARTILE RANGE (OCCASIONAL RESIDENTS), SOURCE: AUTHOR

In general, the results showed that "Providing drinking water from the desalination plant" is considered as the most relevant benefit by both groups, and "Supporting the further development of tourism as a major source of income" is the least relevant.

Experience from Aran Islands (Heaslip, 2017) shows that the development of renewable energy projects actually had a positive effect on tourism, supporting green tourism rather than mass tourism, and it was therefore welcomed by the locals. Also, on Tilos, tourism development led to desired population growth (South Aegean Region , 2014). In the case of Unije, which is evident from the answers received on open-ended questions, locals are mostly afraid of the tourism development and overcrowdedness that would endanger the island's peacefulness and untouched nature.

Next, Independent Samples Mann-Whitney U Tests were calculated to compare whether the rankings given by each group of participants differ significantly statistically. Independent Samples Mann-Whitney U Tests showed that the two differ in their understanding of the importance of "Improved energy security, not depending on undersea power cable from the mainland" ($U = 581.50$; $Z = 2.07$; $p < .05$) and "Supporting the further development of tourism as a major source of income" ($U = 496.00$; $Z = -2.89$; $p < .01$). Permanent residents assess more highly the relevance of improved energy security than occasional residents, while occasional residents assess more highly the relevance of tourism development than permanent residents. These results are not surprising, since occasional residents spend less time on the island and probably also experience fewer power cuts. Also, they happen during their vacations when they do not have a business or similar obligations that might be more affected by these incidents. On the other hand, side, while occasional residents see tourism as a potential way to revive the island's economy, permanent residents are afraid of the already mentioned potentially negative consequences. Other differences were not obtained ($Zs < 1.9$; $ps > .05$).

Next, participants were asked to assess on a scale ranging from 1 (Do not support at all) to 5 (Strongly support) their **support towards the listed renewable energy developments on the island of Unije** (**Q3**).

Table 24 shows descriptive data obtained from both groups:

	Permanent residents				**Occasional residents**			
	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.
Installation of LED public lighting	1	5	3,92	1,064	1	5	3,67	1,128
Installation of a photovoltaic plant (done by DSO) with battery energy storage system to support the island's energy security (INSULAE Project)	1	5	3,43	1,068	1	5	3,49	1,203
Possibility of installing "Energy Boxes" in individual households for smart energy	1	5	3,24	1,038	1	5	3,37	1,235

consumption monitoring (INSULAE Project)								
Possibility of installing smart sensors in private water wells for smart water consumption monitoring together with smart agriculture/wineyard irrigation system (INSULAE Project)	1	5	3,62	1,114	1	5	3,63	1,291
Possibility of introducing island-mainland connections running on alternative fuels (e.g. hydrogen)	1	5	3,54	1,169	1	5	3,49	1,387

TABLE 24: SUPPORT TOWARDS THE LISTED RENEWABLE ENERGY DEVELOPMENTS ON THE ISLAND OF UNIJE, SOURCE: AUTHOR

The comparison of the two groups is presented graphically (Figure 13):

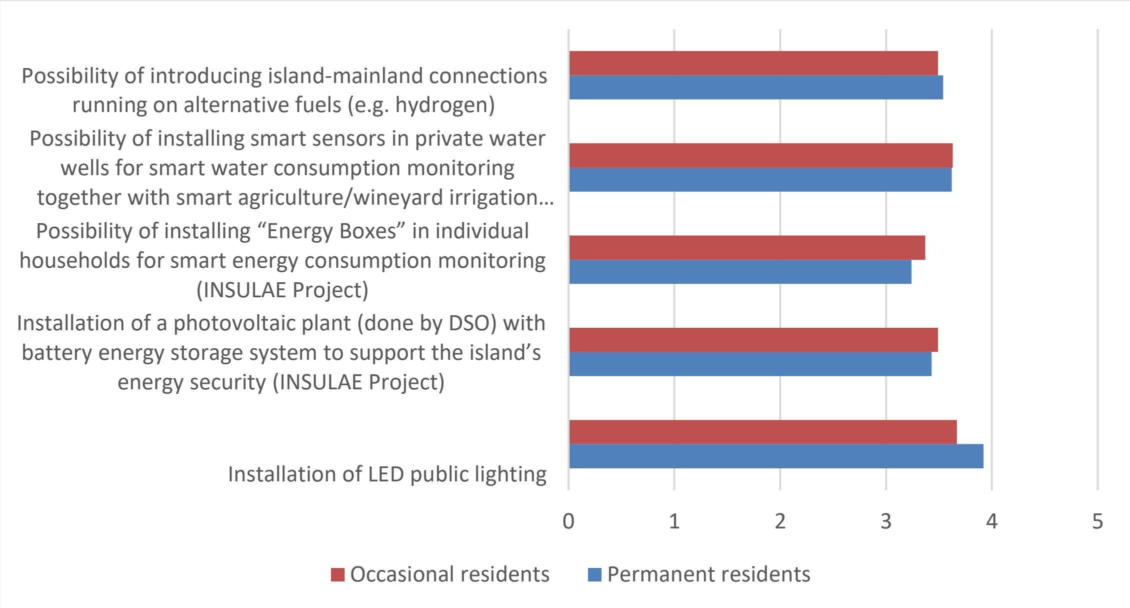

FIGURE 13: ASSESSMENT OF PERSONAL SUPPORT TOWARDS THE LISTED RES ACTIONS, SOURCE: AUTHOR

Again, the results for the two groups are similar. Both groups in principle support the RES developments since the mean for all actions listed is between 3 and 4. Also, the average personal support toward RES actions was calculated (reliability of the scale: α =,78), and T-test for independent groups showed that there was no difference in average support expressed by two groups of residents ($t_{(78)}$ = 0,11, p=,913).

What was interesting to see is that the installation of a photovoltaic plant that will contribute to the island's energy security did not receive the highest support. The reason could be that participants still do not experience that many electricity cut-offs that influence their opinion, especially the occasional residents since the electricity cuts occur mostly in winter. The conclusions of a community survey conducted on Tilos confirm this assumption since it was proven that bigger problems with electricity cuts lead to higher public acceptance of RES projects (UEA, 2018).

