IIIEE Theses 2020:13

Powered by actors and business models

Analysing the potential for energy community development in new regions using the case of Kökar island

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Thesis for the fulfilment of the
Master of Science in Environmental Management and Policy
Lund, Sweden, May 2020

Published in 2020 by IIIEE, Lund University, P.O. Box 196, S-221 00 LUND, Sweden,
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ISSN 1401-9191

Acknowledgements

During the past months, COVID-19 virus has ravaged the world and locked most of us indoors. I greatly appreciate my luck as I was able to conduct my field research before any major movement restrictions were placed. After this acknowledgement for lady Fortune, I want to express my gratitude to the following individuals helping and supporting me in this five-month journey.

Thank you Flexens Oy Ab, especially Tuukka Vainio and Berndt Schalin, for offering me the opportunity to conduct my thesis research on Kökar and energy communities. You provided me with the best motivation to work by allowing me to pursue research on a topic which very much interests me. Thank you for granting me access to material, connecting me with people, providing guidance during my research and financing my trip to Kökar. All of these factors provided invaluable support for my thesis work.

Thank you, Jenny Palm, for supervising my thesis. Your contribution was extremely important in scoping my thesis and improving its consistency. I especially appreciate your encouragements during the process, your availability for any concerns I had, and your promptness in answering my questions. Lastly, one of the main reasons I decided to pursue this topic in my master's thesis was because of your introduction in the AR-document a long time ago, in June 2018.

Thank you, Christian, Madde, Camilla, Rolf, Joel and Daniela for helping to make my stay on Kökar successful and remarkable. I was lucky to have you help me contact the right people, agree on focus group logistics and advertise my events on Kökar. I would like to extend my gratitude to all Kökarbos for taking the time to answer my queries and explain the lifestyle on Kökar. You live on a beautiful island; I hope my work can help in its future endeavours.

Thank you to all the interview respondents giving me their time and familiarising me with the world of energy communities, energy markets, legislation and much more. Your insights were key in helping me to understand what the environment surrounding energy communities is in Åland and Finland.

Thank you, Eeva, for being my co-worker (for these past two months), co-adventurer and supporter. Now that these five months have passed, I think we deserve a holiday before the next adventures. Thank you, Emma, äiti and isä for supporting my process and always providing me distractions when I needed them. Thank you for all my friends! Whether you were with me researching in the pöhinä-rooms of Aalto University on Friday afternoons, having way too long online-meetings, or just generally spending time with me, you helped me to relax and balance my life. In the end, this was a pleasant process, which is to a large extent because of you.

Thank you, insti people! The two years I spent studying here redefined university for me. With the institute as our home base, it felt like I was a part of a big family. I will remember the Christmas parties, the countless fikas and all the time I just spent laying on the red couch in the lunchroom corner. Special thanks to Håkan and Calle for being worthy innebandy opponents and inviting me to blow off some steam on the field.

Thank you, EMP Batch 25 – more familiarly the Guinea pig batch or even more familiarly, the Whiny batch. I shared many great moments with you including the rainiest Kullen in history, a consultancy project in Kenya, study visits, birthday-fikas, parties, the sauna in Bjärred, picnics and Valborg. From you, I received 28 lifetime friends who I know I can count on and will keep in touch in the future. Let us have a great big party to celebrate our graduation when it is possible. Skål and kippis!

Abstract

An energy transition from centralised and fossil-fuelled installations towards decentralised and renewable energy has been advocated by governments, businesses and academia. In the EU it has become a regional strategy, and a desire of citizens, to enable communities to take an active role in the energy market in the hopes of transitioning to an increasingly local, renewable and participatory future energy system. These citizen-led energy communities (ECs) have multiple individual and societal benefits and are expected to have a major role in the future energy system. Prior studies on ECs have mostly focused on analysing existing ECs on regions with a favourable environment for their development. Studies on developing ECs in new regions without existing EC culture have received less attention. Therefore, this thesis analyses EC development in new regions using the case of Kökar island in Åland, Finland. It utilises a developed EC enabling framework to find a suitable EC type fitting Kökar and from these results provides recommendations for future EC development efforts. To determine a suitable EC type on Kökar, data was collected from document analysis, ten expert interviews, a survey and three focus groups and analysed in a content analysis software. As a result, an EC type with six characteristics could be proposed for Kökar, and suggestions provided to simplify and improve the efficiency of the EC enabling framework to aid future EC development work. Additionally, recommendations were provided for EC developers and policymakers to emphasise contextual factors when developing ECs, utilise and continue improving the EC enabling framework, provide development assistance to, and capitalise on the possibilities provided by, the nascent field of ECs. The changing energy environment requires future research to follow and contribute to the field's advancement by e.g. analysing EC development frameworks and suitable organisational forms and taking an active role in producing pilot sites.

Keywords: energy community, development, context, motivations, actors, business models

Executive Summary

In 2017, the heating and electricity sector was the top carbon dioxide emitting industry (IEA, 2017). To mitigate the detrimental effects of the industry, an energy transition from the current system of large-scale, centralised fossil-fuelled plants to decentralised and renewable energy installations is advocated (European Commission, 2019; Singh et al., 2019). Advancing the energy transition, the European Union (EU) has targets on increasing the share of renewable energy and decentralised energy production to mitigate climate change effects, increase local energy production and energy supply security (Directive (EU) 2018/2001 of the European Parliament and of the Council, Art 3 para. 1, Rec. 65). Furthermore, renewable and decentralised energy production can empower and engage citizen communities to take an active role in the energy market, by self-producing energy in energy communities (European Commission, 2019). Energy communities (ECs) are groups of citizens who engage in and manage energy-related activities with the main purpose of producing social, environmental and economic benefits for the community (Seyfang et al., 2013; Walker & Devine-Wright, 2008). By combining the environmental benefits of renewable energy and the socio-economic benefits of engaging communities, the supporters of ECs hope to create to a future energy system where energy production is increasingly local, renewable and participatory, creating thriving communities and advancing the energy transition (Vansintjan, 2015). The emergence of new technologies and actors provide ECs with novel opportunities and solutions to reach these ambitions (Mlinarič et al., 2019). Owing to this potential, ECs are expected to have a significant role in the EU's future energy system (European Commission, 2019; Kampman et al., 2016). Their benefits are especially evident in secluded regions such as islands or rural areas with more community-centred atmosphere and often less developed infrastructure (Berka & Creamer, 2018; van Veelen, 2017).

Multiple previous studies have researched the varying types of ECs (Berka & Creamer, 2018; Hicks & Ison, 2018; van Veelen, 2017) and their business models (Brinker & Satchwell, 2019; Koirala et al., 2016; Nolden et al., 2020). Additionally, several in-depth case studies on ECs have been conducted (Berka & Creamer, 2018), and some development frameworks presented (Hicks & Ison, 2018). These studies provide a comprehensive review of existing ECs but focus mainly on analysing existing ECs in North-Western Europe where EC development is already prominent. In-depth case studies on EC development, including types and business models, in regions with less EC experience are underrepresented. These studies are especially relevant now with enabling EU legislation and developing technologies.

Research questions and methodology

This thesis fills the above-mentioned literature gap by providing an explanatory case study on EC development on the island of Kökar, situated in Åland archipelago, Finland. Motivated by ECs' energy transition potential and the EU's supportive actions towards their construction, Kökar is interested in the role ECs could have in their energy transition project. This thesis aims to contribute to this project by utilising a developed EC enabling framework to identify suitable EC types for Kökar. Based on the results, suggestions were presented to improve the EC enabling framework and EC development generally. Additionally, recommendations were provided for the intended audience, namely EC developers and policymakers, aiming to develop ECs. The following research questions were created to fulfil this aim:

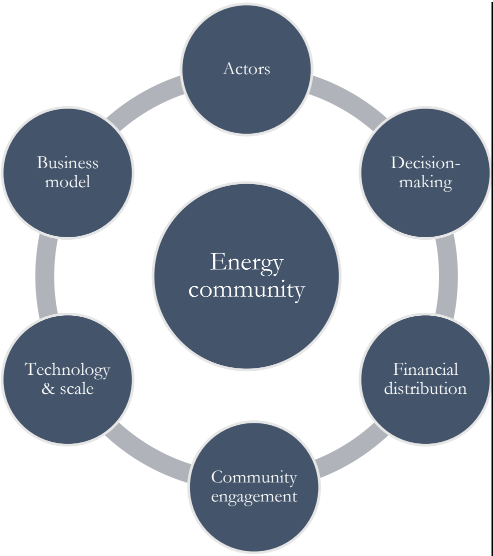
RQ1: What types of ECs are identified in earlier literature?

RQ2: What types of ECs could be developed on Kökar?

RQ3: What suggestions can be provided for EC development frameworks based on the findings from Kökar?

RQ4: What recommendations can be given for EC developers and policymakers in EC development based on the findings from Kökar?

To answer these research questions, an EC enabling framework was developed from existing literature (Gui & MacGill, 2018; Hicks & Ison, 2018). It includes background factors, i.e. the context of the potential EC area and motivations of potential EC members. These background factors were studied on Kökar as they create the conditions in which EC's characteristics can vary. Six EC characteristics, including actors, decision-making, financial distribution, community engagement, technology and scale, and business model were chosen as they were found to represent ECs' main qualities. Each of them were assigned a value spectrum in which they could vary according to the background factors, e.g. actors in an EC could vary from only local individuals to only non-local governments and businesses. The sum of these values would represent the proposed EC for Kökar.



Background factors = context and motivations	Context: contextual differences in regions (physical, technical, institutional, communal). Motivations: reasons to join an EC (economic, environmental, social, political, technological).
Actors	Members in the EC. Local (from Kökar) or non-local individuals, organisations, businesses, governments.
Decision-making	Who has decision-making power in the EC.
Financial distribution	How profits are distributed between EC members.
Community engagement	Frequency and methods of engaging the community.
Technology & scale	Used technology and the EC's scale in relation to the community's energy demand.
Business model	Activities the EC is engaged in, i.e. what it does.

To provide an overview of the field and compare with the proposed EC on Kökar, data on existing EC types and their variations in the six defined EC characteristics was collected from earlier academic and grey literature. Thereafter, to identify Kökar's background factors, document analysis, 10 expert interviews, a survey and three focus groups with Kökar's residents were conducted. Based on the background factors, EC characteristics representing a suitable EC type for Kökar could be identified. Furthermore, suggestions could be given for an improved EC enabling framework and recommendations provided for EC developers and policymakers on EC development.

Main findings and discussion

RQ1: The study of existing EC types found eight different variations of ECs. These included collective procurement, local microgeneration, heating and biogas ECs, development trusts, cooperatives, partnerships, local government-led projects with citizen involvement and municipal energy companies. Although the majority of collected data was from North-Western Europe, significant variations between ECs on the six EC characteristics were identified. Additionally, correlations between certain EC characteristics was recognised.

RQ2: The proposed EC on Kökar would have a mix of local and non-local actors. However, it would emphasise local actors due to the local will for citizen authority in the EC and the island's involvement in the energy piloting project Smart Energy Åland, which provides it with development assistance. Still, due to the limited time, finances and awareness of locals, non-local actors are expected to be a part of the EC to provide technical, financial and political assistance. Decisions in the EC would be made on a 'one vote per actor' basis to ensure democratic participation and local involvement, but the role of non-local assistance would most likely have to be considered. As individual financial incentives are needed to enable EC development, profits from the EC's activities would mainly be channelled to local and non-local investors, and partly to a community fund. In the identified EC examples, the inclusion of non-local actors has allowed ECs to form and spread but has often required a shift of profits and decision-making authority from local to non-local actors. This might end up being the case on Kökar as well. However, this risk is mitigated by the island's involvement in the Smart Energy Åland project. The findings from Kökar suggest, that an EC without non-local actor involvement seemed to be impossible due to the lack of time, motivation, skills and financing in the community. Consequently, the inclusion of non-local actors can lead to decreasing local authority in the EC.

The EC would incorporate a communication strategy where first it would engage the local community frequently, using a broad range of methods, and thereafter adjust according to the received feedback. Possible communication channels include social media and the local monthly newspaper. Clear results on the community engagement characteristic were not found due to lack of data or patterns in responses. Thus, the characteristic is important for EC development but considered as a flexible characteristic which could take different forms to suit the other EC characteristics.

Kökar's ECs would utilise wind and solar power, and biomass to self-produce energy. As a group of actors, the EC can make collective investments which allow it to build larger renewable energy installations than consumers could individually. Additionally, by self-producing energy, the EC can avoid the distribution costs and taxes inherent in purchased electricity. The EC would be scaled to meet the EC's energy demand as a result of the locals' motivations for partial energy independence, possible cost efficiency improvements in the electricity network, and the Smart Energy Åland project's ambitions. The energy installation would be complemented with solutions, such as virtual power plants and peer-to-peer trading, provided by new legislation, market actors and technologies. For instance, the EC's energy resources could be aggregated by a virtual power plant to enable the EC to trade energy within itself and gain additional income through demand-response services. Currently, in an environment with continuously maturing legislation and technology, a collaborative approach with local and non-local actors was seen as the best method for developing the local energy system and to enable a possible later transition towards a fully energy self-sufficient EC.

RQ3: The findings from Kökar verify that the EC enabling framework captures the essential background factors and EC characteristics and can thereby contribute to EC development in new regions. Still, due to the correlation between some EC characteristics and the diminished importance of others, certain adjustments could be made to simplify and improve the framework's process. The characteristics of actors, decision-making, and financial distribution were suggested to be combined to one 'organisation' characteristic due to their strong correlation between themselves and with the chosen organisation form, e.g. a cooperative or a development trust. Depending on the background factors, possible values for an EC in the organisation characteristic are high citizen participation and authority, where local actors mainly own, manage and have authority over the project, or low citizen participation and authority, where the EC is owned and run mainly by non-local actors. Due to a similar correlation, technology and scale and business model characteristics were suggested to be joint under one 'business model' characteristic. Depending on the background factors, this characteristic could vary in its scale and relation to the current energy system, i.e. whether the EC self-produces a share of its energy as a part of the current energy system or aims to become energy self-sufficient. Both of the above-mentioned characteristics have transition potential. An EC can mature from a mainly non-local small-scale EC to a larger-scale EC managed by local individuals. Based on these characteristics and the discovered minor importance of community engagement EC characteristic, a stepwise process for EC development was suggested. In it, background factors would act as a basis for analysing the EC characteristics of organisation and business model. After identifying these EC characteristics, practical aspects, e.g. community engagement and funding options are considered. They are important in EC development but can vary to suit the EC characteristics of organisation and business model.

RQ4: Based on the above-mentioned findings and discussions, recommendations on EC development were made for the intended audience of the thesis, namely EC developers and policymakers aiming to develop ECs in new regions.

Identifying the background factors is important to understand the specific EC characteristics suitable for each region. Both in the identified existing ECs and the case of Kökar, background factors affected the type of EC suitable for the regions. Therefore, background factor studies should be conducted when aiming to develop ECs in new regions. The background factors utilised in this thesis were found sufficient to discover suitable EC types. Required preparation for a background factor study includes the identification and presentation of possible EC types, practical aspects such as funding opportunities, and their impact on the envisioned ECs.

Further assistance is needed for EC dissemination, providing opportunities for multiple actors. Kökar is in many ways in a fortunate state in EC development owing to its background factors. Still, due to e.g. limited time and resources, it needs development assistance. Hence, even with maturing legislation and technology, supporting activities, e.g. information packages, are needed for regions aiming to develop ECs. Moreover, due to the lack of culture and reference cases, ECs should be commercialised for citizens and communities. These activities can be provided by, and offer opportunities for, multiple public or private organisations.

The EC enabling framework with its adjustment could be utilised for simpler and more efficient EC development. Developing ECs is simpler with a prior established framework since it collects the important steps in one place. With the suggested improvements, the EC enabling framework could further aid EC development work. The author invites different actors to utilise, complement and improve the presented framework to create an increasingly functional and realistic EC development model.

Conclusions and recommendations for future research

The study on Kökar provided academia with a case study on EC development in a new region. This is especially relevant in the energy transition as new legislation, technologies and actors are emerging, and improving ECs' possibilities to participate in energy markets in Europe. Furthermore, the suggestions and recommendations on EC development can contribute to future EC development efforts. Thus, in addition to proposing a suitable EC type for Kökar to contribute to the island's energy transition plans, the results of the thesis are of general interest both for academia and for EC developers and policymakers in regions similar to Kökar. However, further research on EC development, e.g. the analysis of existing EC organisation forms or financing options in Finland, are needed to produce comprehensive EC development plans. To build a stronger case for EC development frameworks, more case studies utilising these frameworks should be conducted. As EC related legislation and technology is maturing, research should follow the process and analyse the implications of the suggested and realised events on EC development. One such method would be to test the EC enabling framework in a pilot case on Kökar, thereby creating practical legitimacy for the development framework.

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Abbreviations

EU	European Union
EC	Energy community
REC	Renewable energy community
CEC	Citizen energy community
EV	Electric vehicle
VPP	Virtual power plant
P2P	Peer-to-peer
DSO	Distribution system operator
ÅEA	Ålands Elandelslag
kWh	Kilowatt hour
MWh	Megawatt hour (1 000 kWh)
GWh	Gigawatt hour (1 000 000 kWh)
kWp	Kilowatt peak
ESCo	Energy service company

1 Introduction

Excess greenhouse-gas emissions, such as carbon dioxide in the atmosphere contribute to climate change, which has dire repercussions on billions of people around the world (IPCC, 2018). In 2017, two-thirds of the emitted carbon dioxide was produced by the energy sector (IEA, 2017). Of these two-thirds, the heating and electricity sector emitted more than 40%, being the largest individual sector to contribute to climate change.

Thus, to mitigate climate change, the role of the energy sector is crucial. In recent years, renewable energy sources, such as wind and solar power, have become increasingly popular (IEA, 2019). Renewable energy sources produce energy with low environmental impact, are decentralised, i.e. distributed to a larger area than traditional fossil fuel-powered plants, and irregular, i.e. do not provide a stable source of energy, e.g. depending on weather conditions. The change from the current system of large-scale, centralised fossil-fuelled or nuclear-powered plants to decentralised renewable energy installations is often referred to as 'the energy transition' (Bellekom et al., 2016; Singh et al., 2019).

Advancing the energy transition, the European Union (EU) has set a target of producing 32% of its energy from renewable sources by 2030 (Directive (EU) 2018/2001 of the European Parliament and of the Council, Art. 3 para. 1). As a part of the EU, the Republic of Finland has set a target of becoming carbon neutral by 2035, indicating a 55% carbon reduction by 2030 which will be achieved among others by an increase in the share of renewable energy sources (Government of Finland, 2019). In addition to the benefits of renewable energy, the EU is supporting the creation of decentralised energy systems due to their multiple benefits, including increased local energy production, energy supply security and reduced transmission losses (Directive (EU) 2018/2001 of the European Parliament and of the Council, Rec. 65). Furthermore, decentralised renewable energy systems can empower and engage local communities in a new manner.

This empowerment has realised as increased citizen control of energy resources. Citizens, mostly in Europe, have started to demand control on their energy's production methods and set up citizen or local community-owned renewable energy installations, such as solar power plants (Walker, 2008). These citizen or community groups have been broadly referred to as energy communities (ECs). ECs have no agreed definition in academic literature, but they are often defined as local community collaborations which produce, consume and manage their own energy with the primary purpose of creating economic, environmental and social benefits for the community (Hoffman & High-Pippert, 2010; Seyfang et al., 2013; Walker & Devine-Wright, 2008). By incorporating the environmental benefits of renewable decentralised energy resources and the socio-economic benefits of engaging communities and providing them with an additional source of income, the supporters of ECs hope to transition to an energy system where energy production is increasingly local, renewable and participatory, creating thriving communities and advancing the sustainable energy transition (Vansintjan, 2015). The benefits of ECs are especially evident in secluded regions such as islands or rural areas, where locals are comparably more community-centred than their urbanised counterparts and where infrastructure might not be as developed (Berka & Creamer, 2018; van Veelen, 2017). However, multiple barriers, particularly the lack of membership and policy support, have hindered the diffusion of ECs (Brummer, 2018; Seyfang et al., 2013; Walker, 2008).

To mitigate climate change, address the developing energy market environment and respond to citizen demands, the EU has placed citizens in the centre of its Clean energy for all Europeans package, the new energy rulebook in the EU's energy union strategy, implemented since 2016 (European Commission, 2019). The aim of this strategy is to provide a just energy transition to all players in the EU's energy market, which for citizens means improving their quality of life and finances by providing them with better control and access to energy production. As a part of the strategy, the EU has implemented eight energy legislative acts, as well as non-legislative initiatives, such as the Clean energy for EU islands initiative, which collects and shares best practices and knowledge between EU islands to enable them to develop sustainable societies with renewable energy (Clean Energy for EU Islands Secretariat, 2020).

Additionally, the megatrends of decentralisation, digitalisation and decarbonisation provide ECs with new opportunities beyond their traditional operations (Mlinarič et al., 2019). With the emergence of new market actors and technologies, ECs can develop new business models and diversify their operations. With these measures, ECs can attract an increased number of citizens and improve their long-term sustainability, allowing them to continue fulfilling their purpose of providing economic, social and environmental benefits for communities (Horstink et al., 2020; Nolden et al., 2020). Thus, with the potential from EU legislation and the emergence of new market actors and technologies, ECs could have a significant role in the energy transition and the EU's future energy system (European Commission, 2019; Kampman et al., 2016).

Motivated by ECs' energy transition potential and the EU's supportive actions towards their construction, the island of Kökar, situated in Åland archipelago in Finland is interested in the role ECs could have in their ambitions of becoming a 100% renewable society. As one of the islands in the Clean Energy for EU Islands initiative with sustainability-oriented citizens and as a pilot site for a Finnish energy transition project 'Smart Energy Åland', Kökar believes it has the tools to succeed. Thus, this thesis studied how and what kind of EC could be suitable for Kökar.

1.1 Problem definition

Earlier research has developed different typologies of ECs (Berka & Creamer, 2018; Gui & MacGill, 2018; Hicks & Ison, 2018; van Veelen, 2017) and identified both traditional business models (Brinker & Satchwell, 2019; Engelken et al., 2016; Huijben & Verbong, 2013) as well as new ones (Adu-Kankam & Camarinha-Matos, 2019; Koirala et al., 2016; Mlinarič et al., 2019; Nolden et al., 2020). Additionally, multiple in-depth case studies on ECs have been conducted (see Berka & Creamer, 2018 for a list). While the above-mentioned studies provide a comprehensive review of existing EC variations, they tend to focus on North-West European regions where EC development is the most prominent (Germany, the Netherlands, Denmark, the UK) (Klein & Coffey, 2016; van der Schoor et al., 2016; van der Schoor & Scholtens, 2019; Walker & Devine-Wright, 2008; Yildiz et al., 2015) and on situations where ECs have already been developed.

So far, the literature on regions with little existing culture for ECs, such as Åland and Finland, has received less attention. While certain studies on ECs exist, e.g. (Martiskainen, 2014; Ruggiero et al., 2018), the current situation on the Finnish EC field is especially interesting as EC supportive EU legislation is being implemented in the national level (Airaksinen et al., 2019; Pahkala et al., 2018).

Some frameworks have been developed to provide initial support for EC project planning (Hicks & Ison, 2018). Additionally, EC supporting organisations and international organisations have provided guides for increased EC diffusion, including guiding aspects on EC development (Interreg Europe, 2018; IRENA Coalition for action, 2018; Roberts et al., 2014; Vansintjan, 2015; Viljanen et al., 2020). However, a tested guide for EC development in new regions seems to be lacking in academic literature. As ECs can take varying forms depending on the local context (Creamer et al., 2019; Gui & MacGill, 2018; Middlemiss & Parrish, 2010) an in-depth study should be conducted to analyse their development in a new region. With this in mind, this thesis aims to fill this knowledge gap by developing a framework based on existing academic literature to test EC development in new regions using the case of the island Kökar.

1.2 Aim and research questions

With a case study, this thesis aims to contribute to the energy transition project of Kökar by analysing what types of ECs that could be developed on the island. Additionally, these results contribute to the development of more comprehensive EC development frameworks for academia and provides recommendations for EC developers and policymakers aiming to develop ECs. These recommendations are especially of use to regions similar to Kökar, e.g. in Åland and Finland. The following research questions were developed to fulfil the stated aim.

RQ1: What types of ECs are identified in earlier literature?

RQ2: What types of ECs could be developed on Kökar?

RQ3: What suggestions can be provided for EC development frameworks based on the findings from Kökar?

RQ4: What recommendations can be given for EC developers and policymakers in EC development based on the findings from Kökar?

1.3 Scope and delimitations

To analyse suitable EC types for Kökar, an EC enabling framework was constructed based on the literature by Hicks and Ison (2018) augmented with Gui and MacGill (2018). The community renewable energy framework by Hicks and Ison (2018) was chosen as a basis as it was found to be one of the early academic examples of EC development frameworks. It describes context and motivations as factors which affect the type of EC which can be developed. Context refers to the differences between regions concerning physical, technical, institutional and communal factors. Motivations are reasons for potential EC members to join or not join an EC and can be categorised as economic, environmental, social, political and technological. In this thesis, context and motivations are grouped as 'background factors'. A more thorough presentation of background factors is provided in section 3.2.1.

Background factors affect the type of EC which could be developed in a region, i.e. the 'EC characteristics' that are suitable. From the framework of Hicks and Ison (2018) the EC characteristics of actors, decision-making, financial distribution, community engagement, and technology and scale were adopted. The business model concept by Gui and MacGill (2018) was added to include an aspect of financial sustainability in the ECs. Thus, ECs can vary in these six EC characteristics depending on the regions background factors. For instance, the actors in one EC can be only local individuals and organisations while in another the actors can be a mix of local and non-local actors. The EC enabling framework is illustrated in Figure 1-1 and the definitions for its concepts are clarified in Table 1-1. The presented background factors and EC characteristics were expected to cover the main concepts in EC development. Thus, the thesis research would act as a case study testing this statement and identify potential additional considerable aspects.

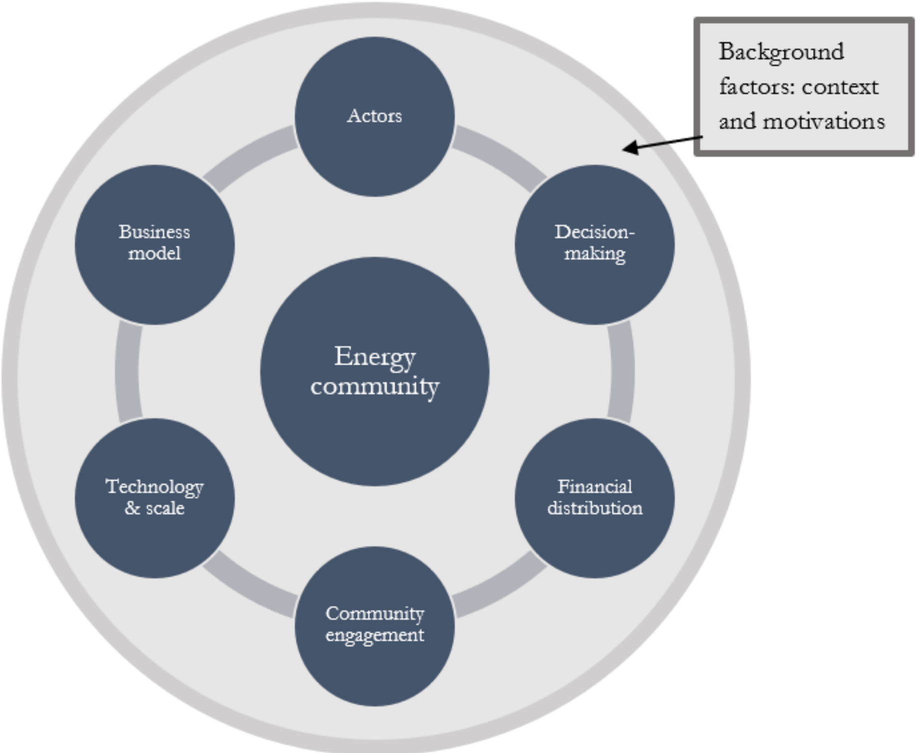

Figure 1-1. EC enabling framework.

Source: Adapted from Hicks & Ison (2018) and Gui & MacGill (2018).

Table 1-1. EC enabling framework concepts and explanations.

Concept	Explanation
Background factors	Context refers to differences between regions concerning physical, technical, institutional and communal factors. Motivations are reasons for potential EC members to join (economic, environmental, social, political and technological).
EC characteristics	Characteristics in which ECs vary. They are actors, decision-making, financial distribution, engagement, technology and scale, and business model.
Actors	Members in the EC. Include local and non-local citizens, organisations, businesses, governments.
Decision-making	Who among the EC actors has decision-making authority.
Financial distribution	How financial gains are distributed between the EC's actors.
Engagement	The frequency and methods of engaging members of the community.
Technology & scale	The technology used and the scale of the project in relation to the community's demand.
Business model	Different business models ECs can engage in. Grouped in centralised, distributed and decentralised business models. Further described in section 3.1.6.

Source: Adapted from Hicks & Ison (2018) and Gui & MacGill (2018).

As an in-depth study on Kökar was deemed necessary to identify suitable EC types on the island and considering the limited time and resources of a master's thesis, the research was conducted as a single case study. The chosen research design has implications on the validity of the research and the generalisability of the results. A more thorough description of these limitations and their mitigation strategies is offered in section 4.4. Moreover, EC legislation is currently being enacted in Finland and new documents are being released constantly. Therefore, the temporal scope of utilised sources would not extend beyond May 2020.

1.4 Ethical considerations

The study on Kökar was funded by an organisation called Flexens Oy Ab (hereafter 'Flexens'). Flexens coordinates the Smart Energy Åland project, which aims to develop Åland, and thereby Kökar, into a society scale demo of an energy system operating fully on renewable energy (Flexens, n.d.). Moreover, they aim to scale this energy transition service to other islands and regions. Therefore, the findings of this thesis will most likely have impacts on the company's business model. However, this did not compromise the research design, which was solely created by the author. Although the research was conducted as a case study for a specific region benefiting the company, scientific methods were used as justifications for including or excluding factors, such as EC characteristics. Integrity and honesty of the research results were ensured through transparency and explicitly documenting the research process, its limitations, and strategies to mitigate these limitations.

Since a large share of the data was collected through interviews, focus groups and surveys, ethical responsibilities to the respondents were considered. Blaikie and Priest (2019) provide a list of these aspects, including voluntary participation, informed consent, freedom to withdraw, right to privacy (see full list p. 56). Actions were taken to mitigate ethical concerns, including writing a short text about the author, the purpose of the research undertaken, the use of the research results and the rights of the respondents, e.g. to withdraw from the research whenever they wished to do so (Appendix B). The collected data is not of sensitive nature and include no questions concerning e.g. health issues or crimes. However, respondent data security was still ensured by storing the data in a password protected cloud server only for the duration of the thesis. Furthermore, all survey results were anonymised. Expert interview respondents are referenced, but only using anonymous usernames, i.e. respondent 1, respondent 2, etc.

As ECs have not yet been developed on Kökar and there is no guarantee that they will be, caution was taken when wording the interview and survey questions. The questions were reviewed beforehand so that no inquiries could lead any respondents to believe that the thesis work signifies a certain implementation of ECs on Kökar. Furthermore, the research design has been reviewed against the criteria for research requiring an ethics board review at Lund University and has been found to not require a statement from the ethics committee.

1.5 Audience

This thesis was developed for the fulfilment of the Environmental Management and Policy programme at the IIIEE at Lund University and aimed for EC developers, policymakers and academia.

By utilising the EC enabling framework suitable EC types were presented for Kökar, thereby contributing to the energy transition ambitions on the island. Based on these results, the suitability of the EC enabling framework was analysed and suggestions made for its improvement. These suggestions aimed to contribute to simpler and more efficient EC development, especially in regions similar to Kökar without existing EC experience. Furthermore, the presented recommendations on EC development for EC developers and policymakers would further contribute to the diffusion of ECs in new regions.

1.6 Disposition

The introduction provided an explanation and overview of the thesis subject and its academic and practical relevance. Additionally, it outlined the ethical considerations and audience which have to be accounted for during the research process.

The literature review describes the current state of knowledge on ECs and their development including definitions, relevance, barriers and enablers. Additionally, it answers the first research question by listing the existing ECs identified in earlier research. Thereafter, to identify the variation possibilities in existing ECs, it analyses these EC types in relation to the EC enabling frameworks' six EC characteristics.

Theoretical model – presenting the EC enabling framework introduces the EC enabling framework and the background factors and EC characteristic spectrums attached to it. This framework was utilised to determine a suitable EC type on Kökar and thereafter adjusted based on these findings.

Methodology presents the chosen research design of single explanatory case study, the scientific approach and data collection and analysis methods. Moreover, the section justifies why different choices were made, explains the limitations of these choices and their mitigation strategies.

Case description describes the case island of Kökar and its background factors.

EC characteristics on Kökar analyses the EC characteristics on Kökar in relation to the background factors. By identifying a value for each of the six EC characteristics, it presents a suitable EC type on Kökar.

Discussion reviews the implications of the findings from Kökar. It summarises the thesis' findings and formulates how they relate to prior research. In addition, it produces a critical reflection on the results.

Conclusion and recommendations close the thesis by presenting its main conclusions and by providing recommendations for the intended audience and further academic research.

2 Literature review

Prior to analysing the potential EC types on Kökar, a literature review on existing EC literature was conducted to gain an understanding on the state of the art in EC development research and identify existing ECs as stated in the first research question. The literature review includes EC definitions, their development enablers and barriers as well as an analysis of existing ECs and their differences. When researching existing EC types, no limits were placed for the search but mainly sources on North-Western European countries were found. A more comprehensive methodology for identifying the existing EC types is provided in section 4.4.1.

2.1 What are ECs?

No widely accepted name, nor definition can be recognised for ECs, leading to the use of different expressions e.g. community renewable energy (Hicks & Ison, 2018), community energy (Walker & Devine-Wright, 2008), clean energy communities (Gui & MacGill, 2018). Therefore, ECs are often defined via their activities – what they do (Becker & Kunze, 2014; Creamer et al., 2019). The literature from the UK, the earliest and arguably the most prominent country in EC research, refers to an ideal EC project to be a situation where "a group of local people organise and operate the project and also receive the benefits of the project" (Walker & Devine-Wright, 2008). Hence, in EC definitions the local community is seen as a decision-maker, i.e. having an active role in the EC's management, and as a benefactor, i.e. the EC's benefits are enjoyed by the local community. Within this broad meaning, ECs can operate in multiple different ways. Walker (2011) argues that ECs vary depending on the relationships between its individuals, their location(s) and their type of network, which can be virtual or physical. Hicks and Ison (2018) argue that ECs can take different forms depending on the context and motivations of the region in which they are implemented. Even though traditionally most ECs have been formed to produce and consume energy by and for the local community (Horstink et al., 2020; Walker et al., 2010), they can engage in energy activities beyond production (Caramizaru & Uihlein, 2020) and are not bound to either locality or energy purposes. Moroni et al. (2019) refer to this variation by dividing ECs into place-bound (tied to a certain region) or non-place bound (no regional tie) and single-purpose (only energy purposes) or multi-purpose (multiple reasons of existence). Gui and MacGill (2018) agree that ECs can take part in other activities such as transport, water and waste. Thereby, ECs can take varying forms to produce social, environmental and economic benefits for different types of communities.

Indeed, there is no 'perfect fit' or an optimal type which all ECs should strive to be (van Veelen, 2017). Because the specific regional or local conditions affect the type of ECs which occur, research on their application in different areas should be conducted in relation to each region's specific conditions. After presenting the varying activities ECs can engage in, the next sections introduce their benefits, enablers and barriers to contribute to the analysis of suitable EC types on Kökar.

2.2 Why should ECs be developed?

In a thesis discussing the development of an EC in a new region, the benefits of this should be provided. Without deeper knowledge of ECs, one could argue that they are merely niche level operations by a small number of individuals having a minimal effect on climate change mitigation and community benefits. This section aims to prove the relevance of ECs on an individual and societal level by producing a counterargument to the aforementioned statement.

Individuals could benefit from ECs via energy savings, increased reliability of supply and added control on their energy sources, but also through a sense of sustainability and environmental protection as well as community building and self-realisation (Berka & Creamer, 2018; Brummer, 2018; Walker, 2008). The European Commission believes that providing citizens with more control and access will enable them to improve their quality of life and finances (European Commission, 2019).

On the societal level, ECs have been found to have substantial potential in decreasing the emissions of energy production, increasing renewable energy acceptance, mobilising private capital to renewable energy investments, improving network flexibility, promoting regional economies and establishing innovative practices (Caramizaru & Uihlein, 2020; Celata & Sanna, 2019; McLaren-Loring, 2007; Walker et al., 2010). A local community-owned renewable energy installation enables profits to remain in the local region rather than be transferred to external actors, e.g. multinational energy companies (van der Schoor et al., 2016). This has a positive socio-economic impact on the region and increases local energy autonomy and community resilience (Berka & Creamer, 2018; Celata & Sanna, 2019; Walker, 2008). Additionally, ECs are expected to alleviate energy poverty and thus protect vulnerable citizens (European Commission, 2019). These positive effects were found to be especially prominent in rural regions with high energy costs when the produced energy is consumed within the region (Berka & Creamer, 2018). Thus, the most potential for positive effects from ECs exists in regions similar to Kökar.

Currently, the European energy market is dominated by a few multinational energy companies which can lead to the energy transition becoming problematic and expensive, with the risk of centralisation of renewable energy profits (Hewitt et al., 2019). Hewitt et al. (2019) found that in Scotland an 800 kW EC wind turbine provided the local community with the same amount of direct financial benefits that a private 93.2 MW offshore wind park did. The difference between the share of local benefits is considerable even before the inclusion of social and environmental benefits. Thus, ECs could contribute to the redistribution of assets from private actors to local communities (Hewitt et al., 2019). However, currently, ECs' occurrence is not frequent enough to facilitate a positive change in the adoption of renewable energy (Wirth, 2014). Nevertheless, the EU has estimated that by 2030, ECs could own 17% of the installed wind and 21% of solar capacity in the EU (European Commission, 2019). More optimistic estimates argue that half of EU citizens will produce their own energy by 2050 accounting for 45% of the whole electricity production of EU (Kampman et al., 2016). Hence, ECs are expected to play a major role in the EU's future energy system. Therefore, the counterargument for the statement presented at the beginning of this section would be:

ECs have a variety of benefits attached to them. Individuals can benefit economically through increased profits, socially via increased community engagement and energy democracy, and environmentally by a sense of sustainability and environmental protection. ECs promote the greening and flexibility of energy systems, enables local socio-economic development and increases community resilience. In the future energy transition, they are expected to play a central role in the adoption of renewable energy sources.

2.3 EC development barriers

Currently, ECs have often been considered as niche operations (Dóci et al., 2015). Their diffusion in the energy system is hindered by multiple factors, or barriers of operation (Bomberg & McEwen, 2012; Brummer, 2018; Horstink et al., 2020; Middlemiss & Parrish, 2010; Seyfang et al., 2013; Walker, 2008; Wirth, 2014). In general, these barriers can be divided into internal and external barriers (Seyfang & Smith, 2007). Internal barriers are issues within the community while external barriers refer to the conditions of the environment where the ECs function.

Internal barriers are related to the motivations and capacities of communities and their members. The lack of human resources, both number of members and knowledge, pose a major hindrance. For an EC to function there should be motivation for their implementation in place

(Middlemiss & Parrish, 2010). Currently, ECs are often run by passionate, sustainability-oriented volunteers (Brummer, 2018; Horstink et al., 2020). Therefore, their operations and potential growth are susceptible to the lack of time of these people. Although ECs provide a learning platform for their members, they are often still missing in-house knowledge and are therefore dependent on expert guidance in technical and organisational aspects (Walker, 2008). Moreover, ECs are often quite homogeneous in terms of male-female ratio (Celata & Sanna, 2019; Holstenkamp & Kahla, 2016), country of origin, income and education level (Caramizaru & Uihlein, 2020). Additionally, ECs might lack organisational direction or leadership due to their formation as a community group (Seyfang et al., 2013). Lastly, ECs often function with limited finances as their profits are low or fully invested in communal projects (Brummer, 2018). Hence, many projects have been dependent on external funding such as subsidies and grants (Nolden et al., 2020).

When it comes to external barriers, cultural characteristics, such as whether locals are accustomed to collaboration and sharing, can become an enabler or a barrier for EC development (Middlemiss & Parrish, 2010; Wirth, 2014). Moreover, the current energy market can pose challenges to an EC as they are in a less advantageous position in the energy market, where they have to compete against or work with incumbent market actors (Brummer, 2018; Hewitt et al., 2019). To increase their diffusion, ECs need policies which create a levelled playing field in the energy market (Brummer, 2018). Currently, the number of grants and subsidies are decreasing often leading to ECs becoming similar to their traditional privately-owned competitors (Nolden et al., 2020; Oteman et al., 2014). This transition has implications on ECs, leading to larger entities with increasing profit-creation motivations (Herbes et al., 2017; Holstenkamp & Kahla, 2016), and a potential loss of some of their community spirit (Oteman et al., 2014). Thus, for now, it seems unclear whether ECs can compete with existing actors while keeping their community spirit, and to what extent ECs could be protected from centralisation of their operations (Braunholtz-Speight et al., 2019; Hewitt et al., 2019).

2.4 Disseminating ECs

New actors, legislation and technology provide opportunities to mitigate both internal and external barriers. Internal barriers could be mitigated with new business models and partnerships allowing the ECs' to attract a larger membership base and improve their operations. External barriers are expected to decrease with the implementation of new business models and supporting legislation. With these developments, ECs could fulfil their potential to become increasingly sustainable and significant players on the energy markets.

2.4.1 Increased motivations with new business models

The membership of ECs is currently mostly small, homogeneous and voluntary run (Brummer, 2018; Celata & Sanna, 2019). Simultaneously they are experiencing the diminishment of subsidies on which they have relied for financial sustainability (Herbes et al., 2017; Nolden et al., 2020). A possible remedy for these challenges could be the introduction of new business models to complement the traditional ones. New business models, and the technology and market actors enabling them, could allow ECs to continue to fulfil their purpose while keeping their operations financially sustainable (Mlinarič et al., 2019). Additionally, they could attract an increased number of members to ECs with new value propositions and by offering varying participation models e.g. being a member without any extra effort or responsibilities (Seyfang et al., 2013). A larger, motivated, membership base would reduce the reliance on single members, create a culture of collaboration, and possibly bring more skills, finance, and organisational direction to the ECs.

2.4.2 Partnerships and intermediaries

Partnerships and networks can offer solutions to many of the internal and external challenges. ECs can establish partnerships with private utilities (Eitan et al., 2019), municipalities (Becker & Kunze, 2014), NGOs (van Veelen, 2017) or with other ECs (Herbes et al., 2017). The partnership's idea is to acquire something that is not possible without the partner, e.g. capital, skills or land. To help ECs in partnerships and in general to aid their creation and diffusion, central support organisations for ECs have been formed. These national or regional intermediary organisations, such as Rescoop.eu and Community Energy England, are organisations which provide resources and assistance to ECs facilitating learning between communities, brokering and coordinating partnerships and representing ECs in policy arenas (Bird & Barnes, 2014; Hargreaves et al., 2013; Kivimaa et al., 2019).

2.4.3 Supportive policies

New EC supporting policies have been developed in accordance with the EU Clean energy for all Europeans package. Especially two directives: the Renewable Energy Directive (Directive (EU) 2018/2001 of the European Parliament and of the Council) and the Electricity Market Directive (Directive (EU) 2019/944 of the European Parliament and of the Council) are important since they provide ECs with an enabling framework (the former) and a levelled playing field (the latter) within the EU's energy market (Roberts et al., 2019). Both directives define a type of energy community as a legal entity. These are renewable energy community (REC) in the Renewable Energy Directive and citizen energy community (CEC) in the Electricity Market Directive. Although both directives are similar in their goals and definition, in general, CECs can be viewed as a larger entity including RECs, which have stricter eligibility requirements, e.g. in terms of EC members' locality (Roberts et al., 2019). Both directives have specific requirements on their control rights: CECs require their controlling actors to be small in size and RECs proximity to the energy installation (Lowitzsch et al., 2020; Roberts et al., 2019). The transposition of both directives into national legislation should occur in member states during 2021. In Finland, this work is run by the Ministry of Economic Affairs and Employment, and in Åland both the aforementioned Ministry and the Government of Åland (Airaksinen et al., 2019; Pahkala et al., 2018). The appearance of RECs and CECs in Finland and Åland is expected to happen in 2020-2021. The enabling framework and levelled playing field stipulated by the directives are essential since they will have a significant effect on the emerging EC types. Even historically EC formation has been heavily linked to supportive policies and available organisational forms (Hewitt et al., 2019).

As is evident from the barriers and disseminating factors presented in the literature review, there are multiple factors which can affect EC development and success in a region. These examples have been provided to offer an overview of the situation ECs are currently in. The next section presents a summary of the existing ECs to indicate what types of ECs already exist in the current energy market and how they vary in relation to the six EC characteristics presented in the EC enabling framework.

2.5 ECs in earlier literature

Different EC types have been analysed based on their varying characteristics (Berka & Creamer, 2018; Gui & MacGill, 2018; Roberts et al., 2014), business models (Mlinarič et al., 2019) or regions (Hewitt et al., 2019; van Veelen, 2017). In this section, a summary of ECs from earlier research is presented to gain an understanding of the different existing EC types. Additionally, the identified eight EC's (Table 2-1) were analysed to identify their variation in the six EC characteristics, namely actors, decision-making, financial distribution, engagement, technology and scale, and business model. The results indicated the possible variations of ECs in each characteristic, highlighting the importance of background factors and contributing to the EC characteristic spectrums presented in section 3.2. Moreover, in the discussion section, the results are discussed with the findings from Kökar to provide suggestions for the EC enabling framework and recommendations on EC development for EC developers and policymakers.

Table 2-1. Identified eight EC types.

EC type	Operations	Example
Collective procurement	Individuals group together to collectively purchase renewable energy installations for their individual use. EC lasts only for the bidding process.	1 block off the grid in San Francisco (Cohen, 2010)
Local micro-generation	Community group invests in and manages an energy installation or an energy efficiency measure for community buildings.	Abriachan Village Hall in Scotland (van Veelen, 2017)
Heating and biogas	ECs operate a heat/biogas unit producing heat/biogas for the local community, using local resources. Can operate in a district network system or individual buildings.	Samsø (Jørgensen et al., 2007), South Tirol (Wirth, 2014)
Development trusts	Community-led groups consisting of community members and business associates aiming to improve the autonomy and quality of life within a region by e.g. producing local renewable energy.	North Harris Trust in Scotland (North Harris Trust, n.d.; van Veelen, 2017)
Cooperatives	Organisations where individuals can buy ownership shares in the cooperative, which owns e.g. a renewable energy installation.	Middelgrunden wind park in Denmark, (Roberts et al., 2014)
Partnerships	Actors, e.g. communities, public institutions and/or private organisations, develop a joint project. Partners can provide each other with technical knowledge, social acceptance, finance, operational support, land, or employment.	Maranchón wind park in Spain (Eitan et al., 2019), Upper Palantine wind park in Germany (Roberts et al., 2014)
Local government-led project with citizen participation	Municipality creates a project (e.g. renewable energy installation) and consequently offers the public shares.	Vosges et Bas-Rhin wind park in France (Hewitt et al., 2019)
Municipal Energy Company (MEC)	MECs act on behalf of the citizens to provide energy services within their region of influence.	Samsø (Jørgensen et al., 2007)

Source: Adapted from Adu-Kankam & Camarinha-Matos (2019); Bauwens (2016); Becker & Kunze (2014); Berka & Creamer (2018); Braunholtz-Speight et al. (2019); Brinker & Satchwell (2019); Brown et al. (2019); Eitan et al. (2019); Hall & Roelich (2016); Herbes et al. (2017); Hewitt et al. (2019); Huijben & Verbong (2013); Interreg Europe (2018); Jørgensen et al. (2007); Klein & Coffey (2016); Nolden et al. (2020); Roberts et al. (2014); van der Horst (2008); van Veelen (2017); Walker (2008), (2011); Walker & Devine-Wright (2008).