Finally, the participants who stated that they "Tend to oppose" or "Strongly oppose" to any of the renewable energy developments listed were asked to **explain the main reason(s) of their opposition (Q4)**, and the following explanations were received (Table 25):

RES development:	**Participants' reasons for being opposed (quoted):**
Installation of LED public lighting	/
Installation of a photovoltaic plant (done by DSO) with battery energy storage system to support the island's energy security (INSULAE Project)	*The solar power plant is a major polluter of the environment and destroys natural ecosystems.;* *It is better to encourage the installation of photovoltaic systems on private houses while addressing water issues as photovoltaic modules prevent the use of rainwater from the roof.;* *The construction of DSO's power plant would certainly bring secondary pollution during the construction and operation, additional betonization, bringing in temporary mechanization, etc.;* *Large PV areas and also the solar panels on private roofs would not look good, the island's natural panorama with traditional red roofs needs to be preserved (unless the panels are to be hidden or somewhat incorporated not to change the image of the village, which I doubt).*
Possibility of installing "Energy Boxes" in individual households for smart energy consumption monitoring (INSULAE Project)	*There is no need for the introduction of new electronics, it is better to focus on actions to preserve the authenticity of the island instead of forcing new market products under the disguise of 'green'.*
Possibility of installing smart sensors in private water wells for smart water consumption monitoring together with smart agriculture/vineyard	*A lot of these novelties that are being talked about are already getting on our nerves because they will be unprofessionally executed as everything else before. The new waterfront and sewage system are bad, some pretentious fence has been put on the promenade, destroying visually the First bay.*

irrigation system (INSULAE Project)	
Possibility of introducing island-mainland connections running on alternative fuels (e.g. hydrogen)	*Unnecessary costs, hydrogen is a very unstable and dangerous fuel;* *There is no need for this given the small number of shipping lines and the amount of pollution they cause;* *First, make those lines more frequent, and then we can talk about preserving the ecology.*

TABLE 25: REASONS FOR BEING OPPOSED (QUOTES), SOURCE: AUTHOR

Also, some further comments were received, not referring to any of the proposed RES developments but stressing the overall desire to keep the island simple and authentic and avoid mass construction. Finally, it was stated that all these developments could be beneficial, but the priority is to decrease the island's depopulation. Ten years ago around 100 people were living on the island, now there are only 50, so the question is who would benefit from all this in the end if people continue leaving the island.

5.2.2 Willingness for more active personal engagement

The next set of questions questioned the participants' willingness to engage personally, e.g. by investing in domestic RES installations, or just by changing their energy consumption habits. The comparison of answers among the two groups is shown in graphs.

Q5: Would you be more willing to support the installation of renewable energy systems on the island if it would bring you direct financial benefits, e.g. savings on utility bills?

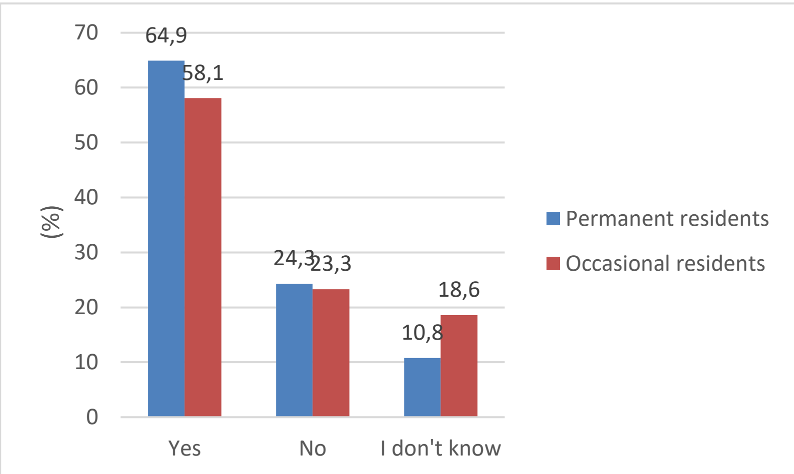

Figure 14: Willingness to support the installation of renewable energy systems on the island if that would bring direct financial benefits, Source: Author

This data showed that the majority of participants would be willing to support the installation of renewable energy systems on the island in return for some direct financial benefits. What's more important, the distribution of answers does not differ between the two groups of residents, $\chi2 = 0{,}962$, df = 2, p >,05.

Q6: Would you be willing to invest personally in renewable energy systems in your property on Unije that would lower your utility bills in the long term (e.g. solar collectors for water heating, photovoltaic panels for electricity generation, heat pumps for heating and cooling, etc.)?

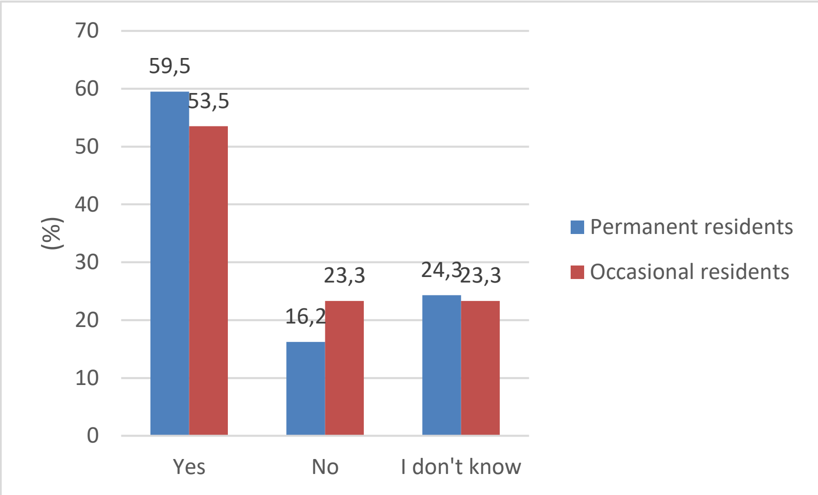

FIGURE 15: WILLINGNESS TO INVEST PERSONALLY IN RENEWABLE ENERGY SYSTEMS IN YOUR PROPERTY ON UNIJE IF THAT WOULD LOWER THE UTILITY BILLS, SOURCE: AUTHOR

This data showed that the majority of participants would be willing to invest personally in renewable energy systems in their property on Unije in return for some direct financial benefits. Also, the distribution of answers does not differ between the two groups of residents, $\chi2 = 0{,}628$, df = 2, p > ,05.

When a similar set of questions was posed in 2016 to the residents of Tilos island, the results demonstrated a widespread local acceptance of RES solutions but also the unwillingness of a large part of the community (nearly equal levels of support and opposition) to engage personally by investing in RES infrastructure (UEA, 2018). The difference was, however, that they were asked about investing in public infrastructure, while in the Unije survey focus was on investments in private RES systems.

To examine the relationship between the financial capacity of participants and their willingness to make investments in RES, Cramer's V correlation coefficient was calculated. In the case of permanent residents, a low correlation was obtained between financial capacity and willingness to invest ($\phi c = .384$; p <, 05), while such a correlation was not significant in the case of occasional residents (ϕc = .220; p>, 05). However, when interpreting the results, it is necessary to take into account that these calculations were done on relatively small samples.

Q7: To what extent would you be willing to change your habits in order to lower your utility bills or earn an extra profit (e.g. by turning on the domestic electrical appliances when the electricity rate is lower and not when it suits you best)?