This section takes the identified ECs and presents them in each of the six EC characteristics. The eight EC types assessed in this section are generalisations and do not represent any individual EC, even though Table 2-1 provides examples to illustrate different EC types in practice.

2.5.1 Actors

According to Hicks and Ison (2018), actors are the members of ECs. They can be local or non-local individuals, communities, businesses, or organisations depending on the background factors. The actors characteristic was found to correlate with the decision-making and financial distribution characteristics.

Collective procurement and local microgeneration emphasise the role of local individuals. For instance, in collective procurement after the investment decision, each renewable energy installation is owned by each individual separately (Huijben & Verbong, 2013; Klein & Coffey, 2016). Although these groups can be formed individually, under an external organisation or municipalities, the end result is an installation managed by individuals (Ruggiero et al., 2015). Local microgeneration ECs are more collective, often initiated and managed by the local community association (Berka & Creamer, 2018; van Veelen, 2017).

Many EC types involve a larger group of local individuals, organisations, governments, and businesses. For example, heating or biogas ECs often require a variety of actors to provide fuel resources or to operate the installation. These installations can be managed by a citizen-group, local utility or private entrepreneurs (Jørgensen et al., 2007; Pöyry Management Consulting Oy, 2017). Development trusts are community-led groups consisting mainly of community members but accept business associates to join as well.

The involvement of non-local actors, such as energy companies or financial institutions, can enable ECs to reach higher potential with assistance in e.g. technical and financial aspects, but often coming with a price of losing authority within the EC. For instance, cooperatives allow both local and non-local individuals to buy ownership shares in the EC, which owns a renewable energy installation (Herbes et al., 2017; Roberts et al., 2014; Walker, 2008). Cooperatives can vary in their restrictions towards members, some requiring geographical proximity (Horstink et al., 2020). It should be noted that other EC types, such as heating, or biogas ECs may take the organisational form of a cooperative. Partnerships are organisations where communities, private actors and governments can in various forms pool their resources (Eitan et al., 2019; Roberts et al., 2014). They might include a variety of actors depending on the chosen organisation structure and the actors' relative power, assets, and skills. In general, allowing non-local membership enables ECs to improve or scale up their operations, but can threaten their local community direction. For instance, if private organisations are included, the installation might become larger than the community would wish for due to the private company's profit maximisation motivations.

Furthermore, ECs can be established without the direct influence of an individual citizen and managed by the local government or a private organisation. ECs in this category are local government-led projects with citizen participation and municipal energy companies (MECs). MECs can establish a partnership with another MEC or a private company to pool resources and knowledge to enable the development of a project which was not possible individually. Similarly, should the local community lack resources a private organisation can own and manage an energy installation on behalf of the EC via a partnership (Eitan et al., 2019). While these types of partnerships are often seen as a method to maximise efficiencies and the inclusion of local resources and community, they might have challenges in realising the participatory potential of ECs (Hewitt et al., 2019).

2.5.2 Decision-making

Decision-making represents the distribution of voting power within an EC (Hicks & Ison, 2018). It can range from a democratic voting system where all members have one vote regardless of their investment amount, all the way to a monopoly system where one actor has all votes.

Many of the EC types have a democratic voting system where all members who join the ECs have one vote irrespective of their investment amount. These ECs, such as local micro-generation, development trusts and cooperatives, are often governed by an elected board which are voted by the members and make decisions on their behalf (Horstink et al., 2020; Roberts et al., 2014; van Veelen, 2017). However, these structures might not appeal to external investors looking for decision-making power based on their investment share. Therefore, partnerships have been emerging especially within German wind power installations (Roberts et al., 2014). In these partnerships, members' votes are defined based on the values of their investments, leading to an increased number of installations but on the expense of granting authority to non-local actors.

Heating and biogas ECs are often constructed around a group of natural resource owners, e.g. wood and manure, entrepreneurs or MECs (Jørgensen et al., 2007; Pöyry Management Consulting Oy, 2017). Thus, decision-making varies depending on the owner(s) of the installations.

Additionally, decisions can be solely taken by one actor, such as an individual, government, or a private company. In collective procurement, each member decides on whether to be a part of the collective purchasing scheme and what to do with the renewable energy installation afterwards. MECs are run by public officials, but locals can influence their decisions indirectly through municipal elections. In some partnerships between private companies and communities, private organisations can own the facility and have full decision-making authority (Eitan et al., 2019).

2.5.3 Financial distribution

Financial distribution refers to the profit-sharing practices between the EC's actors (Hicks & Ison, 2018). Within an EC, profits can be distributed solely for the local community via a communal benefit fund, or to local or non-local investors, i.e. individuals, organisations, governments, and businesses. Distribution of profits is important for ECs as research has shown that perceived unfair distribution might jeopardise their long-term sustainability (Abada et al., 2020).

ECs which attribute the majority or all of their financial profits for the local community are often geared for that purpose. For instance, development trusts are constructed to improve the autonomy and quality of life within a region and therefore the generated profits are invested fully back in the trust to develop the local community (van Veelen, 2017). In local micro-generation the accrued profits are small and invested back in the projects themselves.

In some ECs, such as collective procurement and cooperatives, profits are channelled to individual members instead of the local community, increasing local wealth instead of communal wealth. However, Li et al. (2013) argue that these benefits flow to the local economy, via a flow-on effect, when investors spend their earning in local products and services. Same results occur from heating or gas ECs where the installations are owned by producers of raw material, be it an entrepreneur or a citizen group.

When ECs are larger entities, as is often the case with private organisation partnerships and MECs, financial benefits can remain within the partnering organisations or be directly or indirectly channelled to the local community via donations, dividends, investments or flow-on effect. In partnerships, financial distribution often depends on the chosen organisation form and the relative negotiation power, assets, and skills of each actor.

2.5.4 Community engagement

Community engagement refers to the variation and frequency of engagement methods between the EC developers and the community (Hicks & Ison, 2018). Methods of engagement are e.g. channels such as newspapers, social media, tv or radio. Depending on the EC, community engagement can use multiple methods of engagement with high frequency or settle for communication only during key times with limited methods.

Patterns on community engagement were difficult to find as they are not often presented in research, they vary even between similar ECs, and they do not correlate with any other characteristics. One could argue that ECs with local individuals would communicate more often, or that ECs with more members would find it difficult to communicate frequently. However, no explicit results were found to prove these claims. Therefore, community engagement seems to be a modifiable EC characteristic, meaning it can be adjusted to suit the other EC characteristics. These findings are further investigated with the case of Kökar.

2.5.5 Technology and scale

Technology and scale characteristic represents the size of the project in relation to the energy demands of the community and the chosen technologies (Hicks & Ison, 2018). The chosen scale can vary depending on the EC, meeting partly or fully the EC demand or maximising economic output and exporting energy with a larger installation.

ECs meeting partly the local demand are often small-scale and can be considered energy efficiency measures. For instance, in collective procurement and local microgeneration, the renewable energy installation produces energy to cover a part of the households or communal buildings energy needs, thus decreasing the need for imported electricity (Berka & Creamer, 2018; Ruggiero, 2018).

To cover full demand of the EC, larger installations are often needed. These solutions might be beneficial for rural regions with a lack of network infrastructure. For example, heating and gas ECs can be constructed to provide heating for the whole community using locally sourced resources such as wood chips, manure, or pellets, often lowering energy prices and enabling the community to become more self-sufficient (Roberts et al., 2014). With electricity ECs, development trusts are often aimed to develop the local region by producing renewable energy to meet local demand and even to gain profits from energy exports (van Veelen, 2017).

ECs aiming to benefit from energy-exporting profits, such as large-scale cooperatives, partnerships and MECs, are engaged in large-scale renewable energy, often electricity, installations (Berka & Creamer, 2018; Brinker & Satchwell, 2019; Eitan et al., 2019; Roberts et al., 2014). From these installations, energy may be transported directly to the national grid or used in the community or regionally first, with the surplus exported to the grid. Generally, projects with more significant private organisation involvement aim to maximise economic efficiencies with larger installations and export profits (Hicks & Ison, 2018). Thus, these ECs are often focusing on financial benefits rather than powering the community.

ECs can utilise varying technologies to produce energy. Electricity production occurs most often with solar or wind power, followed by hydro, biomass and biogas (Berka & Creamer, 2018; Horstink et al., 2020; Roberts et al., 2014; van Veelen, 2017). In heating, ECs use locally sourced natural resources such as biomass, wood chips and pellets, while biogas ECs utilise farm waste, such as manure, and possibly local biowaste (Airaksinen et al., 2019; Jørgensen et al., 2007; Pöyry Management Consulting Oy, 2017; Roberts et al., 2014). Additionally, new technologies have provided ECs with opportunities to complement their current strategies. These new technologies are discussed next.

2.5.6 Business model

Business model is a process of how a business utilises its assets to create value (Bocken et al., 2014; Teece, 2010). In sustainable business models, this value is economic, social, and environmental (Bocken et al., 2014) – value characteristics which ECs fulfil. As section 2.2 outlined the main environmental and social benefits of ECs, which apply to all of the business models, this section focuses on describing the financial sustainability of different business models. In the EC enabling framework business models are categorised based on their relationship with the current energy system following Gui and MacGill (2018). With this distinction, ECs business models can be centralised, distributed, or decentralised. Within these business models, ECs can engage in multiple activities simultaneously.

Centralised business models

Centralised business models are inclined towards traditional EC activities, i.e. energy production, sales and efficiency measures. These business models function well in the current energy system and are used by most of the current ECs described above (Berka & Creamer, 2018; Horstink et al., 2020; van Veelen, 2017). Depending on the size of the renewable energy installation and its activities, the EC can produce energy for exporting purposes, for sale in the local community and for self-consumption within the EC (Caramizaru & Uihlein, 2020). The replacement of purchased energy with self-produced energy allows centralised ECs to generate financial benefits from e.g. avoided distribution costs and taxes (Airaksinen et al., 2019; Wiktor-Sułkowska, 2018). However, often these business models, e.g. in the case of local micro-generation or development trusts, have benefited from supportive governmental subsidies, such as feed-in tariffs and grants (Herbes et al., 2017; Nolden et al., 2020) which have allowed them to maintain profitability. With the removal of policy support (Nolden et al., 2020) these ECs might become financially unsustainable. Additionally, they have often been volunteer-run and not able to gain a sustainable membership base (Brummer, 2018; Walker et al., 2010).

To combat these challenges researchers have suggested that ECs could increasingly partner with external organisations and other ECs (Braunholtz-Speight et al., 2019) or to a larger extent rely on the assistance of intermediaries (Nolden et al., 2020). Some ECs have been diversifying their operations with other activities such as owning a distribution network and acting as a small-scale distributor of electricity or heat (Yildiz et al., 2015), by providing various energy services e.g. auditing, consulting, monitoring and management (Caramizaru & Uihlein, 2020) or by relying on new technological advancements in e.g. energy storage and e-mobility (Brown et al., 2019; Koirala et al., 2019; Mlinarič et al., 2019). Community energy storage is an energy carrier owned by an EC, e.g. water heaters, electric vehicles (EVs) or batteries, used to store electricity. This electricity can thereafter be consumed within the EC to reduce the need to purchase electricity or to engage in new business opportunities such as demand-response (Brown et al., 2019; Mlinarič et al., 2019). Demand-response balances the common grid by shifting the ECs energy consumption from peak hours to times of low demand in exchange for financial compensation (Koirala et al., 2019). E-mobility refers to the additional services ECs can provide in the field of transport e.g. offering EV users charging points using the ECs renewable energy (Brown et al., 2019). In more complex applications, a vehicle-to-grid solution could offer EV batteries as energy storage for the network. Additional value could be provided via a mixed-mobility service, where members pay for a membership which allows them to use EC owned EVs and bicycles, also providing access to bus services (Braunholtz-Speight et al., 2019).

Complementing centralised business models, distributed and decentralised EC business models could, with the help of new technology and actors, maintain ECs' financial sustainability and provide value for an increasing number of EC members (Mlinarič et al., 2019).

Distributed business models

In distributed business models, ECs can be formed from the energy resources of existing ECs and/or prosumers, which are connected via a virtual or physical entity. Prosumers are consumers who self-produce a share of their energy (van der Schoor & Scholtens, 2015). Thus, using the distributed business models does not prohibit the utilisation of centralised business model activities, e.g. energy production and consumption, but rather enables the EC to capitalise on novel opportunities, such as demand-response. The controlling entities can be physical, e.g.

wind power plants, or virtual, e.g. virtual power plants (VPP). VPPs are ICT-systems which aggregate the decentralised energy production, consumption and storage of prosumers and ECs to function as one large power plant (Gui & MacGill, 2018; IRENA, 2019; Koirala et al., 2016; van Summeren & Wieczorek, 2018). Aggregators are market actors who manage the VPPs. They can be e.g. third-party actors, current electricity traders or even ECs (Airaksinen et al., 2019; van Summeren & Wieczorek, 2018). By bundling energy resources, VPPs can sell electricity or ancillary services, such as demand-response, in the electricity exchange, the wholesale markets or to electricity system operators (IRENA, 2019). Additionally, VPPs can act as a platform for peer-to-peer (P2P) trading between prosumers or EC members, usually below market price (Adu-Kankam & Camarinha-Matos, 2019; Gui & MacGill, 2018; Hall & Roelich, 2016). In early examples, P2P trading has decreased individual energy costs by up to 40-60% (Adu-Kankam & Camarinha-Matos, 2019). VPPs and P2P trading can improve energy market efficiency, increase the production and use of local renewable energy and provide individuals with access to energy markets and additional income or cost savings (IRENA, 2019; Koirala et al., 2016; Mlinarič et al., 2019). With EU legislation both VPPs and P2P trading will become available in EU member states within the coming years (Directive (EU) 2018/2001 of the European Parliament and of the Council, Art. 2 para.18, Art. 21 para. 2a; Directive (EU) 2019/944 of the European Parliament and of the Council, Art. 2 para. 18-19).

Decentralised business models

Decentralised business models are the most disruptive for the current energy system allowing ECs to own and operate an energy network through a microgrid. Community microgrids are locally controlled clusters of decentralised energy installations which can operate within the main grid and if necessary, detach from it to off-grid mode (Koirala et al., 2016). Thus, off-grid ECs are self-sufficient in energy. Within a microgrid, ECs can still engage in centralised and distributed business model activities. A microgrid allows ECs to increase the share of locally produced renewable energy, utilise energy storage and demand-response for additional income, increase network efficiencies and decrease losses when costly network investments are avoided (Adu-Kankam & Camarinha-Matos, 2019; Gui & MacGill, 2018; Koirala et al., 2016). These efforts have been argued to lead to lower energy prices, increased community self-sufficiency, and improvement of vital back-up services for critical infrastructure in remote areas (Adu-Kankam & Camarinha-Matos, 2019). Microgrids can be owned by individual customers with the necessary capital (e.g. universities, and industrial actors), multi-stakeholder collaborations (e.g. public and private institutions, utilities and customers together), or utilities (when utilities base their business model around microgrids) (Vanadzina et al., 2019). In regions where it is socially and economically feasible, usually remote areas, community ECs could own and operate the microgrid (Caramizaru & Uihlein, 2020). This is enabled in the EU's Electricity Market Directive (Directive (EU) 2019/944 of the European Parliament and of the Council, Art. 16 para. 4)

An even more integrated solution would see the combination of energy systems with other cycles in the society, such as water and waste (Gui & MacGill, 2018). These Integrated Energy Systems (ICE) are an aggregation of different technologies to enable the development of an integrated, efficient and sustainable society (Koirala et al., 2016). This thesis focused on energy and therefore ICEs were outside of its scope.

Heat and biogas ECs can be categorised as centralised or decentralised business models. Centralised heat and gas ECs, i.e. district heating or biogas utilise the existing network to supply their heat or gas into (Airaksinen et al., 2019; Roberts et al., 2014). Decentralised heat and biogas ECs usually supply heat and biogas for their own use or to a small number of buildings (Airaksinen et al., 2019; Pöyry Management Consulting Oy, 2017). However, heat and biogas

ECs are often not as successful as electricity ECs due to the poor transferability, profitability challenges and infrastructure needs (Airaksinen et al., 2019).

This section has answered the first research question. Based on earlier research, eight types of EC were identified and analysed in the six EC characteristics. Although, the example ECs were mostly from North-Western Europe, different values were found for most of the EC characteristics, indicating the variation possibilities of these characteristics. It is reasonable to argue that these differences stem from the varying background factors as stated by e.g. Hicks and Ison (2018). Therefore, background factors study is expected to have implications on the EC characteristics on Kökar. Furthermore, while the bulk of ECs still operate in energy generation, supply and consumption activities (Horstink et al., 2020), the emergence of new technical business models and actors provide ECs with new opportunities through activity diversification. In the changing environment surrounding ECs, further studies have a place in maintaining the research field in the same pace.

2.6 Current knowledge and the novelty of this thesis

Although ECs are attributed to having multiple benefits both for individuals and society, they face both internal and external barriers. However, with the emergence of new technology, partnerships and policy support these challenges could be overcome. As a result of these trends and the energy transition behind them, ECs are expected to have an important role in the EU's future energy system. This requires EC development in countries outside the traditionally most prominent EC countries of North-Western Europe. So far, studies on these regions have been limited. ECs are context-dependent structures, and their characteristics are influenced by the present background factors in the region. For instance, the eight identified EC types showcase the differences ECs can take depending on the reigning circumstances in the fairly homogeneous region of North-Western Europe. Thus, a case study is required to analyse EC development with an adequate depth to identify suitable EC types in new regions. This thesis contributes to this body of literature by conducting a case study on the island of Kökar on Åland, Finland. It analyses suitable EC types on Kökar and based on the results suggests adjustments for an improved EC development process and recommendations for EC developers and policymakers on EC development. To reach these results, a developed EC enabling framework was utilised. This framework, along with its two components (background factors and EC characteristics), is presented next.

3 Theoretical model – presenting the EC enabling framework

This section presents the EC enabling framework, the research behind it and how it was utilised in the analysis. The EC enabling framework is based largely on concepts by Hicks and Ison (2018), augmented with Gui and MacGill (2018). The framework (Figure 3-1) was utilised to find suitable EC characteristics for Kökar and to analyse the framework's suitability in EC development. It follows a consistent approach beginning from the background factors on Kökar which affect the EC characteristics on the island. Thereafter, the six EC characteristics, namely actors, decision-making, financial distribution, engagement, technology and scale, and business model, are analysed in their respective variable spectrums in relation to the identified background factors. Based on the results on Kökar, improvement suggestions for the EC enabling framework and recommendations for EC developers and policymakers on Kökar and similar regions can be made. The following sub-sections present the frameworks two levels, background factors and EC characteristics, and their utilisation on the case of Kökar.

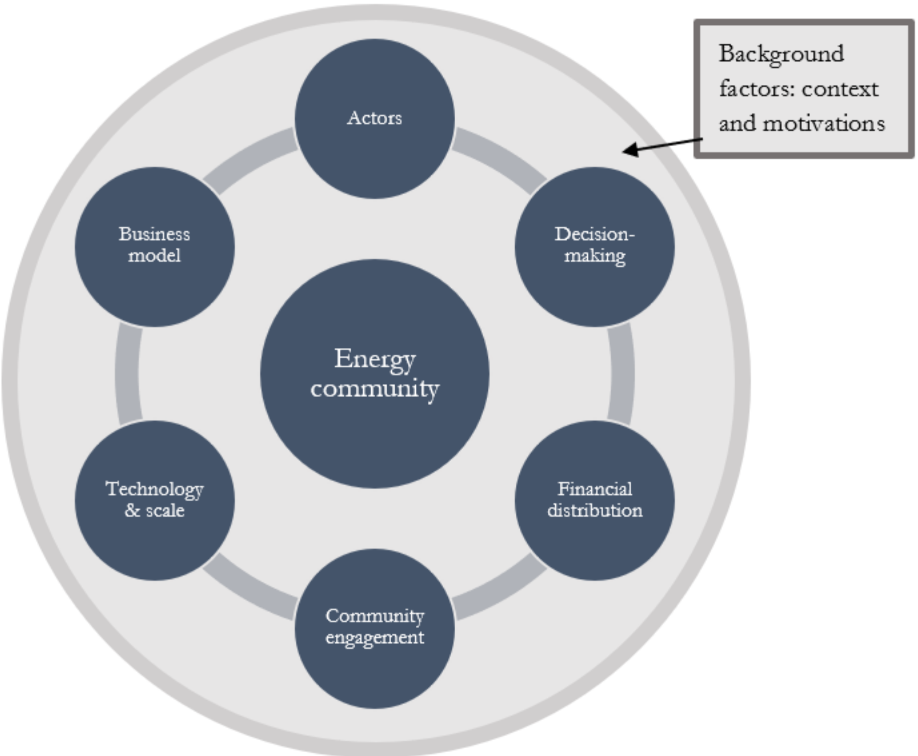

Figure 3-1. EC enabling framework.

Source: Adapted from Hicks & Ison (2018) and Gui & MacGill (2018).

3.1 Background factors

Hicks & Ison (2018) studied existing literature to present motivations and contextual factors which affect the way EC characteristics are formed within a region. According to their findings, ECs are developed to reflect the existing motivations and context (Table 3-1). Motivation represents the reasons why members would join an EC, and context refers to the environment for EC development (Hicks & Ison, 2018).

Table 3-1. EC enabling framework's background factors.

Motivation	Economic, e.g. community income Environmental, e.g. local environmental benefits Social, e.g. local ownership and decision-making Technological, e.g. energy security and self-sufficiency Political, e.g. political mobilisation
Context	Physical: Topography, energy infrastructure and renewable energy resources. Technology: Cost and maturity of technology. Energy demand and profile of the community. Institutional: Structure of energy market, culture between institutions and regulatory environment. Communal: History, culture, social capital, skills and knowledge in the region.

Source: Adapted from Hicks & Ison (2018).

In this thesis motivations and contexts were grouped together as background factors. The idea was not to do an in-depth analysis of them, but they played an important role in guiding the data collection structure, eventually leading to the identification of suitable EC characteristics on Kökar.

3.2 EC characteristics

The inner circle of the EC enabling framework include EC characteristics, adapted from Hicks and Ison (2018) and Gui and MacGill (2018). As was evident with existing EC types, these six characteristics, namely actors, decision-making, financial distribution, engagement, technology and scale, and business model, can vary depending on the present background factors. Therefore, to analyse suitable EC characteristics for Kökar a spectrum of variables was utilised, adapted from Hicks and Ison (2018). In it, each characteristic could vary within a spectrum which consists of different variables, described in figures 3.2-3.7 below.

Actors are the members of ECs. The types of actors in an EC have implications on the other EC characteristics, especially decision-making and financial distribution. On the spectrum five variables are presented in which ECs can vary, ranging from ECs run by local individuals to ECs managed by non-local organisations, business & government actors (Figure 3-2). Local refers to within Kökar, while non-local is outside of Kökar.

Figure 3-2. Actors spectrum.

Source: Adapted from Hicks & Ison (2018).

Decision-making presents the distribution of voting power within an EC. These can range from 'one vote per actor' to 'one actor has all votes' (Figure 3-3).

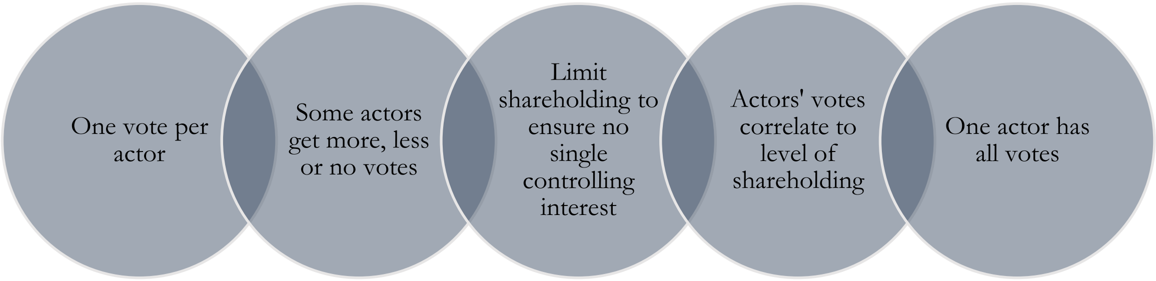

Figure 3-3. Decision-making spectrum.

Source: Adapted from on Hicks and Ison (2018).