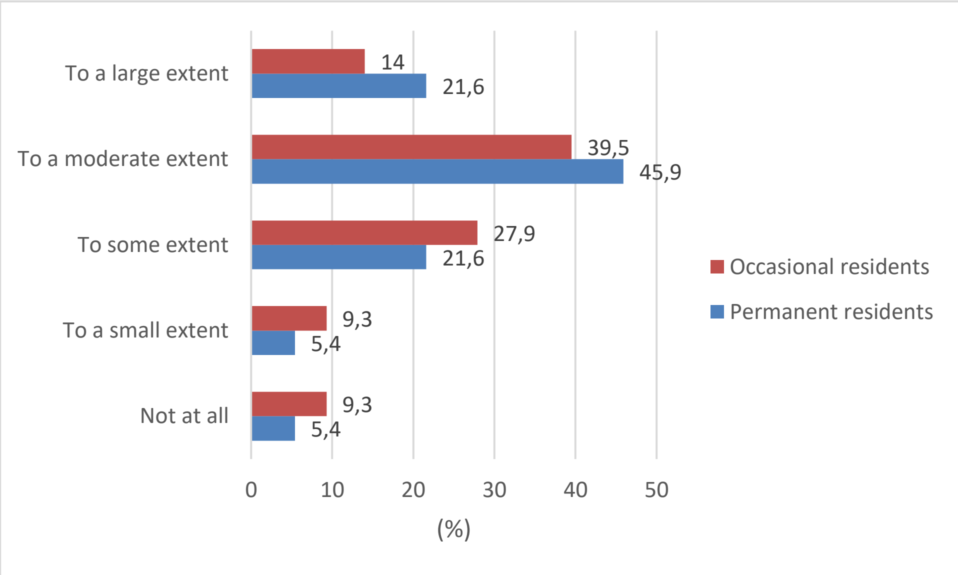

FIGURE 16: WILLINGNESS TO CHANGE PERSONAL HABITS TO LOWER THE UTILITY BILLS, SOURCE: AUTHOR

This data showed that the majority of participants would be “to some extent” or “to a moderate extent” willing to change their habits to lower their utility bills or earn some extra profit. Also, the distribution of answers does not differ between the two groups of residents, $\chi 2$ = 1,980, df = 4, p >,05.

In his analysis of the Tilos case, Stephanides (2019) concluded that the social acceptance of RES is to be considered crucial for successful decarbonization and real acceptance can be reached only if individuals embrace the energy-saving principles and change their habits (i.e. if they „walk the talk“). Hoppe & De Vries (2019) also stress the importance of the social acceptance of local renewable energy projects (RES) claiming that they are of immense importance in successful energy transitions.

In recent years, the EU has been pushing the creation of energy communities in which the citizens organize collectively and implement citizen-driven energy actions, in one of the two organizational forms, either as *renewable energy community* or *citizen energy community,* depending on whether their members invest regionally - only in RES systems to be built in their area, which is the case with renewable energy communities; or supra-regionally, regardless of the region they live in, which is the case with citizen energy communities (International Labour

Office, 2013). The legal form present in Croatia is the *energy cooperative*, which does not make this distinction.

Q13: Would you be interested in taking part in such activity on Unije, by becoming a member of a potential Unije Energy Cooperative?

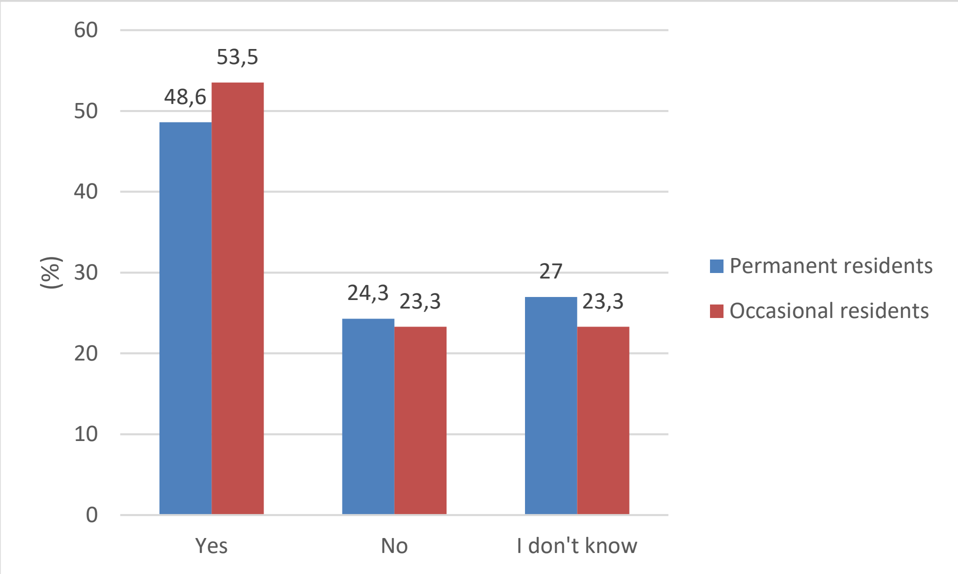

FIGURE 17: WILLINGNESS TO BECOME MEMBERS OF UNIJE ENERGY COOPERATIVE, SOURCE: AUTHOR

This data showed that about half of the participants would be interested in joining such a cooperative, and the distribution of answers does not differ between the two groups of residents, $\chi 2 = 0{,}214$, $df = 2$, $p > {,}05$.

Back in 2010, in a survey done within the preparation of "Island of Unije Energy Scenarios" (Jardas et. Al., 2011), on a sample of 32 participants, 78% of participants stated their willingness to enter such a cooperative, and 12% were against. There was no „I do not know" option, but it seems that interest in this kind of activity among the islanders has decreased, which can be significant for the planning of future transition activities.

5.2.3 Actions that could increase the overall public support towards the island energy transition

In this set of questions, participants were asked to assess on a scale ranging from 1 (Not at all important) to 5 (Extremely important) **the importance of certain listed actions for increasing their personal acceptance of RES developments on the island (Q11)** and **to name some other actions that could further increase this acceptance (Q12).**

The first table (Table 26) shows descriptive data obtained from permanent residents, ranked from the most to the least important:

List of actions:	Min	Max	Mean	Std. Dev.
Better risk communication (communicating the potential downsides of energy projects)	2	5	4,51	,837
Being informed in person about the projects' progress (during local meetings with project owners)	2	5	4,43	,801
Stronger and more visible endorsement of energy projects from the municipal government	2	5	4,03	,957
Being informed about the projects' progress by the local media (incl. social media)	1	5	3,89	1,100
Being more directly informed about the projects' progress (via a mailing list or regular post)	2	5	3,81	1,050
Possibility to get more actively involved in local energy project planning processes, coordinated by the local government	1	5	3,46	1,043
Being not only energy (electricity, gas, or heat) consumer but becoming also a prosumer who produces energy through, for example, photovoltaic panels (a.k.a solar panels) installed on or around your house	2	5	3,43	1,119
Participation in the ownership of energy infrastructure (holding a share), via energy community or similar models	1	5	3,38	1,089
Introduction of different "green nudges" (i.e. policy tools to foster environmental friendly behavior) to stimulate the use of RES technology	1	5	3,27	1,097
Branding your island as a front-runner, the first energy self-sufficient island in Croatia	1	5	3,22	1,397

TABLE 26: LIST OF ACTIONS ASSESSMENT – THE RESULTS OBTAINED FROM PERMANENT RESIDENTS, SOURCE: AUTHOR

The second table (Table 27) shows descriptive data obtained from occasional residents, ranked from the most to the least important:

List of actions:	Min	Max	Mean	Std. Dev.
Better risk communication (communicating clearly the potential downsides of energy projects)	3	5	4,49	,631

Being informed in person about the projects' progress (during local meetings with project owners)	2	5	4,23	,812
Being informed about the projects' progress by the local media (incl. social media)	2	5	4,19	,906
Stronger and more visible endorsement of energy projects from the municipal government	2	5	4,07	,828
Being more directly informed about the projects' progress (via a mailing list or regular post)	1	5	3,98	1,185
Participation in the ownership of energy infrastructure (holding a share), via energy community or similar models	1	5	3,88	1,138
Being not only an energy (electricity, gas, or heat) consumer but becoming also a prosumer who produces energy through, for example, photovoltaic panels (a.k.a solar panels) installed on or around your house	1	5	3,86	1,082
Branding your island as a front-runner, the first energy self-sufficient island in Croatia	1	5	3,86	1,246
Introduction of different "green nudges" (i.e. policy tools to foster environmental friendly behavior) to stimulate the use of RES technology	1	5	3,77	1,020
Possibility to get more actively involved in local energy project planning processes, coordinated by the local government	1	5	3,51	1,121

TABLE 27: LIST OF ACTIONS ASSESSMENT – THE RESULTS OBTAINED FROM OCCASIONAL RESIDENTS, SOURCE: AUTHOR

For each item, T-tests for independent groups were calculated to compare whether the importance attributed to actions by each group of participants differs significantly statistically. The results showed that the importance was assessed differently by two groups of participants for introducing different "green nudges" to stimulate the use of RES technology ($t_{(78)} = 2,10$, $p < ,05$), participation in the ownership of energy infrastructure ($t_{(78)} = 2,02$, $p < ,05$), and branding of the island ($t_{(78)} = 2,18$, $p < ,05$). Whereas, the importance was rated higher by the occasional residents. Other differences were not significant, ts < 2, ps > ,05.

Actions that appeared at the top of both groups' lists (in a very similar order) were the following:

- Better risk communication (communicating clearly the potential downsides of energy projects)
- Being informed in person about the projects' progress (during local meetings with project owners)
- Being informed about the projects' progress by the local media (incl. social media)
- Stronger and more visible endorsement of energy projects from the municipal government.

In other words, the improvement in those four fields of engagement is expected to increase the local community's acceptance of RES developments on the island of Unije. The importance of early communication and good risk communication was stressed also by Heaslip (2017) on the example of Aran Islands.

In addition, participants were asked to describe some other actions that could contribute to increasing their personal acceptance of RES developments on the island. Most of the answers received did not relate to the energy transition, but general island development issues. Comments of particular relevance for this topic were as follows (Table 28):

Q12	**Participants' comments (quoted):**
#1	*All these actions make sense, I think the most important thing is reporting back to the local community on what has been done, what will be done, and by when, and how it will help them. The islanders are quite disappointed with how some projects were run in the past, people and teams came, promised a lot but either it was not realized or it was short-lived, so I think communication is very important at the moment.*
#2	*Electricity produced on the island must be free for islanders (when available) and thus directly reduce their utility bills, unlike the current situation, when in fact the use of electricity from renewable sources is actually charged on each monthly bill, which leads to an absurd situation in which someone makes a nice profit. For elderly people, a winter electricity bill of 600 Croatian kunas (HRK) becomes a bill of 700 HRK (approximately) just because for every kWh consumed, 0.105 HRK is paid as a fee for production from renewable energy sources.*
#3	*Projects must be run transparently, especially in terms of public resources that are being spent.*
#4	*Project leaders come to the island and invite islanders for dialogue, while it is obvious that everything has already been pre-arranged and that the islanders' opinion will not change anything. This is not good, they should be listened to and heard, they know the island in-depth, and no one asks them anything.*
#5	*I am absolutely in favor of LED lighting, but the performance of the public LED did not preserve the ambiance at all. The light was supposed to be warm (about 3000K), not cold. The lamps should have been aesthetically integrated into the architecture of the island, and instead, it looks like a public parking lot of a shopping center.*
#6	*Fierce and open communication between the Unije Local District, the Municipality of Mali Losinj, and the islanders should be nurtured.*
#7	*Many projects were initiated but never reached the realization phase.*
#8	*Islanders should have a say in the priorities are and not let some officials in the government offices decide for them.*

TABLE 28: OVERVIEW OF PARTICIPANTS' COMMENTS TO Q12, SOURCE: AUTHOR

5.2.4 Level of familiarity with the "social innovation" concept

The final set of questions was focused on social innovation – the level of familiarity with the concept and the ability of participants to recognize or propose social innovations in the island context. Finally, having been given some examples of social activities connected to renewable technology acceptance as well as being explained the meaning of social innovation, survey participants were asked to **assess how much on a scale from 1 (Not at all familiar) to 5 (Extremely familiar), are they familiar with the term "social innovation" (Q8).** In general, survey participants assessed to be "moderately familiar" (grade 3) with the term "social innovation" (permanent residents: Mean = 3,03, Std. Dev.= ,986; occasional residents: Mean = 2,98, Std. Dev. = 1,035).

Being asked to **recognize precisely *social* innovations among the list of five different innovations (Q9)**, only 13,5% of permanent residents and 9,3% of occasional residents gave accurate responses, which confirms the claim that general knowledge about social innovation within the community is quite low.

According to Hoppe & De Vries (2019), decarbonization cannot be seen solely as a technological issue, it also requires social innovations. Hence, the participants further had an opportunity to **describe any other social innovation that could contribute to their island's energy transition (Q10)**. The answers received were either technological innovations (e.g. better use of geothermal energy, photovoltaic collectors on houses) or solutions to some general local development needs (e.g. subsidies for young families to relocate to the island) but a few answers did propose social innovations that could contribute to the island's energy transition, namely (Table 29):

Q10	Participants' comments (quoted):
#1	*Co-financing the energy retrofitting of old houses that were built with sea sand and are thus full of moisture and salt; and also quite expensive to renovate while maintaining the historical architecture;*
#2	*Co-financing the purchase of small electric trucks together with the relocation of boats to Maracol Bay (goods from the bay could then be more easily transported to the village);*
#3	*Asking the older islanders for advice and opinion, they know the island, i.e. they knew that the new dock would not be good and what happened? The catamarans and ferries now have trouble berthing. The sewer drain is planned in the worst possible place, no one asks locals anything;*

#4	*Giving free municipal land and houses to young families and introducing more regular boat lines to Mali Lošinj;*

TABLE 29: OVERVIEW OF PARTICIPANTS' COMMENTS TO Q10, SOURCE: AUTHOR

There was also one sarcastic comment saying that the government officials should be invited to come and see what it is like to live on an island, stating that it would be one useful social innovation. In any case, two comments raised the issue of co-financing and it is worth mentioning that banks were precisely one of the key stakeholders of Samso's energy transition (Papazu, 2016), offering affordable loans to islanders and enabling them to engage financially and invest in RES infrastructure.