Financial distribution refers to the partition of profits between actors. In one end of the spectrum, profits are distributed to a community fund, while the other end sees the profits distributed to non-local investors, with surplus leaving local and possibly national economies (Figure 3-4).

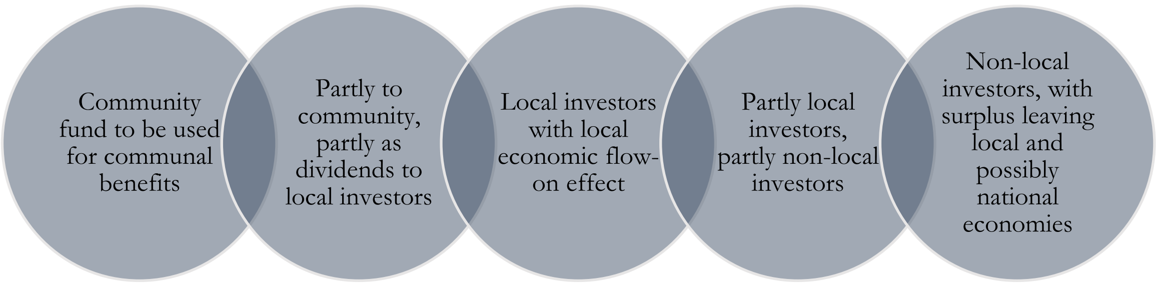

Figure 3-4. Financial distribution spectrum.

Source: Adapted from Hicks & Ison (2018).

Community engagement refers to the variation of engagement methods and the frequency of communication with the community. Community engagement can range from occurring often via multiple methods to occurring rarely and using very limited methods (Figure 3-5).

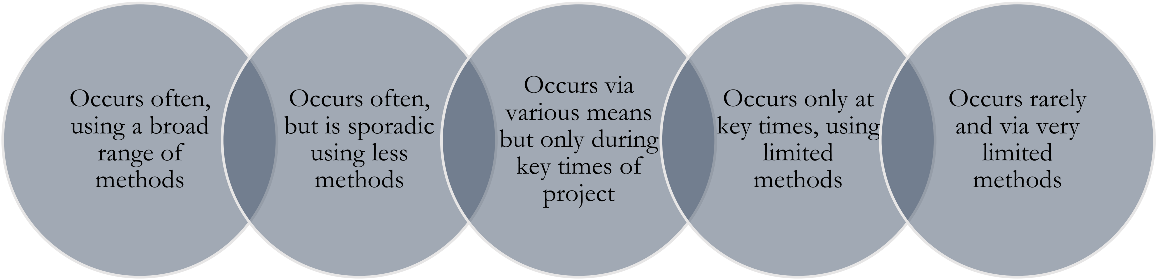

Figure 3-5. Community engagement spectrum.

Source: Adapted from Hicks & Ison (2018).

Technology & scale present the size of the project in relation to the energy demands of the community. The choice of technology is not presented in the spectrum but has implications on the scale, e.g. the number of installations needed for the EC's needs. Scale can vary from meeting a part of the ECs demand, to maximising economic efficiencies and energy export (Figure 3-6).

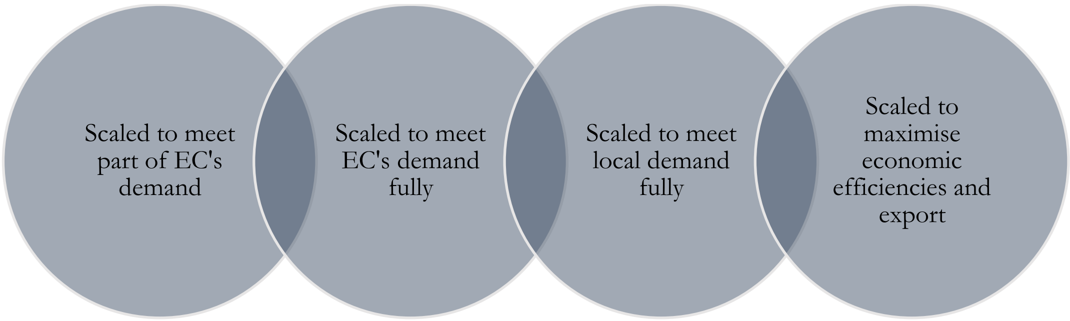

Figure 3-6. Scale spectrum.

Source: Adapted from Hicks & Ison (2018).

Business model spectrum introduces the chosen EC business model and its relationship with the current energy system. ECs can engage in centralised, distributed, or decentralised business models (Figure 3-7). However, they can undertake activities from many business models simultaneously.

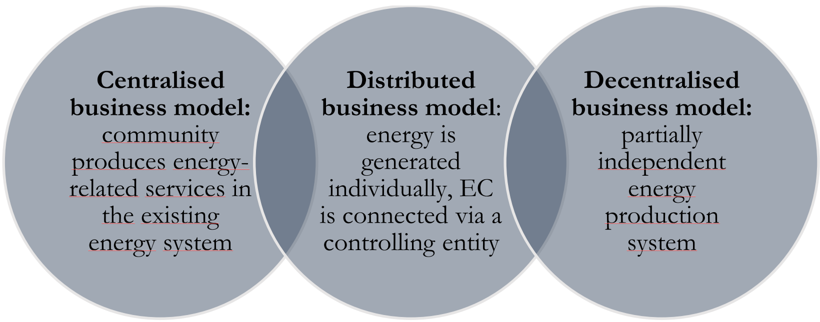

Figure 3-7. Business model spectrum.

Source: Adapted from Gui & MacGill (2018).

The different spectrum variables are not superior to others. As stated in section 2.1. ECs have a flexible definition rather focusing on what they do than on what they should be. Having a flexible definition is beneficial since it allows communities to tailor the EC characteristics for their needs based on the existing background factors. For instance, ECs can vary depending on the available resources, e.g. a windy region is more likely to implement wind power technology and a forest-covered cold region could develop a district heating plant using biomass. Taking the background factors into consideration and reflecting them to the EC characteristic spectrums could ensure a suitable EC for all involved stakeholders. This is what the EC enabling framework aimed to achieve on Kökar.

3.3 EC enabling framework, research questions and study propositions

Now that the EC enabling framework has been presented, the next step is to clarify its connection to the research questions. To guide this process, study propositions were developed. Study propositions are hypothetical descriptions of how events are expected to pass (Blaikie & Priest, 2019). Therefore, the EC enabling framework can be presented as a hypothetical description of how ECs development could function, and this is tested in the case of Kökar. The obtained results indicate the implications for future EC development e.g. whether certain aspects in the framework should be adjusted. The functionality of the study propositions is evaluated in the discussion section.

RQ1: What types of ECs are identified in earlier literature? Section 3.1 answered this research question by presenting eight existing EC types and their variations in the six EC characteristics. The section did not only present the current situation on the EC market but also indicated how they can vary between regions based on the background factors. This information is further utilised in the analysis of suitable EC types on Kökar and the discussion section.

RQ2: What types of ECs could be developed on Kökar? Using the EC enabling framework the background factors on Kökar were analysed and used to identify the suitable EC characteristics on Kökar. The obtained results would point out the suitable EC types on Kökar, and either confirm or challenge the findings from the first research questions, i.e. whether background factors affect EC development. The relevance of background factors in EC development was thus placed as the first study proposition (Table 3-2).

RQ3: What suggestions can be provided for EC development frameworks based on the findings from Kökar? RQ4: What recommendations can be given for EC developers and policymakers in EC development based on the findings from Kökar? Based on the findings from Kökar, implications on the functionality of the EC enabling framework in EC development was discussed. The second and third study propositions are related to this topic (Table 3-2). Furthermore, recommendations on EC development were provided for EC developers and policymakers on Kökar and in similar regions aiming to enable EC development.

Table 3-2. Study propositions.

Theme	Findings from earlier research (Gui & MacGill, 2018; Hicks & Ison, 2018)	Study proposition
Background factors	EC development is affected by background factors, i.e. context and motivations.	Kökar possesses background factors which affect EC development on the island.
EC characteristics	ECs characteristics are divided into six categories: actors, decision-making, financial distribution, community engagement, technology & scale, business model, each of which can be implemented in varying ways.	ECs are likely to differ on these six characteristics and no other characteristic should be found.
EC enabling framework	The background factors affect the varying EC characteristics. Together these two can act as a basis for EC development in new regions.	The EC enabling framework should provide indicate what EC types and how would be the most suitable for Kökar.

Source: Adapted from Hicks & Ison (2018) and Gui & MacGill (2018).

The literature review presented the state of the current knowledge on ECs and highlighted the need for further research in EC development in regions without existing EC culture to fulfil ECs' potential. This section presented the EC enabling framework which was utilised to analyse suitable ECs on Kökar and contribute to the field of EC development. Next, the employed methodology is presented, especially emphasising case study research design and data collection and analysis methods.

4 Methodology

An explanatory single case study is conducted on Kökar to analyse suitable EC characteristics on the island utilising the EC enabling framework. This section presents, explains, and justifies the reasoning for the choices made on methodology and methods.

4.1 Case study research design

Yin (2018) describes case study as an empirical method which "…investigates a contemporary phenomenon (the "case") in depth and within its real-world context…", and where there are "…many more variables of interest than data points" (Yin, 2018, p. 15). In the case of Kökar, an in-depth real-life case study is required due to the proven variations of ECs depending on the existing background factors. Due to the need to conduct an in-depth case study the analysis has more variables of interest, e.g. perceptions from different stakeholders, than data points, i.e. cases.

Moreover, Yin (2018) argues that case study research is a relevant research method when three characteristics are fulfilled. First, case studies are relevant for answering 'how' and 'why' research questions, since they are better in uncovering hidden characteristics such as perceptions or personal motivations. Secondly, case studies encourage participants to speak freely and encourage an actual real-life scenario, rather being a scientist controlled experiment. Thirdly, case studies should focus on contemporary events, on aspects which are currently high on the discussion agenda.

This thesis has placed more focus on 'how' than 'why' questions, indicating that it is more leaning towards intervening and bringing about change than explaining underlying reasons for an event (Blaikie & Priest, 2019). Although all of the research questions are 'what' questions, they are designed to fulfil the aim of the thesis, i.e. to contribute to the energy transition ambitions of Kökar and EC development in new regions. Thus, the intention is to provide knowledge which could lead to a change, i.e. EC development, as advocated by (Verschuren & Doorewaard, 2010). 'What' questions were chosen simply because they clearly communicate the knowledge the thesis produces to accomplish this aim. As for the second point, to obtain a neutral image of the background factors influencing the possible EC development on Kökar, focus group members, interview respondents and survey participants were encouraged to speak freely to obtain a real-life scenario. Lastly, ECs are currently high on the research and political agenda, especially in the EU (Airaksinen et al., 2019; Caramizaru & Uihlein, 2020; European Commission, 2019; van der Grijp et al., 2019). Based on these justifications, a case study was reasonable for fulfilling the aim of the thesis.

4.1.1 A single embedded explanatory case study

A single embedded explanatory case study was conducted on Kökar. The following sub-sections present these different case study qualities and how they affect the research process.

Critical case

With its involvement in the Smart Energy Åland project, Clean energy for EU islands initiative and local enthusiasm on sustainability, Kökar is arguably the best-suited islands for ECs in Åland and Finland, and thus a suitable candidate for a critical case. Flyvbjerg (2006) characterizes a critical case to apply in situations where "If it is valid for this case, it is valid for all (or many) cases." (p. 230). A critical case can be conducted when an existing theory has presented the circumstances under which its propositions are believed to be true (Yin, 2018). Therefore, the study propositions presented in section 3.3 were tested in a single case study to assess the functionality of the EC enabling framework in guiding EC development in a new region. These findings would assist EC development in other similar regions, e.g. in Åland and Finland.

Embedded case

Embedded case study refers to a study where multiple groups are identified and studied within the case (Yin, 2018). In the case of Kökar, this means that both local and non-local individuals, businesses, governmental actors were studied to gain insights from a variety of stakeholder groups. While accessing information from multiple sources is important, the collected data still has to be based on the case itself, not the opinions of a single group, i.e. the thesis analysed the suitability of ECs on Kökar based on all collected data, not just at what the citizens of Kökar mentioned.

Explanatory case

There are multiple different types of case studies, which is often determined from the research aim and the chosen research questions (Blaikie & Priest, 2019; Yin, 2018). This thesis was conducted as an explanatory case study. Explanation aims to identify the mechanisms and elements which cause a regularity in a social phenomenon (Blaikie & Priest, 2019). In accordance with the EC enabling framework, an explanation was sought for how the background factors affected the EC characteristics in the case of Kökar. However, to develop an explanation, an exploration, i.e. developing an understanding of a social phenomenon (Blaikie & Priest, 2019), was needed. Therefore, an exploration of existing EC types from earlier research was performed in section 2.5 to answer the first research question.

4.2 Scientific approach

The first research question focused on exploring existing ECs and their characteristics. Therefore, it incorporated an inductive logic of inquiry where data is collected based on concepts and theories from earlier research (Blaikie & Priest, 2019). Thereafter, in the explanatory phase of the thesis, retroductive logic of inquiry was used. Its aim is similar to an explanatory case study, as it aims to discover observed regularities which are constructed from context and mechanisms (Blaikie & Priest, 2019), i.e. that the EC enabling framework can be utilised for EC development on Kökar.

The ontological and epistemological assumptions included in the chosen logics of inquiry have implications on the thesis process. According to the ontological assumption of subtle realist, there is an objective reality which exists independently of social scientists, and which everyone can solely observe from their perspective of it (Blaikie & Priest, 2019; Sovacool et al., 2018). Hence, when conducting research, the author had to acknowledge and transparently communicate that the findings are created from his point of view. Subtle realist ontological assumptions are often paired with the epistemological assumption of constructionism which assumes that knowledge is created when the researcher interprets the meanings and actions of subjects when interacting with the real world and its social actors (Blaikie & Priest, 2019). Indeed, conducting a case study on EC types on Kökar required the author to partly discover the answer from the "inside", through interactions with different stakeholders. These ontological and epistemological assumptions fit the proposed research questions, are applicable for case studies and qualitative data collection and analysis methods presented next (Blaikie & Priest, 2019; Sovacool et al., 2018; Yin, 2018).

4.3 Data collection and analysis methods

For data collection and analysis, mixed methods were found to be the best methods to answer the research questions as they are often paired with case study research and are suitable to acquire both response quantity (number of respondents) and quality (explanation). Multiple data collection and analysis sources were utilised to mitigate the risk of decreased research validity.

4.3.1 Literature review

To acquire a sense of the current state of academic research on EC development and to explore existing EC types, a literature review on academic sources and grey literature was conducted. The literature review aimed to create a context for the thesis research by describing ECs, their development and current and future expected role in the energy system. Thus, it contributed to the identification of a knowledge gap for the thesis research. A synthesis matrix was constructed to gather and analyse data succinctly and efficiently (Table 4-1).

Table 4-1. Literature review synthesis matrix.

Theme/Article	Article 1	Article 2	Article 3	Article 4	Article 5… etc.
What are ECs?					
Benefits					
Enablers					
Barriers					
Typologies					
EC business models					

Source: Author's own illustration.

To identify relevant literature, initially the reference lists of articles suggested by the supervisor were investigated (Mlinarič et al., 2019; van der Grijp et al., 2019). Afterwards, a keyword search was completed from five academic databases (Scopus, ScienceDirect, Web of Science, Ebsco host, Google Scholar), followed by a general search from Google search engine to identify potentially missed details. Keywords used were 'energy communities', 'community energy', 'grassroots energy' or 'local energy' with and without 'business model' to grasp the different EC types and business models. An extensive list can be found from Appendix A. The search was continued until no new articles were discovered (saturation). As a part of the literature review, data on existing EC types was collected to discover their current state. As a result, eight EC types were identified and their variation in the six EC characteristics was analysed in an excel matrix (Table 4-2). This analysis was presented in section 2.5.

Table 4-2. Existing ECs matrix.

EC characteristic	Collective procurement	Local microgeneration	Heat and biogas	Cooperative	Partnership	Development trust	Government-led project with citizen involvement	Municipal energy company
Actors								
Decision-making								
Financial distribution								
Community engagement								
Technology and scale								
Business model								

Source: Author's own illustration

4.3.2 Background factors on Kökar

After the literature review, data was collected to analyse the background factors on Kökar to determine suitable EC characteristics for the island. Various methods were used to collect data, including document analysis, expert interviews, a survey, and focus groups. The data collection process was guided by contextual and motivational factors by Hicks and Ison (2018) presented in section 3.1. With the document analysis, answers were mainly sought for physical, technological, and institutional context as they are based on facts rather than opinions (weather conditions, technological maturity, legislation). Documents consulted for this phase included research by Smart Energy Åland, the Finnish state and EU, legal documents from Åland and Finland, academic articles and technical documents on energy technologies and ECs in Finland. The document findings were then complemented with expert interviews.

Ten expert interviews were conducted with a distribution system operator (DSO), Smart Energy Åland representatives, governmental officials, Kökar's leaders, and Finnish academia from the 5th of March until 23rd of April 2020 (see Appendix B for a full list of interviewees and a general interview guide). Interview respondents were chosen based on an initial analysis of the available documents and suggestions from Flexens. Expert interviews were conducted for information mainly on the institutional context on Kökar, e.g. energy market in Åland and Finland and incoming EC and energy legislation. Additionally, they complemented the information gained from the document analysis and provided insights on communal context and motivations on Kökar. The interviews were semi-structured, lasted approximately one hour each and were mostly conducted online. The interview questions were mainly tailored for each respondent, but everyone was consulted on the general questions on institutional and communal context as well as motivations (Appendix B). Interview respondents are referenced anonymously in this thesis, using solely their given username, e.g. 'respondent 1' based on the temporal order of the interviews.

The main sources for local motivations and communal context were two focus groups conducted on Kökar on the 12th and 14th of March 2020 (Appendix C), a meeting with Kökar's energy group on the 13th of March 2020 and a survey for local citizens (Appendix D). The two focus groups had an attendance of 12 individuals in total and lasted three hours each. At the focus group meetings, the thesis subject was presented, followed by an open discussion around establishing an EC on Kökar. During the discussion, notes were made which were transcribed on the same day. The focus groups were complemented with 15-45 minute discussions with eight locals in the store, on the road, or at their home. In addition, the author was invited to a two-hour meeting with the energy group of Kökar. This group consists of eight members including local municipal employees, entrepreneurs, and enthusiastic individuals, who coordinate the energy transition project on behalf of Kökar municipality. The meeting notes and transcription provided insights into the current state and future ambitions of the energy system on Kökar. Lastly, an online Google forms survey consisting of five parts was sent to full-time and part-time citizens of Kökar, using the local Facebook group, newspaper and by distributing paper forms to mailboxes during a visit on the island between the 11th and 15th of April 2020. The survey began with an introduction of the author and ECs. It was structured according to the EC enabling framework's background factors and EC characteristics, mostly focusing on motivations to join an EC (Figure 4-1). The survey was open from 3rd of March until 15th of April and received a total of 21 responses, a small absolute number but a relatively high percentage (~9%) considering the population size of Kökar (232).

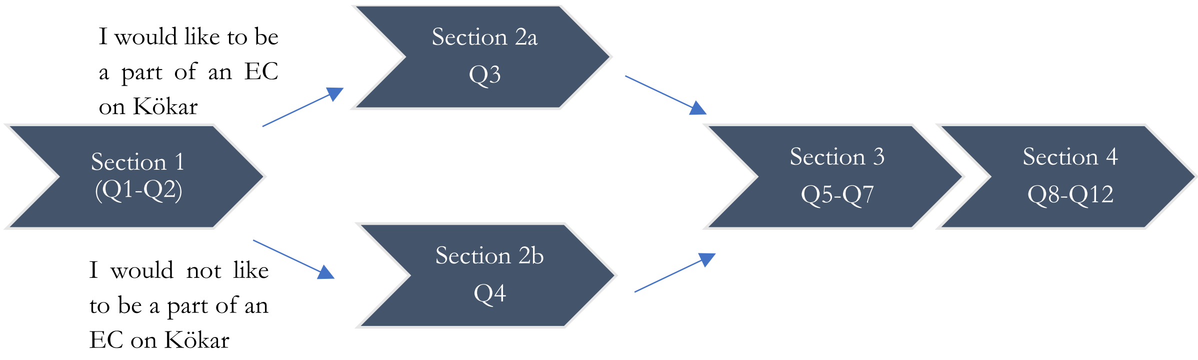

Figure 4-1. Survey structure.

Source: Author's own illustration.

For the collected data, a content analysis was performed in the software tool NVivo, using structural and pattern coding approaches. These coding approaches were chosen as they suited the EC enabling framework and provided a method for finding patterns in the large amount of data collected. In structural coding, codes are created based on concepts which guide the data collection process (Saldaña, 2013). Hence, the background factors were set as codes as data collection methods were structured according to them. Thereafter, a more detailed coding process could be performed. In this second coding cycle, pattern coding was used. Miles and Huberman (1994) describe pattern coding as "explanatory or inferential codes, ones that identify an emergent theme, configuration, or explanation. They pull together a lot of material into a more meaningful and parsimonious unit of analysis." (Miles & Huberman, 1994, p. 69 as cited in Saldaña, 2013). Pattern coding further developed meta-themes from the background factors e.g. how they affected each of the EC characteristics on Kökar. A detailed coding structure is provided in Appendix E.

4.4 Limitations

This section discusses the limitations of the chosen research design and methods. They are divided into case study limitations and limitations related to mixed data collection and analysis methods.

4.4.1 Case study limitations

Case studies, and especially single case studies, have been criticised especially by older publications as mere pre-studies for larger research projects and for lacking scientific value (Abercrombie, Hill, & Turner, 1984 as cited in Flyvbjerg, 2006; Campbell & Stanley, 1967). Single case studies should be especially well-motivated (Yin, 2018) and might lack external validity and breadth (Sovacool et al., 2018). However, Flyvbjerg (2006) argues that case studies are valuable to scientific development, often even surpassing theory-based studies. Additionally, through careful research design planning, acknowledging and communicating case studies' limitations, single case studies can have value both in practice and academia (Sovacool et al., 2018; Yin, 2018). Moreover, considering the temporal and structural limitation of a master's thesis, only a single case was deemed possible to be studied within the appropriate depth an EC development investigation requires. To mitigate the criticism on case studies, Yin (2018) identified four criteria which should be considered to deliver a quality case study. These criteria and their solutions in the context of this thesis are outlined below.

Construct validity requires the study to identify correct operational measures for the utilised concepts. That the concepts are based on justified, rigorous research data, not the researcher's opinion. For example, multi-interpretable concepts in the EC enabling framework were explicitly defined and attached to the research questions. To increase its construct validity multiple sources of evidence were utilised to complement each other and to converge findings. Additionally, the thesis was reviewed by both university and company supervisors.

Internal validity refers to a situation when an event leads to another one, presenting a clear causal relationship, i.e. that the structure of the EC enabling framework is consistent. This expected structure is highlighted in the study propositions. To ensure internal validity, the study should assess and document whether an observed event is caused by another event or by an unknown third party, i.e. whether only background factors lead to observations on EC characteristics (Yin, 2018). To increase its internal validity, this thesis utilises the existing framework of Hicks and Ison (2018) and pattern coding approach explained in section 4.3.2., to identify whether the six EC characteristics truly are affected by the background factors as the EC enabling framework states.

External validity is concerned about whether the study is generalisable outside of the case. Yin (2018) explains that case studies can be generalisable via analytic generalisation, not statistical generalisation. Analytic generalisation can either strengthen, adjust, or reject, (1) an existing theory which is used in the research design (the EC enabling framework), or (2) new concepts which the case study discovered (Yin, 2018). Yin (2018) argues that case studies cannot generalise from the case itself, but from the case study. Meaning that case studies can provide value for policy implications and theory but cannot make generalisations on a population as statistical generalisation can. For instance, generalisation on all islands cannot be made based on the findings from Kökar. However, providing a practical example for academia produces additional value for scientific development, even though these 'forces of example' have often been undervalued in literature (Flyvbjerg, 2006). Hence, the generalising value of this thesis lies in the theoretical and practical spheres.

Reliability means that the study and its results can be replicated by another researcher following the same steps as the original researcher. These requirements are fulfilled by making the research process explicit and transparent. Therefore, all utilised data collection and analysis method guidelines are presented in Appendices A-F.