Finally, the participants were assessing **how much in their opinion, on a scale from 1 (Not at all) to 5 (To a large extent), social innovations could contribute to Unije's energy transition (Q14)** and the results are shown below (Figure 18):

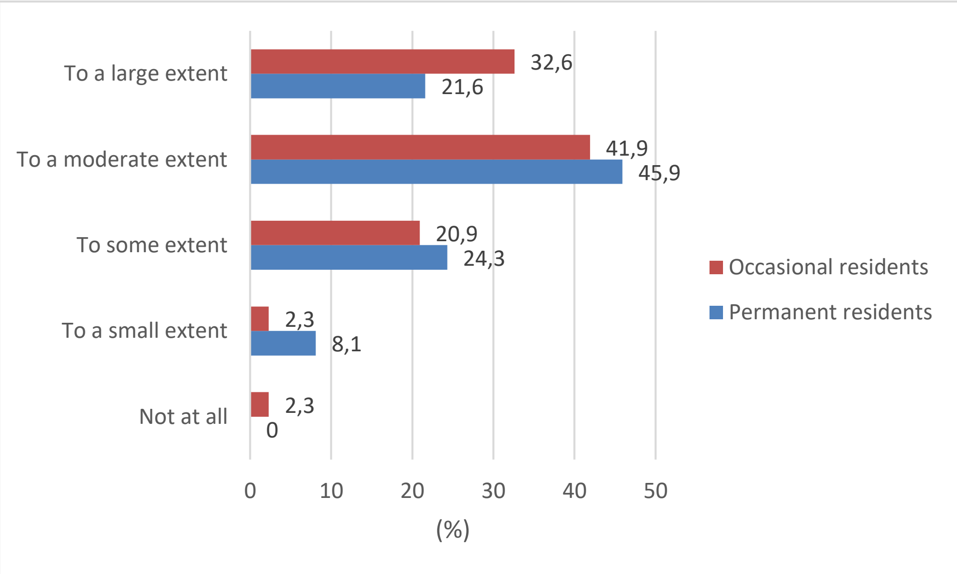

FIGURE 18: ASSESSMENT OF HOW MUCH SOCIAL INNOVATIONS COULD CONTRIBUTE TO UNIJE'S ENERGY TRANSITION, PER GROUPS, SOURCE: AUTHOR

The majority of participants believe that social innovations can contribute to Unije's energy transition up to a moderate or large extent, whereas the distribution of answers does not differ between two groups of residents, $\chi2 = 4{,}468$, df = 2, p >,05.

This also suggests that even though the participants are not that familiar with the "social innovation" concept, the term as such has a positive connotation, which is also confirmed in the literature (Selvakkumaran & Ahlgren, 2020 & 2021).

5.3 Recommendations for local (regional) government

One of the intriguing comments received from a Unije community survey participant was that ten years ago, at the last national census, the island of Unije had 88 permanent inhabitants, while today, after six years of "Unije Self-Sufficient Island" project implementation, it has only 50. Why is this relevant? Because this is what feasibility studies also look at. If the island is faced with a serious depopulation trend, is it justifiable to spend (mostly) public money on RES infrastructure? The energy transition makes sense only if there are energy consumers present. This puts local governments in a causal loop or, to use a metaphor, in a chicken or the egg causality dilemma. Should the RES investments come first, hoping that the energy transition will bring new jobs, open new green tourism opportunities, and – consequently – keep people on the island, and attract new residents? Or, should the island be adequately populated before the decision on investment to secure the ROI from the very start?[10]

In the case of Croatia (regional) government interventionism to combat island depopulation is rooted in strategic plans, such as the Development Strategy for the Primorje-Gorski Kotar County 2016-2020[11] or the National Island Development Plan 2021-2027[12], so the planned investments are in line with the long-term goals and are not necessarily expected to be feasible in a short-term. In any case, population issues are surely something to keep in mind while talking about the energy transition of small islands. Jantzen, Kristensen, & Haunstrup Christensen believe that *„an island, which suffers from depopulation, would wish to increase population by applying policies, such as the following: to increase the frequency of ferry departures, to build an airport, or to build a bridge to the mainland"* (2018:22). In the case of Unije, a bridge connection is not an option, but the frequency of ferry departures and putting the old airport in use surely are. The importance of frequent connections to and from the islands is confirmed both by the experiences of the observed best practice islands and by the survey participants in their comments *("Quick connections to Mali Losinj are needed so that people can commute." / "Look how they have done it on the island of Ilovik, they easily live on Ilovik and work on Losinj." / "It was better while the airport was in operation, great for higher class tourists, but also locals in case of emergencies- business, not just health-connected.").*

Once the island becomes (more) easily accessible, local/regional government should examine what further actions are the top priority for the island. The current Unije Self-Sufficient Action

[10] For example, the planned RES investments on Unije within the H2020 INSULAE project are in total worth about 500k EUR, which is a significant financial amount for an island with only 50 permanent residents.
[11] The new Development Plan of Primorje Gorski Kotar County will be adopted by the end of 2021.
[12] National Island Development Plan 2021.-2027. is under preparation, but it's measures have been publically presented on several occasions by the Ministry of regional development and EU funding.

Plan has been created ten years ago and should be re-examined in collaboration with the locals. Survey results have shown that some of the actions contained in this action plan have really low support from the residents (both permanent and occasional), such as building the green hotel in Maracol bay, preservation of the Istrian cattle ("boškarin") or the fish farming (see Tables 18 and 19 for detailed results), and if there are no people interested in those activities (especially farming), there's no use of developing them. On the other hand side, experiences from other EU islands (Samso, Aran Islands) show that tourism may bring some positive benefits or motivate tourism workers to settle on the island, so that might be something to analyze further.

When it comes to technology investments, the population of Unije (both groups of residents) in principle supports the RES developments on the island (the mean for all actions listed in the survey is between 3 and 4). However, they give water-related issues a priority over other sustainability issues (see Table 21). In other words, they would be more eager to support water and drainage-related activities rather than energy independence projects.

"The individual energy use is socially constructed and influenced by societal norms and routines" (Heaslip & Fahy, 2018, p.153), thus the energy transition acceptance issues are to be considered from the very start and can be influenced by appropriate measures. Investigating the success factors of Samso, Papazu (2016) concluded that the islanders should be informed about the transition activities from the very start and also that, as a result of their active engagement, project leaders should make people believe it (energy transition) is their idea. Not in a sense of deceiving them, but rather making them embrace the idea and pushing jointly towards the realization.

This was confirmed also by the survey results since different communication measures (better risk communication, personal participation in project meetings, stronger and more visible endorsement of energy projects from the municipal government, and promotion via local media or direct communication channels such as post or e-mail) came on top on the list of actions that could increase the participants' acceptance of RES developments on the island (see Tables 26 and 27).

The experiences from the islands observed (Samso, Aran Islands) showed that cooperatives as a method of organization are a good concept for the realization of decarbonization projects. This also calls for the involvement of local banks that should provide affordable loans and enable every citizen to take part in the ownership of RES infrastructure. This also means that citizen engagement becomes very tangible, and not only pro-forma. Survey results showed that about half of the participants would be interested in joining the energy cooperative on Unije (Figure 17), and the distribution of answers does not differ between the two groups of residents. The role of cooperatives has been identified as significant in the success of the Aran islands' transition towards a decarbonized energy system. Evident from the comparison of surveys done in 2010 and 2021, the willingness of local inhabitants at Unije to join such an initiative is dropping. Thus, the local/regional government could play a role in educating and motivating the locals (based on successful examples from other islands) to re-examine the possibility of joining such initiatives Also, it could promote and support the establishment of such cooperative.

Being engaged in cooperatives or not, islanders have to understand what they can gain from it, how concretely can they benefit from transition activities. The majority of survey participants would be willing to support the installation of renewable energy systems on the island in return for some direct financial benefits (Figure 14). Also, they would be willing to invest personally in domestic renewable energy systems on their property on Unije if they were able to gain some concrete benefits from it (Figure 15).

In communicating those benefits and bridging the gap between the new technology and society, the successful engagement and collaboration of both technical and social experts are highly appreciated (which was very well illustrated in the presented story of Samso's energy transition). The technicians of course know how RES technology works, what are its outputs, and also what the environmental risks are (which often concerns the local community), but social experts should also be hired as communicators, to reach the final users and in a sense „storify" the transition. The local/regional government, as project owner, has complete authority over this matter.

Furthermore, creating an appropriate transition narrative was one of the key success factors for Samso. As they like to point out, energy transition as such was rarely mentioned in communication with the islanders. It was a development project rather than an energy project. It was supposed to open new jobs for factory workers that were at some point left jobless, also to open some high-tech jobs and attract younger people to stay on the islands. Finally, the transition project was meant to awaken the community spirit, contribute to repopulation, attract researchers and tourists, etc. Although the technology as such was new, the principle was not, islanders were used to saving energy and living sustainably, taking care of available resources.

Different "green nudges" (i.e. policy tools to foster environmentally friendly behavior) to stimulate the use of RES technology or branding their island as a front-runner in decarbonization does not mean much to the population on Unije (Tables 26 and 27). One of the comments received summarizes the Unije population's attitude towards new initiatives very well: "*The most important thing is reporting back to the local community on what has been done, what will be done and by when, and how it will help them. The islanders are quite disappointed with how some projects were run in the past, people and teams came, promised a lot but either it was not realized or it was short-lived, so I think communication is very important at the moment."* More efforts should thus be put into communication via all possible channels, from live meetings to online and social media.

However, there is no universal communication nor project implementation recipe that fits every island community perfectly. *"The conventional 'one-size-fits-all' national approach to community engagement and public consultation has many times proved unsuccessful"* (Heaslip, 2017, p. iii) and *"practices promoting and recognizing expert knowledge over local knowledge foster a community engagement process that is inattentive and indifferent to the distinctive and divergent needs of island communities"* (Heaslip, 2017:4).

Community surveys (such as in the cases of Aran Islands and Tilos) seem to be a good way to research and understand local community perspectives, before setting up concrete projects. For example, as already mentioned, the survey conducted on the island of Unije showed that the islanders are mostly concerned with water-related issues. Thus, a sustainability programme focused on water and later on solar energy and other issues could have been more easily accepted by the community. Also, European funding directed at solving those issues would be beneficial.

Islanders should be well informed not only about positive aspects but also about all possible downsides of RES infrastructure. The need for better risk communication was emphasized by both groups of survey participants (Tables 26 and 27). In parallel, supportive national legislation and policies would be appreciated, but cannot be influenced. Property and land rights issues often complicate the realization of projects on the islands, so additional effort must be put into resolving those barriers.

There is also a question of setting up the vision and mission for the island. Sometimes some activities pose a threat to the realization of some other. In Unije, for example, there is a parallel aspiration to preserve cattle breeding and to develop green tourism (Jardas et. al., 2011), which may not go hand in hand. In terms of energy, solar power plant construction is foreseen, and solar panels on private houses are also a possibility, but the islanders are concerned that it would destroy the natural landscape and authenticity of the island.

There is, of course, no progress without some investments, but the challenge for the local/regional government is to find the right balance between progress and preservation. Technology solutions to satisfy both, of course, do exist, such for example solar roofs designed with tiles that look similar to a traditional roof, but are much more expensive. This brings us back to population issues and cost-efficiently of capital-intensive investments in societies with decreasing populations. Yet, this should be the role of local/regional governments, to enable the realization of projects that are not always cost-efficient in market terms but could bring some important benefits.

Given the current focus of the European Union on the revitalization of remote island communities, local/regional government should work on multiplying scarce budgetary resources by attracting European funding, but also private funds (where feasible). Also, local/regional governments can develop and introduce different small-scale subsidies for islanders that could also contribute to island energy transition, or can work with the banks on developing more comprehensive financial schemes. The role of banks and such schemes was evident on Samso, where every resident was given an opportunity to invest in RES projects on the island (Papazu, 2016).

In the case of Unije, the challenge to improve the project communication on all levels remains an open task, together with the need to make greater use of local knowledge, to re-examine the current sustainability action plan, and to fine-tune it along with the islanders' needs – having in mind the re-population of Unije as a long-term goal. All these areas of concern can offer fertile ground to the development and implementation of social innovations (e.g. new energy market models, better institutional support, new governance models, increasing citizens' participation and cooperation in energy services, community energy initiatives, and similar).

The majority of survey participants believe that social innovations can contribute to Unije's energy transition up to a moderate or large extent (Figure 18) and it is up to the project leaders to exploit this potential.

6 CONCLUSION

The main research question to be addressed in this thesis was the following: *What is the role of social innovation in energy transition and can social innovation be considered as a success factor in the island of Unije energy transition process?* A set of additional questions was also intended to be addressed, i.e.: *What are the social aspects of local energy transitions? Which types of social innovation could support local energy transitions in the islands? What are the foreign islands' best practices when it comes to using social innovation to accelerate their energy transitions that could be applied also on Unije island? Who are the actors on the pilot island of Unije that need to address the social side of technical zero-energy innovations and how it should best be done? What types of social innovations can be introduced by the local (regional) government to support the energy transition process?*

Different authors (Young & Brans, 2020, Selvakkumaran & Ahlgren, 2021, Gjørtler Elkjær, Horst, & Nyborg, 2021) stress the fact that energy transitions are not to be considered strictly technical, but rather as socio-technical since they are comprised also of policies, politics and other artifacts and not just technological. Nevertheless, the role of social innovation in local energy transitions is still under-studied (Selvakkumaran & Ahlgren, 2020 & 2021). This thesis aimed to contribute to this lack of literature, focusing on the local energy transitions of islands.