Case studies with mixed, but mostly qualitative, methods require researchers to approach the social world to view it from the inside e.g. via interviews and focus groups (Blaikie & Priest, 2019). Hence, the researcher creates knowledge in interaction with the real world which leads to the construction of their own framing of reality. The previously mentioned steps were taken to ensure a transparent and valid research design. Additionally, as case studies are more concerned with falsification, i.e. studying whether suitable ECs could be found using the EC enabling framework, rather than verification that they occur as the EC enabling framework states, the personal values of the researcher were not emphasised and thus did not pose a problem. (Flyvbjerg, 2006).

4.4.2 Limitations of mixed data collection and analysis methods

Data was collected from various sources, including expert interviews, focus groups, discussions, a survey and documents. As a mixed-method study, the thesis utilised both qualitative and quantitative data collection methods, mostly focusing on the former. Therefore, most of the discussions on limitations focus on qualitative methods. Each of the utilised methods has distinct benefits and limitations introduced in Table 4-3.

Table 4-3. Strengths and limitations of the utilised data collection methods.

Data collection methods	Strengths	Limitations
Documents	Stable – can be reviewed repeatedly Unobtrusive – not created as a result of a case study Specific – contains exact data, references, and details Broad – can cover many events and settings	Retrievability – can be difficult to find Biased selectivity – author chooses the utilised sources Reporting bias – reflects document author's bias Accessibility
Interviews and surveys	Targeted – can focus on case study topics Insightful – provides explanations and personal views	Bias due to poorly articulated questions Response bias – general failures in responses Inaccuracies due to bad memory Reflexivity – respondents say what interviewer wants to hear Selectivity – broad coverage difficult
Focus group	Immediacy – covers actions in real-time Contextual – covers case context Insightful into interpersonal behaviour and motives	Time-consuming Selectivity – broad coverage difficult and only enthusiastic individuals may show up Reflexivity – actions may proceed differently because participants know they are being observed Bias due to authors manipulation of events

Source: Adapted from Yin (2018).

Documents provided a broad basis for research on ECs on Kökar, especially since the area of research is high on the political agenda, and Kökar is fairly researched due to the ongoing Smart Energy Åland project. However, the extent of the documents found was subject to the methods used e.g. databases, keyword searches and article reference lists. Even though data collection was continued until saturation leading to an extensive reference list, the collected data is vulnerable to the limitations posed by the allocated time for data collection and the chosen sources.

While interviews and surveys are useful in creating targeted and insightful responses with personal views, they have distinctive flaws which stem from interactions with people. For instance, respondents might have answered untruthfully due to question structure, lack of concentration and reflexivity reasons. Moreover, the variety of respondents could be small since interview logistics (identification, contact, interview, analysis) take time and surveys might be answered only by enthusiastic individuals, and thus not reach the full intended population.

Focus groups complementing the surveys were essential in identifying personal opinions in a contextual setting, and thus for the success of this thesis. Additionally, when groups of people gather in the same space to discuss a topic, interpersonal behaviour and motives can present themselves. However, focus group observations take time and are subject to the same type of selectivity, bias, and reflexivity than interview and survey methods.

The limitations of each data collection method were mitigated through triangulation of evidence sources. Thus, by utilising multiple data collection methods which complement each other and arrive in similar results, the findings were strengthened.

5 Case presentation

Kökar is an island municipality in the south-eastern corner of the autonomous Swedish-speaking province of Åland, an archipelago situated between Finland and Sweden (Figure 5-1). The island covers an area of 63.58 km^2 making it approximately the same size as the Manhattan borough in New York (National Land Survey of Finland, 2019; U.S. Census Bureau, 2019). The municipality has a small permanent population of 232 individuals (Statistics Finland, 2019), although, in reality, approximately 170 people live on Kökar throughout the year (Respondent 7, personal communication, 14 March 2020). Thus, the island has a low population density, only 3.65 residents/ km^2, which is significantly smaller than the national average in Åland 19.24 or Finland 18.18 (National Land Survey of Finland, 2019; Statistics Finland, 2019). Although the island's buildings are otherwise sparsely situated, the village of Karlby holds a small centralization of buildings, including residential buildings as well as tertiary buildings such as the school, a bakery, a hotel, and the local store. The local population increases to approximately 1000 during the summer months with the arrival of summer residents. Additionally, with the recent increase of tourism activities, the island may see as much as 18 000 visitors per year, mostly during the summer months (Respondent 9, personal communication, 31 March 2020). This inconsistency of population size, ranging from 170 to a few thousand, requires flexibility of the local infrastructure, such as the energy system.

Figure 5-1. Municipalities of Åland on a map.

Source: Adapted from Wikimedia commons.

The local economy is driven by the service sector, such as tourism, shipping and services (Baldacchino & Pleijel, 2010; Respondent 7, personal communication, 14 March 2020). Many of the islanders are active in multiple economic affairs, e.g. farming and tourism, diversifying their source of income to combat the challenging and varying economic environment on the island (Baldacchino & Pleijel, 2010). The island is currently challenged by a declining and ageing population, which could endanger its possibilities in supplying essential services to its inhabitants. Therefore, the municipality has high ambitions in developing Kökar to protect the natural environment, create employment and attract new residents (Respondent 9, personal communication, 31 March 2020). The development of the island's energy system is one part of these ambitions. A new energy system could include the development of an EC to increase local renewable energy production and local control of the energy system.

5.1 Åland – an autonomous archipelago province

The autonomous province of Åland has approximately 30 000 inhabitants, approximately 7% of which inhabit its six archipelago municipalities, one of which is Kökar (Statistics Finland, 2019). Åland differs from mainland Finland in culture and language. With the decision by the league of nations in 1920, Åland became an autonomous province in the Republic of Finland. With its autonomous status, the government and parliament of Åland can legislate in issues regarding the autonomy of the island group, such as education and healthcare, and in the preservation of its cultural and linguistic rights (Act on the Autonomy of Åland 16 August 1991/1144; Widlund, 2018). However, in matters such as taxation, disregarding some exemptions, citizenship, and foreign policy Åland abides according to the legislation of the Republic of Finland.

In terms of energy policy, Åland has the authority to decide on its energy legislation, still naturally abiding by EU legislation (Act on the Autonomy of Åland 16 August 1991/1144, Art. 18 para. 22). However, in practice, due to the limited resources of the island's government, often Finnish legislation is brought into force in Åland with some changes to fit the archipelago context (Widlund, 2018). Therefore, the legislation discussed in this thesis is mostly developed by the Finnish government. With the transposition of the EU directives part of the Clean energy for all Europeans package into national legislation, Åland can legislate on the aspects left for member states. Still, most likely Åland will adopt similar policies to mainland Finland, with some exemptions (Respondent 8, personal communication, 23 March 2020). These exemptions will most likely concern the archipelago-specific contextual factors and new technologies or solutions which Åland is aiming to pilot.

5.1.1 Smart Energy Åland and Flexens

Because of the abovementioned legislative liberty in Åland, the archipelago county is considered a legislative sandbox for new innovative solutions. In addition, Åland represents a small-scale but comprehensive society, is located between Finland and Sweden in the Nord Pool electricity market, has an ambitious sustainability agenda (Bärkraft.ax, 2016) and possesses the most favourable wind and solar conditions in Finland (Saari et al., 2019). Due to these characteristics, Åland was chosen as a pilot site to develop a future flexible renewable energy system. In 2018 a public-private partnership company called Flexens was established to run this project called Smart Energy Åland. Flexens is owned by Ålandic companies, the Government of Åland and a Finnish multi-stakeholder research institute. Within Åland, Kökar represents a pilot site for Åland and other small island societies. Kökar is a functional piloting ground for a new flexible energy system due to its status as a municipality, its involvement in the Clean energy for all EU islands initiative and the sustainable mindset of its citizens (Respondent 9, personal communication, 31 March 2020).

5.2 Energy system in Åland and Finland

To elaborate on the opportunities of ECs on Kökar, the existing energy system in Finland and Åland is briefly explained. The section is divided into electricity, heat and biogas sub-sections.

5.2.1 Electricity

The electricity system in Finland and Åland have differentiated the roles of distributor and trader of electricity, the former being a state legislated monopoly and the latter a competed market-based position. Hence, electricity consumers may choose their trader, but the distributor is determined by their location. Consumers' electricity prices are created from three roughly equal shares: electricity price, taxes and distribution costs (Finnish Energy Authority, n.d.). Especially the rise of distribution costs in recent years has raised discussions in Finland (Kallionpää, 2018; Nikula, 2020). In 2013, after a storm which caused serious power outages, the Finnish

Parliament enacted a decree to ensure the operational reliability of the electricity network, e.g. requiring that no area (with some exceptions) should experience power outages of more than 36 hours due to abnormal weather conditions (Electricity Market Act 588/2013). The same legislation, with less stringent requirements due to the archipelago context, was enacted in Åland two years later (Provincial Act (2015: 102)). In practice, the distribution companies solved this problem by digging the power cables underground, thus weatherproofing them. However, these activities are expensive and raise distribution costs throughout the country, especially in rural areas with longer distances (Partanen, 2018). Therefore, distribution costs are expected to rise until 2028 (Partanen, 2018; Electricity Market Act 588/2013, Art. 119). The marine environment and submarine cables pose additional challenges to ensure grid connection in the sparsely populated archipelago of Åland.

Currently, there are approximately 80 electricity DSOs in Finland, most of which are municipally owned (Finnish Energy, 2014). Åland has two DSOs: Mariehamns Elnät (MEL) which operates only in Mariehamn and nearby areas, and Ålands Elandelslag (ÅEA), a cooperative which provides electricity to the rest of the archipelago, including Kökar (Saari et al., 2019). Both DSOs in Åland are small enough to avoid legal unbundling, meaning that they can both trade and distribute electricity (Saari et al., 2019). Distribution costs on Kökar are developed from the maximum fuse size in a household added with a cost of cents per kilowatt hour (kWh) of electricity consumed (Ålands Elandelslag, 2020). In a survey conducted to the locals, more than 40% perceived these costs to be too expensive (Sved, 2019). However, they are not alone in these thoughts as the discussion on distribution costs is still vibrant in Finland (Kankare, 2020).

Finland is a market-based economy, meaning that a market-based approach is preferred for the development of the electricity system (Respondent 2, personal communication, 6 March 2020). For now, the role of citizens in energy production has been largely excluded in Finland and Åland, and the electricity sector has traditionally been centralised (Muukka & Huhtala, n.d.). Additionally, the secure supply of electricity and low prices have not generated a need to establish ECs to ensure cheap energy access for locals (Respondent 5, personal communication, 11 March 2020; Ruggiero et al., 2015). As there is limited practical experience on the benefits of ECs to the electricity markets or the consumers, the Finnish legislators have taken a cautious approach in their support (Widlund, 2018). Motivations for this approach have been worries on increasing administrative burden, distortion of competition, unequal treatment of actors and consumer rights. This has led to low legislative incentives for EC development (Ruggiero et al., 2019). However, with the enaction process of EU directives from the Clean energy for all Europeans package into national legislation, enabling EC legislation will be legislated in Finland. These are discussed further in section 6.6.

5.2.2 Heat

In heating their households, Finnish and Ålandic consumers mostly rely on district heating networks, ground heating, heat pumps, oil and wood. District heating networks are the most popular heating source in Finland with a 46% share and are especially applicable to urban areas with higher population density (Hillamo, 2019). Most of the district heating companies are owned by cities or municipalities (Muukka & Huhtala, n.d.). In Åland, which is mostly composed of sparsely populated areas, a district heating network has been built only in the capital of Mariehamn, which contains a third Åland's inhabitants (Saari et al., 2019). The small inhabitant amount and long distances in the archipelago municipalities pose challenges in the creation of a common district heating network, as heat losses can easily render the distribution of heating unprofitable (Airaksinen et al., 2019). Therefore, in these municipalities, such as Kökar, residential and tertiary buildings rely on other sources of heating such as ground heating, heat pumps, natural resources such as wood chips, and oil complemented with electrical heating (Saari et al., 2019). Instead of a district heating network or self-heating with natural resources, locals could entrust their heat provision to heat entrepreneurs providing heating for residential and tertiary buildings by utilising local biomass (Pöyry Management Consulting Oy, 2017) – an activity in which an ECs could be a part of.

5.2.3 Biogas

In Finland, biogas is produced from industrial or societal wastewater, biowaste or farm residue (Airaksinen et al., 2019). Wastewater and biowaste applications are often industrial size installations. Thus, ECs could be the most applicable for farm residue processing. However, the profitability of these installations was found to be minimal without support schemes (Pöyry Management Consulting Oy, 2017). Additionally, biogas has potential as a fuel used in heavy transport, but these applications are expensive and require a constant flow of resources (Respondent 5, personal communication, 11 March 2020). Having a biogas network would possibly improve the profitability of these installations, but the lack of networks in Finland and the rural location of farms prohibits this option (Respondent 5, personal communication, 11 March 2020). Additionally, the transport and storage of biogas is problematic. Therefore, potential for biogas ECs is mainly found in small scale co-production facilities between farmers for their own use, replacing purchased heat, electricity, oil or peat, and potentially selling surplus electricity to the network (Airaksinen et al., 2019). Due to the limited number of farms in Kökar, a biogas solution seems unlikely.

5.3 Energy system on Kökar

Even with its remote location in the Baltic sea, Kökar is connected to both mainland Åland (and Sweden via Åland) and Finland with power cables (Saari et al., 2019). Most of the electricity is imported to Kökar from Finland, although small private production of electricity exists. Although the local electricity network has been partly renovated recently, occasional power outages occur due to disturbances in the submarine cables, e.g. accidents with wildlife (Respondent 1, personal communication, 5 March 2020). These power outages occur 3-4 times per year and have led to some islanders acquiring reserve generators (Respondent 9, personal communication, 31 March 2020). New investments to the submarine power cable are expected to occur in the near future (Respondent 1, personal communication, 5 March 2020). The two next sub-sections present the energy consumption and production profiles on Kökar for electricity and heat. Currently, no significant biogas production or consumption exists on the island.

5.3.1 Energy consumption

The annual electricity consumption on Kökar is 2.9 gigawatt hours (GWh), the highest peak load being 800 kW and the minimum being 400 kW (Respondent 9, personal communication, 31 March 2020). Most of the island's residents and summer cottages use electricity for heating, often combined with wood/oil or air-to-water heat pumps to decrease electricity needs. Tertiary buildings, such as the local school, coast guard station, elderly home and vicarage have done the same or are completely self-sufficient in energy. A number of residential buildings are off-grid, with solar panels, small wind turbines and wood chips or oil. Ferries are the only means of transportation to and from the island and consume half of the total energy on the island (Respondent 9, personal communication, 31 March 2020). The island has currently only one EV (Respondent 9, personal communication, 31 March 2020), but ideas for a larger fleet of rentable EVs has been presented (Witting, 2019). ÅEA has provided all buildings with a smart meter which allows locals to view their energy consumption, leading to more efficient energy usage (Respondent 1, personal communication, 5 March 2020; Saari et al., 2019).

5.3.2 Energy production

"Mika" is the lone 0.5MW wind turbine on the island accounting for 39% of the local energy consumption. However, as Mika is owned by Allwinds, a company based in Mariehamn, and sells its production to the grid. Therefore, its production cannot be certifiably used on Kökar. In addition to Mika, the island has some small-scale privately-owned solar PVs on the roofs of farms and residential buildings and micro-wind installations, the electricity of which is mostly used within the production site. Natural resources on the island such as wood chips are used for heating in some residential and tertiary buildings.

5.4 General background factors on Kökar

In the focus groups and the survey answers, multiple noteworthy factors were presented regarding the background factors of Kökar. These more general factors have implications on all the EC characteristics when analysing suitable EC types on Kökar. Therefore they are introduced before a further presentation of Kökar's EC characteristics.

5.4.1 Demographics of survey respondents

The survey, conducted for full-time and part-time residents of Kökar, was answered by 21 individuals, representing roughly 9% of the local population full-time. A clear majority, 67%, of the respondents were male and 50-69 years old, reflecting the ageing population trend on the island (Statistics Finland, 2019). Additionally, in the local population, men outweigh women by a small margin (Association of Finnish municipalities, 2019). Half of the respondents were full-time residents, the other half identifying themselves as summer residents. The most commonly emerging professions were entrepreneurs and retirees.

5.4.2 Local motivations to become an EC member

In the survey, 95% of the respondents reacted positively to joining an EC (Figure 5-2). The motivations mentioned were economic (decreased energy and network costs), environmental (sustainability and lower emissions), but to a large extent social (increased local control of energy, local community development, community resilience, community benefits, employment and decreased dependence of others).

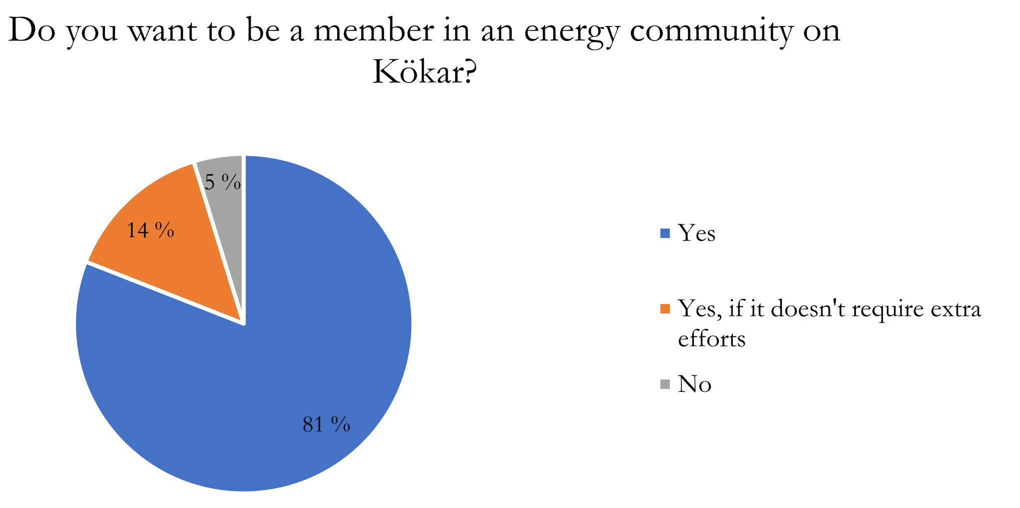

Figure 5-2. Locals' willingness to join an EC.

Source: Author's own illustration.

Although the majority of locals responded that they would be willing to join an EC even if it would require additional work, the focus group findings indicated that the EC should have a clear value proposition for locals and offer possibilities for joining without extra effort to obtain a large membership base. Financial benefits were seen as important in setting up the EC to attract locals and allow them to work with the EC rather than focusing on their income-producing activities. Still, as research shows, other values such as developing the local community could ensure long-term healthy EC operations and membership base (Kotilainen et al., 2017). Nevertheless, as the questionnaire and focus group participation was limited, the EC could first constitute of the most eager members but increase its membership when the concept matures and becomes popular on the island.

5.4.3 Local values

A feature of locals, which becomes evident in discussions, is the sense of independence in decision-making and self-sufficiency, i.e. not being reliant on others. Locals feel passionate about having the possibility to self-rule and make decisions which affect them. Therefore, aspects which for them feel dictated on a top-down manner often might face opposition, one example being the irregularity of ferries to and from Kökar (Respondent 7, personal communication, 14 March 2020). Future aspirations on the island aim to increase local self-sufficiency in energy, water, and other sectors. Though these ideas exist, there is still a need for an entrepreneur to initiate these visions. For instance, developing new energy installations on the island could provide locals with employment opportunities, but would require an entrepreneur to take advantage of those opportunities (Respondent 7, personal communication, 14 March 2020). This entrepreneurial spirit is sought after in future residents as well.

Due to the nature of life on Kökar, locals are cognisant of the practical side of sustainability, e.g. that fish stocks have become smaller, and have taken action to mitigate these challenges by not fishing during certain periods. In general, locals value the natural environment as the most positive aspect of life on the island, which can be seen e.g. in their behaviour and consumption choices (Sved, 2019). Nature is even the main attraction for tourists coming to the island (Baldacchino & Pleijel, 2010). Therefore, the implementation of new solutions, such as an EC, should not endanger but rather complement these values, since they have been and are likely to be the backbone of the island for a long time.

5.4.4 Land ownership

Land ownership on Kökar is heavily distributed, leading to small property sizes. In practice, this means that properties are narrow and long to maximise the number of individuals who can own the sparse agricultural land on the otherwise rocky island. Land ownership has caused problem before in e.g. hunting rights. With ECs, the development of energy cables or renewable energy installations could be challenging if a large consensus between landowners is needed. With long and narrow properties even one property owner could severely alter the course of a cable or switch the location of a solar power plant and thereby increase the EC's costs. Thus, a value proposition should be presented to landowners which would ensure the EC access to land or natural resources, such as wood chips, within that land. Possibilities could be to offer them a share of the produced energy, payments on the land's natural resources or rent for land use on top of the social and environmental benefits included in ECs. At times, the ownership of a land piece can be especially difficult due to complex ownership structures. A piece of land might be owned by heirs of former locals, who might live abroad and not even know of their land possession. Therefore, locals argue that a thorough investigation on land ownership of Kökar should be performed to enable the development of an EC. With these general background factors in mind, an investigation of the suitable EC characteristics, including more specific background factors for each characteristic, can be conducted.

6 EC characteristics on Kökar

Based on the existing background factors on Kökar, suitable EC characteristics can be suggested. These characteristics then jointly create an EC which would contribute to the energy transition ambitions of Kökar and mitigate the challenges which the current energy system faces, e.g. power outages, high distribution costs, imported fuel dependency and changing infrastructure needs. The role of an EC in this work could be to increase the share of small and local renewable energy production and storage and empower consumers to participate in the energy system (Respondent 9, personal communication, 31 March 2020). To find the suitable EC type for Kökar, this section presents all six EC characteristic spectrum variables based on the background factors of Kökar collected from the survey, focus groups, expert interviews, and document analysis.

6.1 Actors

Actors are the members engaged in the EC. When asked about the potential EC actors, two main findings emerged (Figure 6-1). First, most of the respondents emphasised locality, wishing for an EC which is more local than non-local. The same observation was made in the discussions with the focus groups. Secondly, respondents identified that external actors are needed to implement ECs on Kökar. They could aid e.g. in technical, financial, and bureaucratic aspects. Even though the importance of the non-local actors was identified, this should not occur on the detriment of the EC's locality. During the data collection process, a diverse group of potential EC actors was found. These actors can be divided into citizen groups, local administration and economy, and non-local actors.

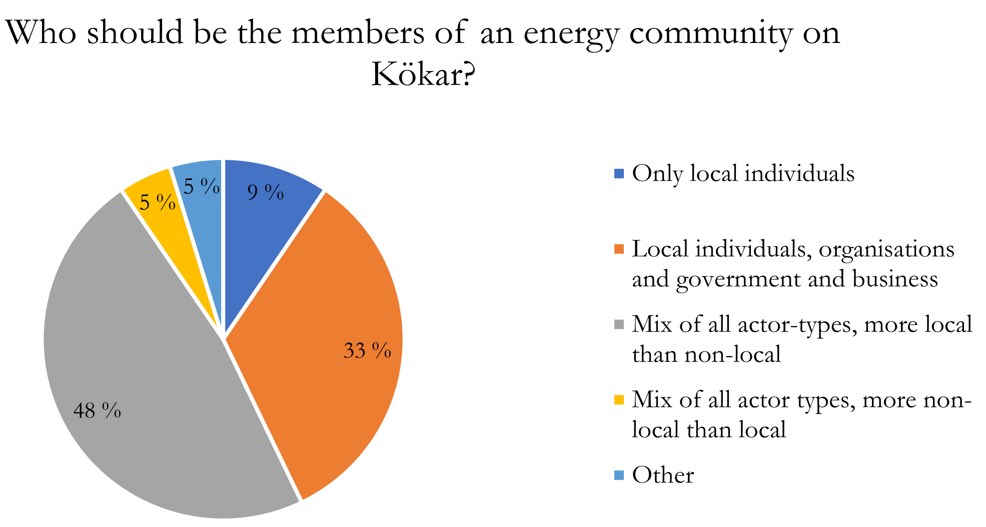

Figure 6-1. Preferred actor structure in an EC on Kökar.

Source: Author's own illustration.

6.1.1 Citizen groups

Even though Kökar is a small municipality, it includes several citizen groups. Some locals made the distinction between islanders and those that moved to Kökar in a later age, some with Hellsö and Karlby, the two separate centres on the island, and some on a language-basis, Finnish and Swedish. Additionally, historically locals have had a sense of independence which still exists on Kökar. Living on an island with limited resources teaches one to take care of oneself. Although locals are independent and might form smaller groups within the island, collaboration on the island is still strong. Locals have a sense of adaptability since inhabitants of a small island cannot choose the individuals they socialise with similarly as urban citizens (Respondent 7, personal communication, 14 March 2020). Therefore, locals have learned to collaborate since they are often dependent on each other. This way of thinking materialises in the local store which was often used as an example of local collaboration. It was built with crowdfunded capital collected from local and non-local investments only within three weeks.

Nevertheless, if an investment would be made in a renewable energy installation, costs are expected to be higher than in the case of the local store. This would raise concerns on the ability of locals to invest capital or time on the installation. Capital-wise an EC should be able to provide locals with a clear financial incentive on the expected advantages of join. The focus group findings indicate that locals do not necessarily have the funds or the interest to invest in projects with long payback periods. Hence, two options arose from the focus group discussions. First, the investment should be made tempting for individual members to raise a similar community project as with the local store. Second, the bulk of the investment could be paid with external financing, e.g. EU and/or Government of Åland grants. However, in this scenario, locals should be engaged as well to ensure the long-term sustainability and community benefits of the project. In short, local leadership is needed (Respondent 6, personal communication, 14 March 2020).

Furthermore, locals might not have enough time to contribute to an EC. As mentioned earlier, they are often 'jacks of all trades' due to the need to diversify sources of income (Respondent 3, personal communication, 9 March 2020). Therefore, their knowledge base on practical issues is wide. However, even though locals have useful skills for EC development e.g. technical aspects, politics and communication, the utilisation of these skills for a common purpose was not expected to work, at least in long-term, due to the need to replace own income-generating activities with voluntary EC activities. Case in point is the municipality's energy group which represents the municipality in the Smart Energy Åland project. However, this group is voluntary-run and does not have the resources to single-handedly develop solutions to the challenges of Kökar's energy transition. For instance, practical issues such as collecting wood chips for a local heat production plant was not seen as a volunteering activity, but rather as a service provided by a heat entrepreneur who is compensated for this service. This would fit the goals of the municipality to create employment for locals but might challenge the projects financial sustainability.

Even though the municipal energy group is not equipped with full-time employees, the existence of local leadership is vital for ECs long term functionality. In general, Kökar has community members who can engage groups of people to take collective action. In addition to leading the energy projects on Kökar, these individuals can help the municipality to broker partnership deals, acquire financing and help to engage locals. However, non-local assistance is crucial in EC development as these actors can bring additional development assistance on e.g. marketing, technological, bureaucratic and financial aspects.

6.1.2 Local administration and economy

Kökar is a full-scale municipality with the responsibilities of a municipality. Still, the local municipality is relatively small with only four employees, some of whom work only part-time (Kökar municipality, n.d.). Similarly, local businesses are small scale, mostly operating in activities related to services within the island (shop, elderly home, vicarage, coast guard) or tourism (hotels, camping site) (Baldacchino & Pleijel, 2010). Thus, although the role of the local municipality, local businesses and entrepreneurs should not be undermined, as has been proven by good-case examples such as Samsø island in Denmark (Jørgensen et al., 2007), the local municipal resources are still limited.

In addition to the locals, Kökar is a centre for summer cottages. During the summer, the population amount rises to approximately 1000 inhabitants with the arrival of summer residents. While some of them spend only a small time on Kökar, many stay for the whole summer. The general notion among locals on the summer residents and their stance on ECs on Kökar was that the ones staying for longer periods understand the reality on the island and have the aim to develop it. On the other hand, the ones that stay for shorter periods might foresee changes as detrimental to nature and tranquillity they are seeking from Kökar. These findings are confirmed by the survey where both locals and summer residents were positive on the development of ECs. Still, should there be individuals on the island not wishing to be a part of the EC, they should be allowed to do so. Additionally, all should have the possibility to leave the EC whenever they see fit (Pahkala et al., 2018).

6.1.3 Non-local actors

When non-local actors are included in an EC, it might have implications on the decision-making structure and financial division within the EC, since the non-local actor most likely will demand a share of both for its involvement. In the case of Kökar, due to its involvement in Smart Energy Åland pilot, the financial and technical assistance from Flexens could be offered without any significant effects on the financial and decision-making factors if locals continue to manage and own the EC's energy installations. Hence, the local community would profit from the provided assistance and knowledge, and still be the main benefactors and managers of the EC's energy installation. However, part owners of Flexens including ÅEA, Allwinds and the Government of Åland, have their agenda in developing ECs on Kökar.

If Kökar was to develop an electricity EC, the role of ÅEA, the DSO on Kökar, is important. ÅEA has recently invested in the distribution network renovations on Kökar and thus is expecting to be reimbursed for these investments in the next 50 years via customers distribution costs (Respondent 1, personal communication, 5 March 2020). If some local actors on Kökar decide to create an EC and become partly energy self-sufficient, the network will most likely have to charge the remaining customers a higher distribution price to cover its costs. The Finnish state wants to avoid this scenario of inequality between consumers, and therefore will ensure that all electricity consumers will pay a fair price for the distribution network (Pahkala et al., 2018). Currently, the existing distribution tariffs do not encourage consumer electricity efficiency, because the bulk of distribution costs come from a fixed rate. A new type of power based tariff could potentially solve this issue (Airaksinen et al., 2019; Pahkala et al., 2018). The dilemma for DSOs is that they have certain duties they have to provide according to the Electricity Market Act (Provincial Act (2015: 102); Electricity Market Act 588/2013). For instance, the customer has to pay for the initial grid connection, after which all additional maintenance and support costs are borne by the DSO (Electricity Market Act 588/2013, Art. 19-20). Since the operations of ÅEA are highly distributed in the Åland archipelago, this can cause the company financial difficulties in the long-term (Leichthammer, 2016).

Allwinds is a private company, and the only one in Åland to operate and maintain wind turbines, take care of project management and trade electricity produced by local wind power (Saari et al., 2019). The wind turbine on Kökar is owned and operated by Allwinds. Currently, the company is engaged in building a 10 wind turbine park close to Eckerö (Bredenberg, 2020). Therefore, should a second large-scale wind turbine or renewable energy installations be built on Kökar, a renewable energy developer, such as Allwinds, would most likely have to be involved in the process due to the size of the development. Allwinds could own or at least operate the installation and provide consultation assistance.

The Government of Åland has an ambitious goal of making the island group into a sustainable society by 2030 (Bärkraft.ax, 2016). To reach these goals, the Smart Energy Åland project was initiated. Additionally, ECs could contribute to these efforts by producing local renewable energy. The government will be enacting similar enabling EC legislation as Finland but aims to pilot new innovative solutions on Åland, such as VPPs and microgrids (Respondent 8, personal communication, 23 March 2020). Thus, they have an interest to realise these innovative solutions, which ECs could complement.

In addition to these stakeholders, other organisations, such as intermediaries, might be needed in the diffusion of ECs on Kökar. However, the market for ECs in Finland and Åland is currently underdeveloped. Therefore, essentially no EC supporting actors are present on the market (Martiskainen, 2014). In the case of Kökar, Flexens has taken the role of an intermediary by supporting the island in technical and policy-related questions. In the future, Motiva, the Finnish state-owned sustainable development company could produce information packages on ECs for citizens, businesses and interest groups (Pahkala et al., 2018). Still, the development of an EC intermediary is further away. With the EC legislative process moving forward in Finland, different support organisations will begin to summarise important information and roadmaps for their members. These support organisations, such as the Finnish Real Estate Federation or the Central Union of Agricultural Producers and Forest Owners, will produce material for their specific members on ECs most applicable for them. Therefore, these organisations could at least for now replace a central EC intermediary (Respondent 5, personal communication, 11 March 2020). Additionally, groups advocating distributed local energy production, such as the Finnish Clean Energy Association, could provide material, policy representation and technological assistance for ECs.

6.1.4 Actors spectrum conclusion

Kökar has multiple different stakeholder groups which could potentially be part of an EC on the island. Therefore, there are multiple actors which have to be considered when developing an EC. The collaborative spirit, enthusiasm for ECs and local leadership exists on Kökar. Locals feel strongly about keeping the EC's actors local but understand the necessity of non-local actors in helping to solve challenges posed by the lack of time, finances, and technical knowledge of the islanders. Thus, in the actor spectrum, an EC would present itself in a position where a mix of actors is needed, these actors being more local than non-local (Figure 6-2). Local actors would be the citizens, the local energy group, the municipality, and local businesses. Their responsibilities could be to motivate and bring people together to form the EC but also to operate the EC since its long-term sustainability requires local involvement. Therefore, the value proposition, including economic, environmental, and social aspects, for joining an EC should be clarified for potential members. The main non-local actors would be Flexens, ÅEA, Allwinds, the Government of Åland and potential support organisations. Flexens could assist in both technical and political issues concerning ECs. ÅEA would have a role in the implementation of an electricity EC on Kökar since they own the local network and have recently invested in its renovation. These investments should be repaid and a means for ÅEA to gain from the EC should be identified. Allwinds could be included as a renewable energy installation provider, especially in larger projects. Government of Åland is aiming to implement new technologies in Åland, which could bring additional resources for pilot areas such as Kökar. Lastly, intermediaries and support groups are expected to provide ECs with assistance when the legislative work advances. Thus, with the resources provided by a range of involved actors the development of ECs could be possible. However, the increased number of actors can lead to increased complexities in the EC.

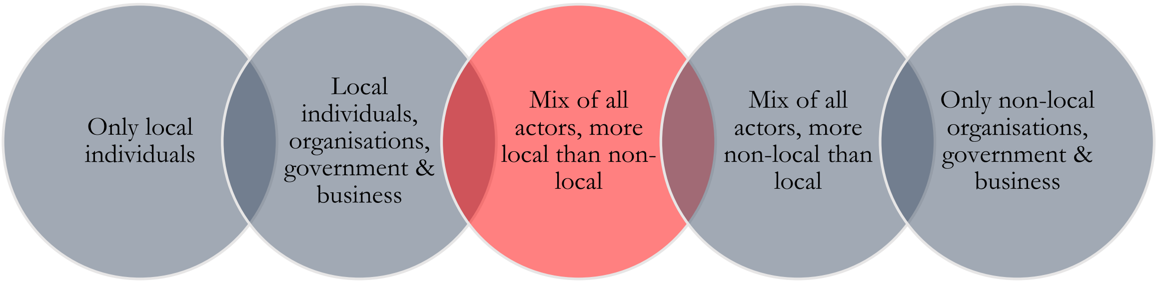

Figure 6-2. Actors spectrum based on Kökar's background factors.

Source: Adapted from Hicks & Ison (2018).

6.2 Decision-making

Decision-making spectrum represents the distribution of decision authority within an EC. The above-mentioned actors spectrum has implications on the decision-making structure of the EC on Kökar. In the survey, a clear majority identified 'one vote per actor' to be the best solution (Figure 6-3) reflecting the locality trend from the actors characteristic. This type of decision-making structure would indicate towards a cooperative or a development trust organisational form. Approximately one-fourth of locals saw that actors votes should correlate to the level of shareholding, that everyone should receive a share for their investment. This type of EC would have the organisational form of a partnership, allowing local and non-local investors and organisations to invest a larger share and receive decision-making rights based on that share.

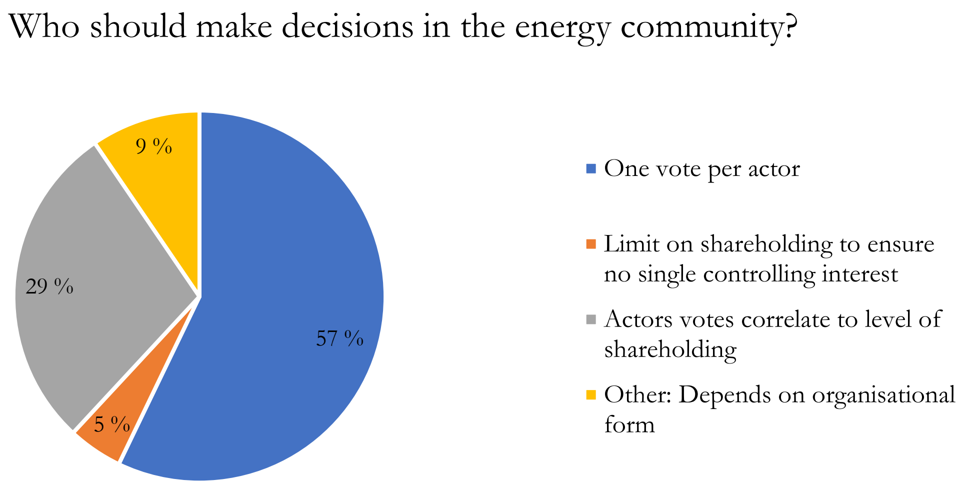

Figure 6-3. Preferred decision-making structure in an EC on Kökar.

Source: Author's own illustration.

The case of Kökar is specific in the sense that the island is a part of the Smart Energy Åland project granting it some concessions. Even though the inclusion of non-local organisations often would require a submission of decision-making leverage from locals to non-locals organisations corresponding their investment, on Kökar this does not need to be the case. As Flexens is a project organisation providing technical and political assistance, the ownership of the EC could land on the hands of the local municipality. Additionally, if the investment is made with an EU and/or a Government of Åland grant, the EC would not have to seek non-local financing for the project. These possibilities would direct the decision-making authority for the local community. However, with an electricity EC, some sort of inclusion of ÅEA should be ensured since they own and maintain the local network. Depending on the business model chosen and the negotiations between actors, the EC could act as a cooperative, where all members have one vote regardless their investment share, or a partnership, where an external actor, could take on a higher share of investment for a higher share of the decision-making authority. Although a clear-cut decision cannot be made, with the Smart Energy Åland project and the local will in ensuring local decision-making power, a 'one vote per actor' seems like a more sought-after option for the EC on Kökar (Figure 6-4).

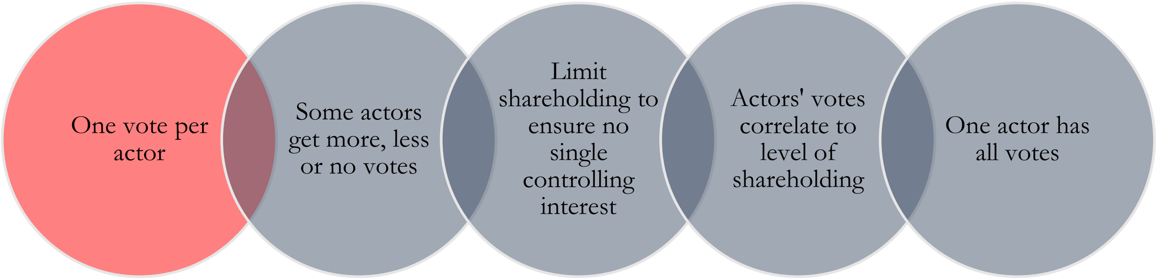

Figure 6-4. Decision-making spectrum based on Kökar's background factors.

Source: Adapted from Hicks & Ison (2018).

6.3 Financial distribution

Financial distribution spectrum analyses the sharing of income between EC participants. Although the spectrum is to a large extent derived from the actors' spectrum, there are some aspects which should be mentioned. In the survey, a clear majority preferred the profits to be distributed to the local community and partly as dividends to local investors (Figure 6-5). These answers break the pattern by not including non-local actors. A third of the respondents would have liked to see all profits shared to the local community.

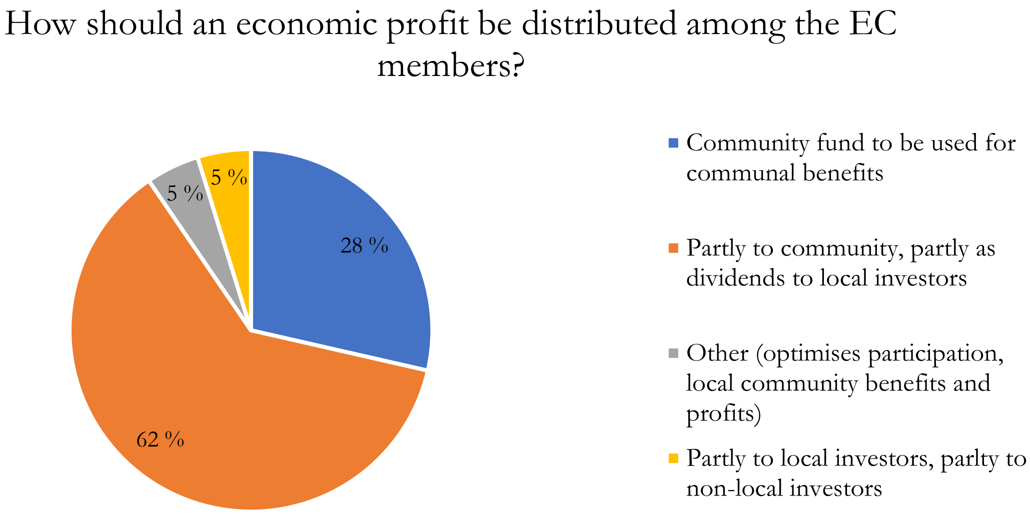

Figure 6-5. Preferred financial distribution in an EC on Kökar.

Source: Author's own illustration.

The inclusion of non-local actors, in many cases, requires the distribution of at least part of the profits to these actors. However, with the Smart Energy Åland project, this is not necessarily the case for Kökar as they might be able to keep a larger share of the profits local. However, should other external investors be included, there will be compensation requirements in their end for their investments and effort. Distributing profits between local investors and the local community is not a complex practice. If the profits are mainly channelled back to the local community, as in a development trust, a local development fund should be created to manage the renewable energy installation. If profits are distributed to individual investors, a cooperative could be the organisational form chosen. Even in a cooperative, a share of the profits would end up in the local community via an economic flow-on effect.

Profit-creation and long-term financial sustainability might be challenging in an EC, and it would not necessarily bring income to EC members, but more likely produce energy cost savings when self-produced energy replaces purchased electricity. These benefits are realised for each member separately. A community fund could benefit from the decreased energy costs or receive minor income from exported electricity depending on the scale of the project. On the other hand, individual members seem to need financial incentive to join ECs in the first place. In light of these findings, an EC on Kökar would focus on individual economic benefits from energy cost savings and potential energy exports. Based on the survey responses, a community development fund should be established, and a share of the EC's profits allocated for community development. More significant community benefits could occur from more technical and sophisticated business models which could require increased non-local involvement, e.g. EV charging and demand-response. Non-local investors could complement local or grant investments and will likely demand a share of the profits. Therefore, the financial profits in the EC would be distributed to local investors, the local community and potentially non-local investors (Figure 6-6).

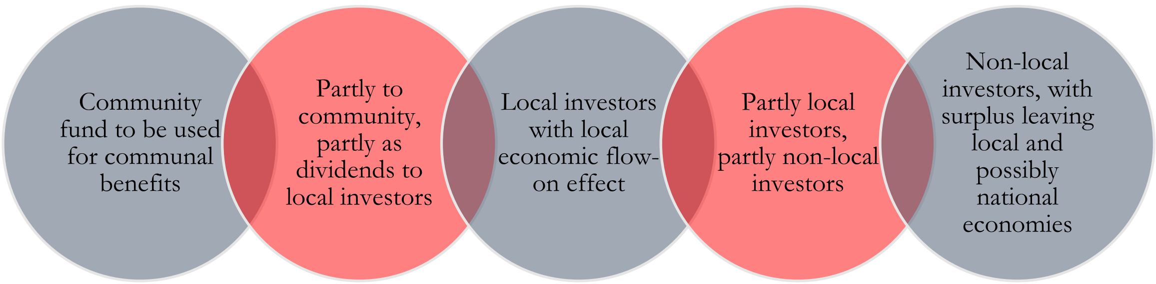

Figure 6-6. Financial distribution spectrum based on Kökar's background factors.

Source: Adapted from Hicks & Ison (2018).

6.4 Community engagement

Community engagement refers to the EC's variation in engagement methods and the frequency of communication with the local community. This question received varying answers and therefore clear conclusions on the preferred engagement methods could not be made (Figure 6-7). Although many respondents (43%) preferred frequent communication, still the majority was content with less frequent engagement (57%). Similar results were obtained from the focus groups, where the respondents did not express frequency preferences, rather focusing on suggesting methods of engagement.

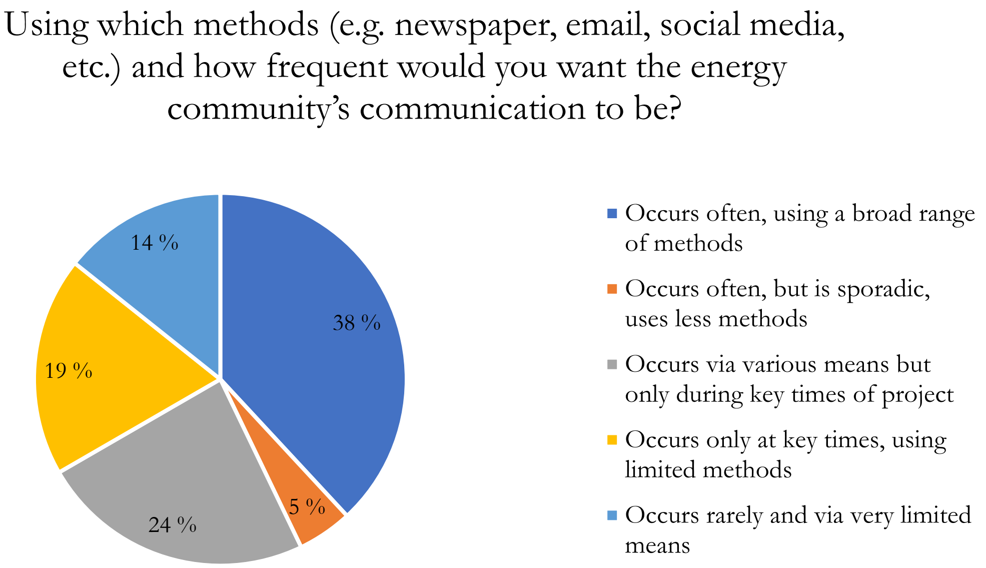

Figure 6-7. Preferred community engagement methods and frequency in an EC on Kökar.

Source. Author's own illustration.

In the communication strategy for prosumers and ECs in Åland the importance of education, provision of information, direct dialogue, demonstration of the value of participation, transparency, visualisation and utilisation of multiple outreach techniques, was emphasised (Saari et al., 2019). However, in light of the results of this thesis, an outright answer for preferred community engagement was not found. Additionally, in the identified existing ECs in section 2.5, no clear results for community engagement were obtained. Additionally, community engagement did not correlate with the other EC characteristics, leaving it as an outlier in the EC characteristics.

Conversely, multiple possible engagement channels with different purposes were identified on Kökar as the locals are active in engaging with matters linked to their community. Methods for discussion, interaction and engagement include the local groups found on social media (Respondent 3, personal communication, 9 March 2020). Thus, the Facebook group, where locals, summer residents and individuals interested in Kökar are actively discussing the island's events, could be a suitable channel for more frequent engagement. An additional Facebook group could be formed only for the EC as a communication channel. For less frequent communication, the local monthly newspaper 'Kökarinfo' could be used. If large local participation is required, in addition to the two former methods, notes could be printed and distributed to locals' mailboxes. Even with the increasing share of social media in communication, locals still value direct dialogue, e.g. in the form of meetings in the municipal building or the local store. By diversifying communication channels, the intended message is more certain to reach the relevant stakeholders. However, with the usage of an excessive number of communication channels and too frequent communication, EC information might drown other relevant information and thus become a nuisance for locals. According to this thesis' findings and the author's experiences when contacting locals, the trick seems to be to start the community engagement early and frequently with a variety of methods and thereafter adjust both methods and frequency if needed (Figure 6-8).