There are different social aspects of local energy transitions, ranging from social incentives influencing behavioral changes, new social configurations, and organizational forms stimulating low-carbon energy services to new forms of governance. Social innovations in all these areas have the potential to support local energy transitions in the islands.

The analysis of best foreign practices from the island of Samso, Aran Islands, and the island of Tilos, demonstrated what worked best at those islands, stressing the following innovations as game-changers: (1) strong community engagement over the idea of general local well-being rather than just energy-related aspects, (2) decentralization of energy generation through community-led RES projects, and consequently (3) having a large number of energy capacities owned by individuals and local/regional groups. Thus, local communities are considered as a key factor in successful energy transitions and the role of local/regional authorities is to set up adequate conditions in which energy transition initiatives can flourish.

The transition processes of Samso, Aran Islands, and the island of Tilos demonstrate how local/regional governments can develop or provide support to different social innovations that are of relevance for the energy transition processes, i.e.:

- Develop different social incentives to stimulate the change of behavior of islanders and motivate them to save energy (including "green nudges");

- Build new social configurations, e.g. by using existing or founding new intermediary organizations to support the energy transition (such as the Samso Energy Academy on Samso);
- Support new organizational forms (e.g. foundation of renewable energy cooperatives) that can lead new RES initiatives;
- Introduce new forms of governance to support the energy transitions process (e.g. promote stronger citizen engagement and co-creation of low carbon policies);
- Develop different local/regional subsidy programs for small RES systems;
- Empower citizens to take an active part in energy transition activities (e.g. through better communication and collaboration in the "citizens – local district council – local government" triangle)

The last point mentioned - empowerment of social groups to engage in low carbon energy activities, or if not to *engage* then at least to *accept* - requires getting to know more about community aspirations, wishes, believes, and fears. Community surveys (for example on Tilos and Aran Islands) proved to be a good method to learn about local community viewpoints and to better plan transition activities on the islands.

The survey conducted on the island of Unije in June 2021 for the purpose of this thesis targeted both permanent residents of Unije island living full-time on the island, as well as the occasional residents with property on the island, i.e. staying with family or their own weekend houses. The aim of the survey was to get to know the opinions of the local population better and to explore the role of social innovation in energy transition, and whether it can be considered as a success factor in the island of Unije energy transition process.

The results showed that the opinions of those two groups of participants regarding the island's sustainability and decarbonization are quite similar. The islanders in principle support renewable energy developments on the island, so the technology itself (or the often seen fear of new technology) is not a big issue - about half of the participants would be interested in joining the energy cooperative on Unije, the majority of them would be willing to support the installation of renewable energy systems on the island in return for some direct financial benefits, or even to invest in domestic RES systems.

On the other hand, some social aspects of energy transition appear to be more problematic. The participants recognized a need for: more efficient and frequent project communication, better risk management, stronger personal involvement, stronger endorsement of RES projects from the local government, need for participatory planning that would not be carried out in a perfunctory manner, better exploitation of local knowledge and experiences, and similar. And this is where social innovation comes in place – by doing things differently, introducing new modes of communication, new (more inclusive) governance models, new organizational forms (i.e. cooperatives), offering new financing models to enable the co-ownership of RES projects, etc. There is no need to reinvent the wheel, many examples of social innovations, system innovations, and game-changers already exist, as well as a certain number of narratives of change (Selvakkumaran & Ahlgren, 2021), they only need to be adapted to specific local circumstances since there is no unique transition methodology fits all. Every island community is specific in its needs and aspirations, although they mostly share similar problems.

The fact that the population on Unije is in general supportive towards RES technology implementation (although to some extent concerned that it might irreversibly affect the island's natural landscape and cultural authenticity), but recognizes the need for improvement in different social areas, leads to the conclusion that social innovation can have a positive role and be considered as a success factor in the island of Unije energy transition process.

There is nevertheless one limitation related to this research. In the empirical part, the survey was able to cover 75% of adult permanent residents, while it would be excellent to have had a 100% representation. Also, surveying was done in the preseason, which could have contributed to a somewhat lower response from occasional residents. Nevertheless, the results gathered to give some important insights into the viewpoints of islanders.

It remains a challenge and idea for some future research to analyze how to measure this impact. Also, some future research might put less focus on community actions (citizen engagement, energy cooperatives, etc.), and more on multilevel governance, energy poverty (putting more focus on people with the lowest energy consumption), and motivation of individuals, trying to answer the question what motivates people to change their lifestyle and voluntarily decrease their energy consumption since it is evident that the large-scale behavior change will be needed if we wish to meet the EU's climate targets.

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APPENDIX: ISLAND OF UNIJE LOCAL COMMUNITY SURVEY – QUESTIONNAIRE

Lea Perinic (1302005@modul.ac.at)
MBA student
MODUL University Vienna
Supervisor: Dr. Sabine Sedlacek

ISLAND OF UNIJE LOCAL COMMUNITY SURVEY
Social Innovation and the Islands Energy Transition
– The Case of Unije Island

Dear Sir/Madam,

You are being invited to participate in a survey that is conducted as part of my master thesis research at MODUL University Vienna. The survey examines your personal opinion on the potential contribution of social innovation to the island of Unije's energy transition.

The survey is intended for:
- Permanent residents of Unije Island (living full-time on the island)
- Occasional residents with property on the island (i.e. staying with the family or their own weekend houses)

Please fill out the survey only if you belong to one of these categories.

The survey is anonymous, and your data and responses will be used exclusively for research purposes in an aggregated manner. There are no correct or incorrect answers. Your participation is entirely voluntary, and you can withdraw at any time. You are free to omit any question. However, I'd appreciate it if you could answer all questions and by doing so contribute to the reliability and quality of the data.
The survey should take no more than 10 minutes to complete.

If you have any questions, please email me at 1302005@modul.ac.at.

Q1: Which of the measures from the „Unije Self-Sufficient Island"strategy do you consider to be the most important for the islands' sustainability?

Legend: ENI - Energy independence, WSD - Water supply and drainage, AAM - Agriculture and mariculture, TIN - Transport infrastructure, TSM – Tourism

1 (Not at all important), 2 (Slightly important), 3 (Moderately important), 4 (Very important), 5 (Extremely important)

No.	Measure	1	2	3	4	5
ENI1	Energy efficient public lighting	1	2	3	4	5
ENI2	1MW PV with battery energy storage system	1	2	3	4	5
ENI3	Solar thermal collectors in buildings	1	2	3	4	5
ENI4	Biogas plant – zero waste system demonstration	1	2	3	4	5
ENI5	Electric bikes and vehicles	1	2	3	4	5
WSD1	Self-powered desalination plant	1	2	3	4	5
WSD2	Municipal drinking water storage tanks	1	2	3	4	5
WSD3	Water supply network	1	2	3	4	5
WSD4	Public sewage system	1	2	3	4	5
WSD5	Wastewater treatment plant with discharge	1	2	3	4	5
AAM1	Land consolidation	1	2	3	4	5
AAM2	Olive oil production – revitalization and mill construction	1	2	3	4	5
AAM3	Growing vegetables in greenhouses	1	2	3	4	5
AAM4	Permanent preservation of the Istrian cattle („boškarin")	1	2	3	4	5
AAM5	Sheep and goat farming - increase in herds and cheese production	1	2	3	4	5
AAM6	Fish farming	1	2	3	4	5
TIN1	Local airport – putting into action	1	2	3	4	5
TIN2	Breakwater extension	1	2	3	4	5
TIN3	Maintenance of field roads	1	2	3	4	5
TSM1	Marina in Maračol bay	1	2	3	4	5
TSM2	Green hotel in Maračol bay	1	2	3	4	5
TSM3	Tourist trails and promenades - cycling, ecology, ornithology, archeology	1	2	3	4	5

Q2: Which of the following benefits to be triggered by the investments in the island's sustainability do you consider the most relevant for your island? (Please rank from 1 to 6, with 1 being the least relevant and 6 being the most relevant)

List of benefits	Your rank (1-6)
Availability of green energy produced from renewable energy sources	
Improved energy security, not depending on undersea power cable from the mainland	
Providing drinking water from the desalination plant	
Introduction of a public sewage system replacing the traditional septic systems	
Enhancing the resilience of agriculture and food security	

Supporting the further development of tourism as a major source of income	

Q3: To what extent do you support or oppose the following renewable energy developments on the Island of Unije?

1 (Strongly oppose), 2 (Tend to oppose), 3 (Neither support nor oppose), 4 (Tend to support), 5 (Strongly support)

No.	RES development	1	2	3	4	5
1	Installation of LED public lighting	1	2	3	4	5
2	Installation of a photovoltaic plant (done by DSO) with battery energy storage system to support the island's energy security (INSULAE Project)	1	2	3	4	5
3	Possibility of installing "Energy Boxes" in individual households for smart energy consumption monitoring (INSULAE Project)	1	2	3	4	5
4	Possibility of installing smart sensors in private water wells for smart water consumption monitoring together with smart agriculture/vineyard irrigation system (INSULAE Project)	1	2	3	4	5
5	Possibility of introducing island-mainland connections running on alternative fuels (e.g. hydrogen)	1	2	3	4	5

Q4: If you "Tend to oppose" or "Strongly oppose" any of the renewable energy developments listed in the previous question, please explain your reason(s) for being opposed.

Q5: Would you be more willing to support the installation of renewable energy systems on the island if would bring you direct financial benefits, e.g. savings on the utility bills?
1 - Yes
2 - No
3 - Don't know

Q6: Would you be willing to invest personally in renewable energy systems in your property on Unije that would lower your utility bills in the long term (e.g. solar collectors for water heating, photovoltaic panels for electricity generation, heat pumps for heating and cooling, etc.)?
1 - Yes
2 - No
3 - Don't know

Q7: To what extent would you be willing to change your habits in order to lower your utility bills or earn an extra profit (e.g. by turning on the domestic electrical appliances when the electricity rate is lower and not when it suits you best)?
1 - Not at all
2 - To a small extent
3 - To some extent

4 - To a moderate extent
5 - To a large extent

Q8: How familiar are you with the term “social innovation”?
1 - Not at all
2 - Slightly
3 - Moderately
4 - Very
5 - Extremely

Q9: Social innovation is (Please mark all answers that you find accurate):
1 - New energy market models
2 - Decentralized power generation
3 - Energy storage technology solutions
4 - Alternative fuels (such as hydrogen, natural gas, and propane)
5 - Community energy initiatives

Q10: Can you name any other social innovation that could contribute to your island's energy transition (meaning the shift from fossil-based systems of energy production and consumption — including oil, natural gas, and coal — to renewable energy sources like wind, solar and other)?

Q11: To what extent do you consider the following actions important for increasing your acceptance of the RES developments on the island?

1 (Not at all important), 2 (Slightly important), 3 (Moderately important), 4 (Very important), 5 (Extremely important)

No.	Action	1	2	3	4	5
1	**Possibility to get more actively involved in local energy project planning processes, coordinated by the local government**	1	2	3	4	5
2	**Being informed about the projects’ progress by the local media (incl. social media)**	1	2	3	4	5
3	**Being more directly informed about the projects’ progress (via a mailing list or regular post)**	1	2	3	4	5
4	**Being informed in person about the projects’ progress (during local meetings with project owners)**	1	2	3	4	5
5	**Better risk communication (communicating clearly the potential downsides of energy projects)**	1	2	3	4	5
6	**Stronger and more visible endorsement of energy projects from the municipal government**	1	2	3	4	5
7	**Introduction of different “green nudges” (i.e. policy tools to foster environmental friendly behavior) to stimulate the use of RES technology**	1	2	3	4	5
8	**Participation in the ownership of energy infrastructure (holding a share), via energy community or similar models**	1	2	3	4	5

9	**Being not only an energy (electricity, gas, or heat) consumer but becoming also a prosumer who produces energy through, for example, photovoltaic panels (a.k.a solar panels) installed on or around your house**	1	2	3	4	5
10	**Branding your island as a front-runner, the first energy self-sufficient island in Croatia**	1	2	3	4	5

Q12: What other actions could contribute to increasing your personal acceptance of the RES developments on the island? (Please describe)

Q13: European citizens are increasingly taking control of their energy supply, introducing secure, renewable sources, through community initiatives. Community energy projects generally refer to projects where citizens own or participate in the generation of sustainable energy. Would you be interested in taking part in such activity on Unije, by becoming a member of a potential Unije Energy Cooperative?

1 - Yes
2 - No
3 - Don't know

According to one of the available definitions, social innovations are defined as "new solutions (products, services, models, markets, processes, etc.) that simultaneously meet a social need (more effectively than existing solutions) and lead to new or improved capabilities and relationships and better use of assets and resources. [The Young Foundation (2012) Defining Social Innovation].

Q14: Having been given some examples of social activities connected to renewable technology acceptance as well as being explained the meaning of social innovation, please assess how much in your opinion could social innovations contribute to your islands' energy transition?

1 - Not at all
2 - To a small extent
3 - To some extent
4 - To a moderate extent
5 - To a large extent

Gender:

1 - Female
2 - Male

Age:

1 - 18-24
2 - 25-44
3 - 45-64
4 - 65 or over

Highest achieved level of education:
1 - Attended or finished primary school
2 - Secondary school
3 - Bachelor degree (In Croatia: VŠS and B.A. degree)
4 - Master degree (In Croatia: VSS and univ.spec. degree)
5 - PhD

How do you assess your financial capacity, in relation to other islanders:
1 - Much higher
2 - Higher
3 - About the same
4 - Lower
5 - Much lower

Your status of residence at Unije island:
1 - Permanent resident (living full-time on the island)
2 - Occasional resident with property (i.e. staying with the family or at its own weekend house)

By clicking the 'Submit' button below, you are consenting to participate in this research, as was described in the introduction of this survey.