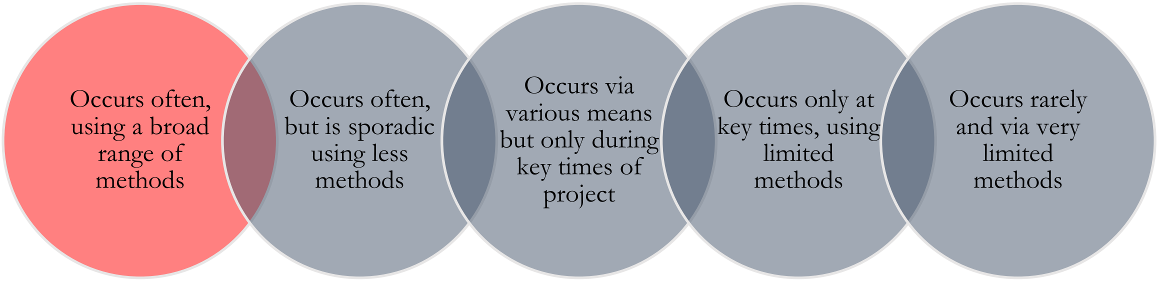

Figure 6-8. Community engagement spectrum based on Kökar's background factors.

Source: Adapted from Hicks & Ison (2018).

6.5 Technology and scale

Technology and scale spectrum presents the size of the ECs renewable energy installation in relation to the energy demands of the community. The choice of energy technology is not presented in the spectrum, but data on it was still collected as it has implications on the project, e.g. the number of renewable energy installations needed for a certain scale. When discussing scale, 'covering demand' means to produce as much renewable energy as is consumed per year.

6.5.1 Scale

Survey responses in scale were varying. Three scale options received approximately the same amount of responses: 'should cover the EC's demand', 'should cover the whole island's demand', 'should be possible to cover the island's demand and export electricity if necessary' (Figure 6-9). Due to the conformity of answer, a clear-cut conclusion cannot be made, which is why the findings had to rely more on other data collection methods. Heat and biogas ECs do not have a major role in the technology and scale spectrum, with the exception of biomass. This is due to their small potential on Kökar and the multiplicity of challenges they face. Nevertheless, they could be important in decreasing the need of electricity in heating and enabling local self-sufficiency. Heat and biogas ECs are further discussed in section 6.6.3.

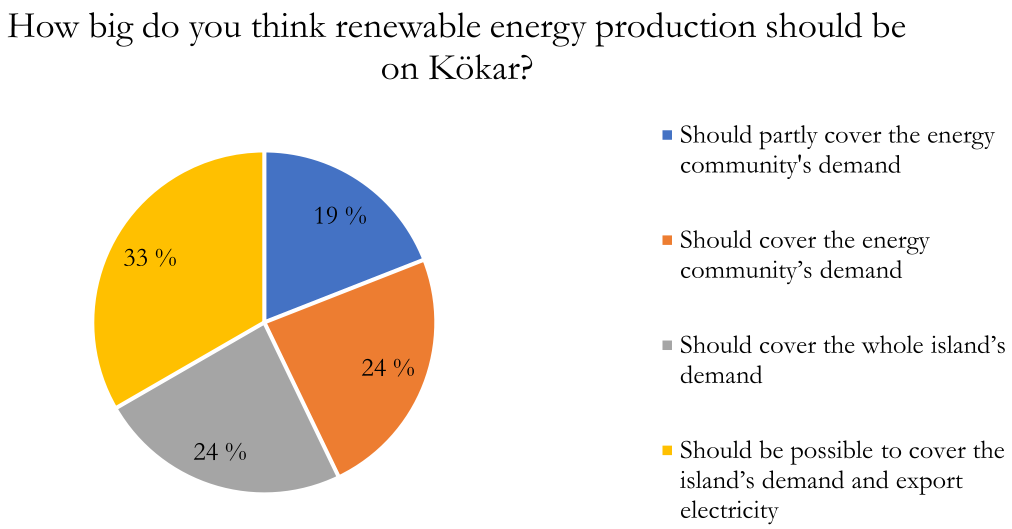

Figure 6-9. Preferred scale of an EC on Kökar.

Source: Author's own illustration.

Locals have a strong sense of independence and self-sufficiency. This view is evident in the scale characteristic, where the results show that locals would prefer to become energy self-sufficient on EC or island level. Even though most respondents wished Kökar to export electricity some expressed negative views on producing surplus energy at all as it was believed to undermine the sustainability ambitions of the island. All locals not wanting to be a part of the EC should be allowed to do so. Therefore, producing electricity to meet the whole island's demand can be considered as producing electricity for export. In any case, when reading the survey comments and analysing the business model spectrum presented in the next section, scaling production for export was often chosen due to its indication that Kökar would self-produce its, not because of the potential export profits. Thus, the most important deciding factor seems to be energy self-sufficiency, which all of the three most preferred survey responses indicate towards.

The relationship with ÅEA and the existing network is highlighted in the discussion on scale. If Kökar would produce enough electricity to become self-sufficient, it could become a microgrid and detach itself from the existing network, or act as a self-producer or an exporter of electricity rather than an importer. Conversely, should Kökar's energy installation only produce a part of the locals energy needs, the installation would merely act as an energy efficiency measure and decrease the amount of imported electricity. Currently, the latter option might be more available and is more widely presented in the legislative work on ECs (Airaksinen et al., 2019; Pahkala et al., 2018). Still, the discussion on more advanced solutions favouring the former approach are very much alive in the Finnish context (Järventausta et al., 2018) and especially intriguing with the Government of Åland's ambitions in piloting new technical solutions. A microgrid could even be a more cost-efficient solution (VTT, 2018). In addition to this inherent connection with the business model spectrum, decisions made on scale are closely connected to the actors involved and other EC characteristics. For instance, if the renewable energy installation is an industrial scale facility designed for export, the necessary inclusion of Allwinds and ÅEA can possibly mean smaller local decision-making authority and financial distribution locally.

6.5.2 Technology

Generally, locals reacted positively on renewable technologies, especially solar and wind power, and biomass (Figure 6-10). Additionally, the conducted expert interviews (Respondent 1, personal communication, 5 March 2020; Respondent 3, personal communication, 9 March 2020) and document analysis (Saari et al., 2019) identified these technologies to having the most potential on Åland. Therefore, the analysis in terms of technology focused on wind, solar and biomass. Other technologies such as micro-hydro and sea heat have been dismissed due to lack of relevance and currently high investment costs. Energy storage is discussed in section 6.6.2.

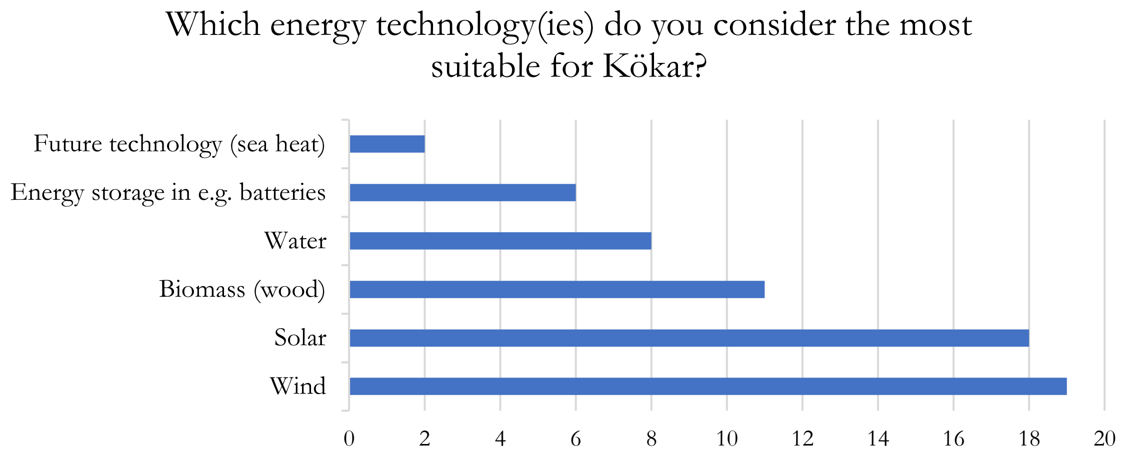

Figure 6-10. Preferred technologies for an EC on Kökar.

Source: Author's own illustration.

Solar power

In terms of solar power production potential, Åland islands and Kökar are the best locations in Finland with matching production levels to Northern Germany (Saari et al., 2019). Solar power can be collected both to produce electricity and heat. This section focuses on electricity due to the unfeasible economic burden of larger-scale solar heating on Åland (Saari et al., 2019). Still, small solar heat collectors could be a beneficial in complementing the primary heating systems in residential buildings to decrease the overall requirements of energy system (Pöyry Management Consulting Oy, 2017).

Currently, the market for solar power is underdeveloped in Åland, which is evident from the total production of less than 1MW (Saari et al., 2019). Saari et al. (2019) calculated that with 50 MW of solar power, Åland could produce 17% of its energy needs. The occurring surplus of 5% during the summer would have to be stored, exported, or curtailed. They state that an ideal solar power investment by an EC would be from 50 to 1000 kilowatt peaks (kWp). This production could be boosted by small residential and possibly large-scale grounded solar systems. Solar installations become increasingly affordable when the price of solar power continues decreasing internationally. On Kökar, some residential micro-production of solar power does exist. Additionally, new systems of 50 kW or less are being planned for tertiary buildings on the island (Respondent 9, personal communication, 31 March 2020). ECs could assist in financing and managing these new installations and thus contribute in increasing the share of solar power on Kökar.

In terms of solar power, the mathematics are against its large-scale installation. In Finland, the profitability of solar power is based on the substitution of purchased electricity with self-produced electricity, which allows the producer to avoid distribution costs and taxes (Airaksinen et al., 2019). Even with the upcoming price decrease of solar power technology and investment grants by the Government of Åland (Government of Åland, 2019), solar power costs (99.6 €/megawatt hour (MWh)) will still be significantly higher than on-shore wind power costs (41.4 MWh), the cheapest form of electricity in Finland (Airaksinen et al., 2019). Thus, solar ECs which have to pay taxes and distribution costs have low profitability compared to purchased electricity. Hence, the production should be directed for the EC members own usage. Although, solar power has some potential in Åland, its share of the future envisioned energy mix is only 10-15% (Saari et al., 2019). By itself, solar power is not be able to produce all energy in Finland even with complementing energy storage (Järventausta et al., 2018). Therefore other types of renewable energy are needed, such as wind power and biomass.

Wind power

Similar to solar power, wind power conditions in Åland are one of the best in Finland due to the abundance of uninhabited islets allowing wind power construction with on-shore costs for off-shore conditions (Saari et al., 2019). Because of the abundance and continuity of wind in Åland, especially during the winter months when heating demand is high, the future envisioned energy mix will mostly rely on wind power (70-80%) (Saari et al., 2019). To increase the share of wind power, the Government of Åland has implemented a feed-in tariff which offers a fee on top of each produced MW for all wind turbines of over 3 MW until the end of 2022 (Decision LTB 34/2019 of the Parliament of Åland). However, this subsidy is essentially not applicable for wind turbines owned solely by ECs, due to its size requirement. The increase in wind power production will thus mostly be accomplished with industrial size installations, the first of which will become operational outside Eckerö in 2021 (Bredenberg, 2020). This installation raises wind power production in the Ålandic energy mix from 20% to approximately 60%. With the intentions to raise Åland's wind power share even further, ambitions have been raised to build a wind power park outside of Kökar in the future (Saari et al., 2019). The EC on Kökar could become a part-investor in this installation to produce electricity and profits for the local community. In larger-scale installations, non-local actors such as Allwinds and ÅEA will most likely have to be involved in the process due to the infrastructure needs.

Another option in increasing the share of wind power in the Ålandic energy mix would be to repower existing wind turbines. Leichthammer (2016) found that new wind turbines in Åland produce more than 2.5 times more electricity than old turbines, such as Mika on Kökar. Therefore, upgrading the existing wind turbines could potentially increase wind power share to the aimed 70-80%. However, repowering is essentially impossible due to the uneconomic nature of the investments (Leichthammer, 2016).

On Kökar, calculations have been made that an additional large-scale wind turbine could fit on the island (Respondent 8, personal communication, 23 March 2020). However, discussions on it have not continued further, rather focusing on micro-wind production (approx. 5 kW). These systems are envisioned to be installed to the local school, but require further feasibility calculations (Respondent 9, personal communication, 31 March 2020). Additionally, private residents are interested in micro-wind installations, should a source of financing and technical assistance be available. Similar to solar power, micro-wind can receive an investment subsidy from the Government of Åland (Government of Åland, 2019). Micro-wind turbines' profitability problems have been hindering their diffusion in the Finnish markets. Average wind conditions should be more than 5 m/s for micro-wind to become profitable (Pöyry Management Consulting Oy, 2017) – a condition that Kökar and the other archipelago islands fulfil (Finnish Meteorological Institute, n.d.). However, activity in the micro-wind industry is limited due to lack of demand (Respondent 5, personal communication, 11 March 2020).

Biomass

Saari et al. (2019) found that when considering biomass, waste and carbon dioxide, biomass is the only one with sufficient availability as a heat source in Åland. Biomass could power combined heat and power plants (CHP), which would produce both heat and electricity. In Mariehamn, which has the only CHP unit in Åland, high costs have rendered it economically feasible to operate the CHP unit only during winter months when electricity prices are higher. On Kökar, initial plans have been presented to install a micro-CHP to the municipal school, which has an outdated oil-dependent energy system and is one of the biggest energy consumers on the island (Respondent 9, personal communication, 31 March 2020). However, further feasibility calculations are required prior to installation. This micro-CHP could provide both heat and electricity for the school and offer a small flexibility asset for the electricity network. The CHP would use local wood chips for fuel. Locals have calculated that the wood chip resources on Kökar should cover the needs of the CHP. Additionally, as is the case for Mariehamn, the micro-CHP could be used only during times of need and left for less use during the summer when the school has fewer heating needs. However, the micro-CHP introduction has multiple development barriers, such as land ownership issues, employment and maintenance needs, heat transferability, mismatch of demand and supply and profitability. These issues are discussed further in section 6.6.5.

6.5.3 Technology and scale conclusion

With the combination of solar power, wind power and biomass complemented with energy efficiency solutions, such as heat pumps and smart meters, an EC on Kökar would be able to provide its members with an ample source of locally produced renewable energy and potentially become, as the locals wish, energy self-sufficient. Even though scaling the production for export would enable the EC and potentially the whole island to be self-sufficient and gain additional income, it could pose challenges for the grid connection and contradict the existing sustainability mindset as excess electricity is produced. Thus, based on these findings, an EC would utilise wind power, solar power, and biomass and be scaled to meet the EC's demand, and due to the nature of electricity, produce occasional surplus (Figure 6-11). This surplus can then be sold to the network or stored within Kökar if energy storage exists. If the EC provides additional electricity using services, such as EV charging, then the scale should be reconsidered and potentially increased.

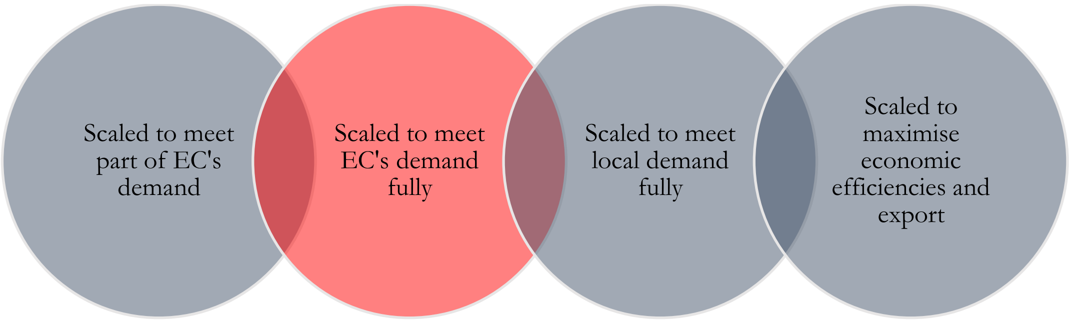

Figure 6-11. Technology and scale spectrum based on Kökar's background factors.

Source: Adapted from Hicks & Ison (2018).

6.6 Business model

The business model spectrum presents the three different business models and their activities in relation to the background factors of Kökar. The business models vary in their relationship with the current energy system, differing in their level of disruptiveness. Centralised EC business models are applicable to the current energy system and engage in activities such as energy production, sales, and storage. In distributed business models energy production is individual and the actors are grouped via a physical or virtual entity. Decentralised business models are the most disruptive for the current system. In it, ECs can function self-sufficiently as a microgrid and become islanded of the main network if necessary. Heat and gas ECs are presented with decentralised business models because there is no existing network for heat or gas on Kökar. Furthermore, during the research process, the role of funding options for the ECs was highlighted. Therefore, the varying funding opportunities for ECs are presented first.

In the survey, the ability to trade energy between islanders, but still have the possibility to access the common network was the most preferred choice. It was followed by the complete isolation from the external network via a microgrid (Figure 6-12). Therefore, these findings confirm the results from the scale spectrum which indicated that the majority wished to see Kökar produce enough electricity for local demand and export. As was presented there, it seems that locals value self-sufficiency in energy production and would rather be exporting than importing electricity from outside the island. Thus, their first interest is in self-producing energy and possibly constructing an energy self-sufficient EC.

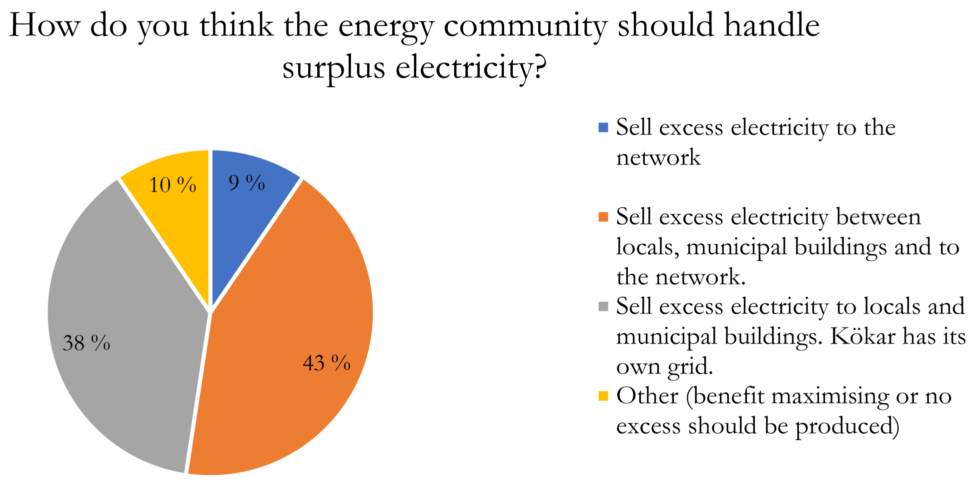

Figure 6-12. Preferred business model for an EC on Kökar.

Source: Author's own illustration.

6.6.1 Funding

Renewable energy installations require fairly high upfront costs, which are one of the main challenges for EC development (Caramizaru & Uihlein, 2020). To highlight the different financing opportunities, some sources are presented next. In Åland, renewable energy or energy efficiency projects by individual households, groups of households or companies are eligible for government grants (Government of Åland, 2019). These grants are technology-specific and apply to e.g. wind power, solar power, and conversion of oil heating. In addition, EU funding, e.g. Horizon 2020, can be applied for by projects contributing to the development of the EU's strategy (European Commission, 2013). Furthermore, financial institutions could provide ECs with loans. These loans could then be repaid from the energy savings the renewable energy installation provides. Energy Service Companies (ESCo) provide these types of financing opportunities. They are mostly private or municipally owned organisations which, instead of solely providing customers with a commodity e.g. solar panels, or electricity, provide them with a service e.g. room temperature or hot water (Brown et al., 2019; Hall & Roelich, 2016). Thus, ESCOs have an incentive to implement energy efficiency measures to their customers to decrease their energy use. This leads to ESCo value maximisation when customer energy demand reduction is maximised. In exchange, customers agree on long-term contracts. In Finland, some ESCOs installations are currently operational (Motiva, 2020), e.g. shopping centre Sello in Espoo, in agreement with the German company Siemens (Siemens, 2018). While many financing options are available (Novikova et al., 2017), many require applicants to be creditworthy enterprises, which often undermines ECs' opportunities to benefit from them (Airaksinen et al., 2019). Consequently, ECs should establish an organisation, but even in these situations proving the creditworthiness for project organisations without any assets be difficult (Airaksinen et al., 2019).

Applying for funding could be simpler for ECs' with a functional business model. Therefore, the following sub-sections analyse centralised, distributed and decentralised business models and their respective activities in relation to the background factors of Kökar. It is important to note that these business models are not constant, i.e. ECs can transition to another business model. Furthermore, most of the business model activities are not exclusive and can therefore also be utilised in other business models.

6.6.2 Centralised business model

ECs operating with centralised business models mostly focus on energy production, consumption, sales, and storage as well as efficiency measures, mobility, and consulting services. They operate in the current energy system and are the least disruptive of the three presented business models.

In 2016, the Finnish government commissioned a working group to research on a flexible and customer-driven electricity system, to facilitate a smooth energy transition in Finland (Pahkala et al., 2018). This Smart Grid working group focused on small-scale energy production where ECs produce electricity only for their own consumption, replacing purchased electricity from the grid. When own production of electricity replaces purchased electricity, the EC's investment can be seen as an energy efficiency measure as its profitability stems from the avoided distribution costs and electricity taxes. This occurs because in Finland and Åland, small-scale energy production for own usage is not taxed, and as the DSOs network is not used with self-production of energy, there is no need to pay distribution costs (Act on excise duty on electricity and certain fuels 19.12.2018/1226, Art. 7 para. 2). Even though electricity production should be dimensioned for own usage, occasional electricity surplus may be sold to the network (Airaksinen et al., 2019; Central Tax Authority, 2019), stored inside the building (Finnish Tax Administration, 2019), or donated to a charity via the grid (Airaksinen et al., 2019). In their report, the working group suggested three types of ECs, all of which are presented in the upcoming sub-sections. Åland will adopt the same suggestions, but with context-dependent changes and allowing piloting for new technological solutions (Respondent 8, personal communication, 23 March 2020).

The Smart Grid working group presented two types of ECs which can be applied to centralised business models: ECs within a housing company and ECs crossing property boundaries. **ECs within a housing company** are not applicable to the context of Kökar since there are no apartment buildings on the island. Still, for potential use in the future or other Smart Energy Åland projects, it is presented shortly. ECs within a housing company can be constituted within an apartment building when residents decide to produce electricity on their own roof, usually by solar panels (Figure 6-13). Electricity produced on the roof is first used in the apartment building, e.g. elevators or shared sauna, and afterwards computationally distributed in the switchboard to the building's apartments based on the chosen structure. Thereby, self-produced electricity replaces purchased electricity and produces cost savings to the EC from avoided distribution costs and electricity taxes.

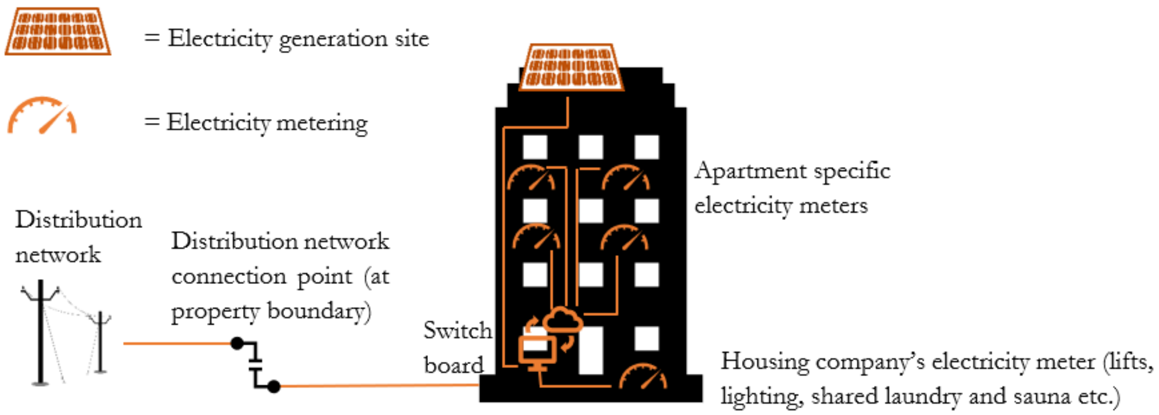

Figure 6-13. EC within a housing company.

Source: Adapted from Pahkala et al. (2018). Icons from Wikimedia commons and Pixabay.com.

ECs crossing property boundaries are more applicable to sparsely populated regions such as Kökar. They occur in situations where suitable electricity production conditions are not located on the roof of a household but e.g. in the field on a neighbouring property (Pahkala et al., 2018). In these situations, the production site, e.g. solar power plant, is placed on a field in a separate property and connection lines from the production site to consumption points (households) are drawn by the EC (Figure 6-14). This brings new responsibilities for ECs, e.g. quality of electricity and electrical safety (Pahkala et al., 2018). Furthermore, the developed connections allow electricity transfer only from the production site to consumption points, not between consumption points (P2P trading) or a circular network parallel to the existing network (microgrid) to ensure fair treatment of customers and electrical safety. Current legislation requires all actors who transmit electricity across property boundaries or build electricity connection lines, to have an electricity network license and permission from the DSO, thus obstructing the implementation of these ECs (Pahkala et al., 2018). However, the decree enabling the development of ECs crossing property boundaries is currently (May 7th, 2020) waiting for stakeholder statements and will be enacted within the year 2020 (Lausuntopalvelu.fi, 2020). Since Åland has the authority to enact its energy policies, the island group could pilot these types of ECs in Åland before the Finnish legislation is in place (Respondent 8, personal communication, 23 March 2020). Still, these types of ECs face challenges as they require a large group of participants who live in close to each other due to the relatively high investment costs, the increased responsibility and low levels of profit (Airaksinen et al., 2019). Therefore, their functionality has been challenged (Airaksinen et al., 2019).

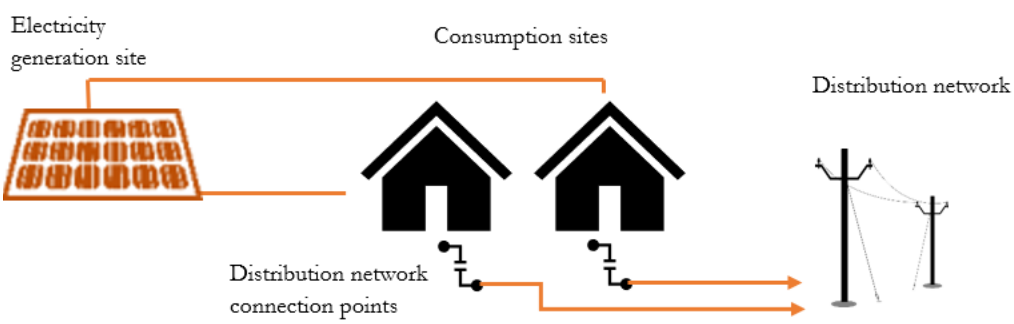

Figure 6-14. EC crossing property boundaries.

Source: Adapted from Pahkala et al. (2018). Icons from Wikimedia commons and Pixabay.com.

Both ECs within a housing company and ECs crossing property boundaries are local ECs, meaning that their membership lives near each other. Their economic benefits arise from the collective investment into renewable energy and the replacement of purchased energy with self-production to avoid distribution costs and electricity taxes. Indeed, it has been proven that an investment within an EC improves the usability and profitability of renewable energy installations compared to individual investment (Kolehmainen, 2019). Collective purchasing by an EC was found to enable 2-3 times larger renewable energy installations (Koskela et al., 2019). The same study found that battery storages are more profitable to invest in as an EC rather than individually, especially after the tax reform enabling small scale tax-free energy storages (Finnish Tax Administration, 2019). An example of a collective procurement programme in Finland is the municipal HINKU-network, developed by the Finnish Environment Institute, where Finnish municipalities collectively purchase solar power plants (Finnish Environment Institute, 2016).

On Kökar, centralised business activities could be implemented in various ways. An EC could invest in a renewable energy installation or become a part-investor in an industrial scale wind power park envisioned close to Kökar in the future (Saari et al., 2019). In a locally owned renewable energy installation, energy production would be shared between members according to the agreed-upon practices. Additionally, the EC could improve local energy efficiency by advocating or providing consulting assistance on smart energy systems for residents or investing in heat pumps. To complement the renewable energy installation, additional services such as energy storage and E-mobility, could be implemented. The next two paragraphs elaborate on these solutions.

Even though the development of energy storage technology is still unclear (Järventausta et al., 2018) many types of suitable storage technologies have been identified for Åland. These are divided into long-term, medium-term and short-term storage (Saari et al., 2019). Long-term storage such as pumped hydro and power-to-gas are more expensive and larger-scale installations developed for societal level storage e.g. for Åland. Medium-term storage, e.g. lithium-ion batteries, are applicable for load shifting, i.e. storing electricity when there is high supply and releasing it when there is low supply. The stored energy could be used for the EC's own needs, provide energy to an EV charging station or offer load shifting services to ÅEA by reducing stress from the network. Short-term storages, for instance flywheels, have fast response periods and are used to improve grid stability. In a smaller society such as Kökar, the types of storage used will be most likely medium term, but with complete isolation from the rest of the Åland islands, other storage options should be used to ensure energy provision even in extreme conditions. In general, diversification of energy production and storage methods decreases the risk of accessibility problems due to changes in weather or electricity markets.

Concerning mobility, locals are often dependent on their own vehicles for transport inside the island of roughly 10 km across. Additionally, many tourists arrive on ferries or their own boats and thus are in need of transport to reach in-land destinations. Currently, the island has one EV, which is owned by a local service company. With an EV charging station using locally produced renewable energy, locals could charge their own or shared EVs and rent out a fleet of EVs for the island's visitors. Additionally, shared EVs could function as energy storages. However, the detrimental effect of the extra charges and discharges on EV batteries should be considered when using them as energy storage.

Centralised business models can take varying forms and are suitable in the current energy system, mostly focusing on energy efficiency measures by decreasing the need for purchased electricity. Their implementation is the least disruptive and simplest of the three business models. Therefore, these activities can be utilised in distributed and decentralised business models. Gui and MacGill (2018) argue that centralised business models could be the first step for an EC. Indeed, this could be the case on Kökar, as a common renewable energy installation could build the foundation for a new and increasingly local energy system on the island. Still, the long-term sustainability of a centralised business model EC should be considered, which might be challenged due to profitability reasons and their dependence on volunteers. Therefore, with the foundation built on centralised business models, new business model solutions could be implemented to improve the ECs sustainability but still keep the community in the centre of activities.

6.6.3 Distributed business model

Distributed EC business models collect individual prosumers together through a physical or a virtual controlling entity. These networks do not have to be in close proximity to each other geographically or cognitively, but together have common rules on network supply and consumption. The connecting entities in these ECs can be virtual, e.g. VPPs, or physical, e.g. a renewable energy installation. The Smart Grid working group presented in their report a **distributed EC type** suitable for the distributed business model. It is not bound to locality and therefore can operate at a national level and accept diverse membership (Pahkala et al., 2018) (Figure 6-15). In practice, it means that an individual can live in central Finland, be a part of a wind power cooperative in Lapland and own solar panels in their summer house in southern Finland, and have all produced electricity decrease their energy bill at home. Each members' electricity share is determined in a centralised unit. In Finland, and possibly in Åland, this centralised unit will be Fingrid's datahub, expected to launch in 2022 (Fingrid, 2019). Distributed ECs differ from ECs crossing property boundaries in their utilisation of the existing distribution network. They are currently possible to create, but unfeasible economically due to the network distribution costs and electricity taxes (Respondent 2, personal communication, 6 March 2020). Distribution costs are justified due to the utilisation of the common network, but electricity taxation has been argued to discriminate distributed ECs (Airaksinen et al., 2019). In Finland, small-scale self-produced electricity is tax-free, except if the electricity is transferred via the common network (Act on excise duty on electricity and certain fuels 19.12.2018/1226, Art. 7 para. 2). Suggestions have been made to computationally differentiate self-produced electricity with purchased electricity to tax only purchased electricity (Airaksinen et al., 2019). In this manner, distributed ECs would be treated similarly to ECs within a housing company when it comes to electricity taxation. It is noteworthy that in this scenario, distributed ECs could replace ECs crossing property boundaries, as they do not require as much investment to electric cables or responsibilities over electrical safety (Airaksinen et al., 2019). However, the tax system has challenges in adapting to these new calculation methods, and the electricity tax has a significant fiscal significance (Respondent 2, personal communication, 6 March 2020). Therefore, changing the taxation system is challenging, but enabling legislation on distributed ECs is still expected to be enacted in 2022 (Pahkala et al., 2018).

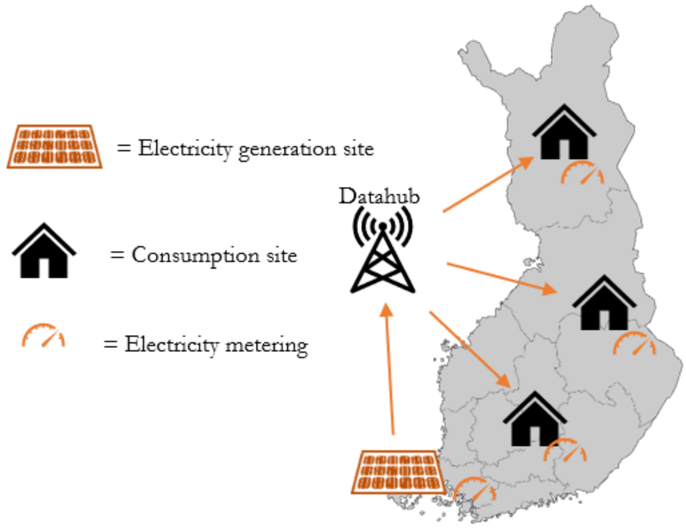

Figure 6-15. Distributed EC.

Source: Adapted from Pahkala et al. (2018). Icons from Wikimedia Commons and Pixabay.com.

In a distributed business model, the EC on Kökar could still engage in the same activities of energy production and consumption as in the centralised business model. Additionally, the EC or individual prosumers could invest in renewable energy installations in other parts of Åland and use the electricity from these installations to decrease the need to purchase electricity. Moreover, the production, consumption, and storage of an EC or individual prosumers on Kökar could be aggregated in a VPP (Figure 6-16). Via the VPP, the EC can gain additional income with demand-response activities and access electricity exchange and wholesale markets (Airaksinen et al., 2019). Demand-response activities could enable ÅEA to save in network investment costs since it helps to avoid consumption peaks stabilising the network. Furthermore, VPPs enable P2P trading within EC members. P2P trading can be facilitated in three ways (Järventausta et al., 2018). First, if the EC owns a common renewable energy installation, the electricity produced can be divided among the participants based on their ownership. Second, the surplus could be sold e.g. via a VPP, to other EC members to minimise the need to use the EC's energy storage or to sell surplus electricity to the network with low compensation. Third, surplus energy could be stored in a common energy storage and used later. In short, a VPP could enable a more flexible and efficient electricity market on Kökar.

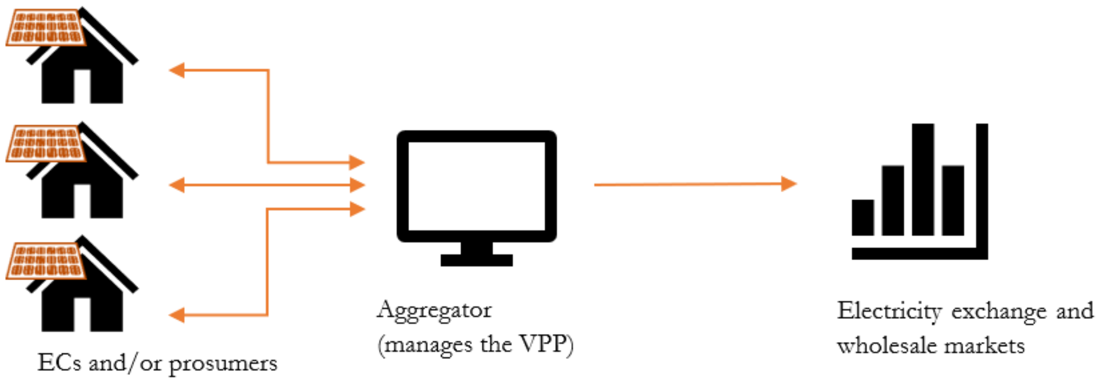

Figure 6-16. Aggregators' operational model.

Source: Adapted from Pahkala et al. (2018). Icons from Wikimedia Commons and Pixabay.com.

However, due to their novelty, demand-response activities, VPPs and P2P trading face challenges in legislation and practice. It is estimated that there is much potential in demand-response with industry and households in Finland (ÅF-Consult Oy, 2019). For households, demand-response methods can be the usage of smart energy systems, such as scheduling heating needs, or energy storage solutions, e.g. batteries (Manninen, 2019; Saari et al., 2019). However, current economic incentives from the Finnish State have encouraged DSOs to perform network renovations instead of demand-response (Mendes et al., 2018). Additional challenges are posed by high investment costs for communication campaigns, new equipment for households and the development of a central unit to manage the system (Saari et al., 2019). Practical challenges for demand-response on Kökar, and the entire Åland islands, stem from the small size and limited energy consumption of the local industry and households. Additionally, the electricity prices in Nord Pool markets have traditionally been low. These two factors may render demand-response activities unprofitable and unattractive in Åland (Saari et al., 2019).

The development of aggregators is obstructed in the Finnish context due to historical reasons which have placed a considerable share of households demand-side management potential, i.e. day and night electricity, to the DSOs load control (Pahkala et al., 2018). The Smart Grid working group has recommended phasing out of the current practice for a competitive market-based approach latest in 2021. Additionally, due to the novelty of the aggregator business model in Finland, there is a limited number of aggregators on the market (Ministry of Economic Affairs and Employment of Finland, 2018).

Currently, P2P trading is challenging in Finland because of the requirements to fulfil the legal obligations of electricity supplier or trader (Respondent 4, personal communication, 9 March 2020). Additionally, should an individual ECs join the P2P trading market, they would be subject to both distribution costs and taxes and have to compete with large-scale industrial electricity providers. Therefore, the P2P market could provide opportunities for aggregators or other actors to act as central entities for multiple decentralised energy resources (Järventausta et al., 2018).

As is evident, the legislation and practical examples on VPPs and P2P trading are limited in Finland and Åland. With the piloting resources of Smart Energy Åland and the government's ambitions, Kökar could become a testbed for these types of new innovative solutions. Via a VPP a local EC could more actively join the electricity market, increasing market efficiency, local production of energy and providing additional income for the EC, in addition to the benefits provided by centralised business model activities. ÅEA could benefit from the demand-response services provided by the VPP to avoid costly distribution network investments in the archipelago environment. However, the network investments which have already been made on Kökar and the upcoming investments for the new submarine cable will still need to be compensated by all network utilisers in a fair manner. Including P2P trading in the platform could enable locals to use an increased amount of closely produced renewable energy, empower them to take more control on the energy use on the island and improve the community's energy self-sufficiency. However, challenges arise from lacking legislation, high resource needs, and lack of actors on the market. Still, with new legislation, technology and actors, and the basis created with centralised business models, an EC contributing to an increasingly efficient energy system on Kökar could be developed.

6.6.4 Decentralised business model

A decentralised electricity EC can operate as a microgrid, and may if necessary, detach to 'off-grid mode', outside the common network. When off-grid, the microgrid is self-sufficient in energy. These microgrids can be owned and/or managed by a variety of actors, including the EC, a third party, or a DSO such as ÅEA (Järventausta et al., 2018). Microgrids increase local renewable energy production, network efficiency and decrease necessary investment on the network (Valta et al., 2018). Therefore, they could provide remote regions, such as Kökar, a cheaper option for the investment heavy distribution network (VTT, 2018). Microgrids can incorporate the activities presented in centralised and distributed business models and are in many ways similar to VPPs in their aggregation of energy resources. However, they differ in their ability to isolate from the network and often focus on decentralised energy resources within a specific region, e.g. an island. Thus on Kökar, the local EC could own the microgrid, produce, consume, and store electricity within the microgrid, and sell electricity or demand-response services to the external network. Moreover, P2P trading within an EC owned microgrid is liable to pay taxes, but not distribution costs. Therefore, in terms of P2P trading, microgrids are a more profitable model than distributed ECs (Airaksinen et al., 2019).

However, due to the novelty of microgrids in Finland, there are currently multiple challenges, both practical and legislative, hindering their further adoption. Järventausta et al. (2018) and Valta et al. (2018) argue that the main challenges with microgrids are lack of clear definition and legislation. Legislative difficulties arise because microgrids break the long-reigning paradigm of DSOs as state legislated monopolies in electricity distribution (Airaksinen et al., 2019; Järventausta et al., 2018). Closed distribution networks are already available for business actors, but not for consumers (Electricity Market Act 588/2013, Art. 11). With upcoming EU legislation (Directive (EU) 2019/944 of the European Parliament and of the Council, Art. 16 para. 4), member states can grant ECs ownership and operation rights of distribution networks. When ECs own the distribution network, the responsibilities of DSOs, e.g. in ensuring grid stability apply to them (Saari et al., 2019). Furthermore, various technical challenges are present with microgrids, e.g. in the switch from on-grid to off-grid mode (Mendes et al., 2018). For instance, off-grid microgrids have to maintain grid frequency which is technically challenging and expensive especially considering the scale of the gained benefits (Respondent 10, personal communication, 23 April 2020). Therefore, currently, a hybrid-model microgrid, where the microgrid is owned and managed by the DSO but the energy installations by the EC, could be the simplest model due to regulatory and technical requirements (Valta et al., 2018). In this microgrid type, Kökar's EC would provide ÅEA with energy and flexibility services. After the legislation and the technologies have matured, the ECs, or another third-party actor, could purchase the grid from ÅEA and thus become grid responsible themselves (Valta et al., 2018). Parallel networks are not allowed since they are not cost-efficient for society (Pahkala et al., 2018). On the other hand, often a better choice would be to operate the network in collaboration with the DSO, where the DSO is responsible for the network's functionality (Respondent 10, personal communication, 23 April 2020).

Future legislation and technological advancement will improve the possibilities for microgrids in Finland and on Kökar. Enabling legislation is expected within the next five years (Respondent 10, personal communication, 23 April 2020). Still, there are multiple legislation-related aspects which should be considered, including taxation, pricing fairness, transparency, DSO rights and consumer rights (Järventausta et al., 2018). Decentralised business models take one step further from distributed ones, developing a self-sufficient energy system, which benefits from and provides benefits to the existing network, but does not have to be connected to it. Thus, it is the hardest to implement but very well might suit the needs of Kökar since it fulfils the locals' wishes on becoming more self-sufficient in energy, the Government of Åland's needs to develop a pilot site for new innovative solutions and even ÅEA's needs in providing electricity to the region cost-efficiently.

6.6.5 Heat ECs

The above-mentioned business models have been focusing only on electricity. Although electricity is essential on Kökar and also has an important role in heating buildings on the island, heat ECs should be presented due to the potential of the island's wood chip resources. There are no legislative barriers to the development of heat ECs. Their problems are related to the transferability and demand for heat, the required infrastructure, and profitability.

On Kökar, heat demand was emphasised due to the windy conditions on the island, the old building base, and the reliance on electrical heating (Respondent 6, personal communication, 14 March 2020). Even though Kökar is an island with a rough environment, there are substantial resources of wood chips on the island – enough to power a micro-CHP in the local school. This micro-CHP could be operated by a local EC and cover the schools heating needs, replacing the old, imported oil-dependent, system. Similar kind of experiences with micro-CHPs and ECs can be found in the Finnish villages of Alpua (Ruggiero, 2018) and Eno (Henderson, 2015).

Kökar school's micro-CHP unit would produce excess heat, which should be utilised. In Alpua, excess heat was used to dry wood chips while in Eno the locals built a district heating network. Currently, Kökar has no district heating network and building one would be 10 times more expensive than building an electricity network (Airaksinen et al., 2019). Additionally, the soil on Kökar is rocky and households are situated within a distance from each other. Still, a mini district heating system could be envisioned in the village of Karlby, which has several tertiary buildings closely built. However, many of these buildings have solved their heating needs by installing heat pumps, pellet burners or closing their operations for winter. Thus, a constant demand for excess heat would be difficult to envision. Furthermore, heat losses during transfer are three-fold compared to electricity (Airaksinen et al., 2019). With high infrastructure costs and lack of customers, the excess heat could be used for drying wood chips. In addition, new types of business models could be pursued to utilise the excess heat, such as heating water, or turning excess heat into electricity (Motiva, 2014).

In the micro-CHP, profits can be collected from electricity or heat sales. In the case of Kökar, electricity seems to be the best option due to its better transferability. Locals could buy the produced electricity from the micro-CHP using a specific electricity certification for locally produced energy, similar to Oulu Energy's Farm Power (Oulun Energia, 2015; Ruggiero, 2018). If electricity costs are low on the market, incentives to buy more expensive locally produced electricity could decrease. If low electricity prices are the norm, calculations should be made on whether to build a CHP or a smaller unit producing only heat (Jääskeläinen et al., 2018).

Local employment is needed for the CHP's maintenance and operative work, e.g. collecting, and driving wood chips, which would be beneficial for the municipality's goals of creating employment but adds costs in the CHPs operations. Moreover, the land ownership structure on Kökar can pose problems in the acquisition of wood chips. An EC could mitigate these challenges by organising itself around forest owners to ensure resource flow for the CHP, such as in the case of Eno (Henderson, 2015). Other members could join the EC, but there should be clear (often financial) benefits for the forest owners in providing their resources for the EC.

Still, the problem of profitability persists. The main challenge for heat ECs is the mismatch between supply and demand for heat (Airaksinen et al., 2019). When considering the profitability of a wood chip heating systems, several aspects should be accounted for, such as sufficient, continuous and constant heating needs (>500MWh/year) and whether the heated building has a water circulating heating system (Pöyry Management Consulting Oy, 2017). Due to the costs of building a district heating network and high transfer losses, heat-producing installations should be situated close-by to their consumption points. As Kökar is a sparsely populated island, a solution keeping the excess heat drying the wood chips could be the best option, as it reduces the fuel need up to 15% (Motiva, 2014). New technology could enable the use of excess heat in electricity production, but even in those cases, the gained production might be minor compared to the required investment.

6.6.6 Biogas ECs

Lastly, biogas EC development was analysed on Kökar. Currently, no gas infrastructure exists on the island. Similar to heat ECs, biogas ECs would be best suited for an existing network, the problem often being distribution. Even though a gas network for consumers could be built, a more likely scenario would include a supplier-based EC, where EC members are the suppliers of waste, e.g. farmers. Therefore, biogas EC would most likely be constructed of closely situated farms, who use the gas to replace purchased heat, electricity, oil or peat (Airaksinen et al., 2019). Kökar has three farms (Respondent 9, personal communication, 31 March 2020) and their low waste production does not enable the development of a biogas EC on the island (Respondent 5, personal communication, 11 March 2020). Thus, a biogas EC was found to be irrelevant for the case of Kökar. The problem with biogas ECs around Finland is the challenge of finding a reliable, high-quality, and local source of waste and demand or transfer opportunities for biogas (Respondent 5, personal communication, 11 March 2020).

6.6.7 Business model spectrum conclusion

In the future, an EC on Kökar could increase the island's energy systems self-sufficiency, raise the share of locally produced energy and improve grid flexibility. Investments in an EC occur if its operational model is attractive for its members. Therefore, the optimal situation would be when the benefits of the EC are maximised simultaneously as the energy solutions of individual member are optimised (Järventausta et al., 2018). This result could be achieved with the implementation of new innovative solutions while keeping the local community in the centre of activities. Gui and MacGill (2018) argue that the implementation of an EC could be a stepwise process where a centralised EC could mature into a distributed and decentralised EC. Indeed, the EC on Kökar could develop from a centralised system with close collaboration with ÅEA into potentially an EC or ÅEA-owned and managed microgrid. During the research process, locals appreciated the possibility to become energy self-sufficient but were uncertain on the measures to do so. For the time being, with legislation on ECs and technology still in nascent form, energy storage technology being costly and existing investment payback times in the electricity interconnection to Finland, a connection to the network and collaboration with the existing actors seems to be the more relevant and implementable solution. As Åland and Kökar will be pilot-sites for new technological solutions, the implementation of an EC with new innovative technologies such as microgrids or VPPs, in collaboration with non-local actors, could enable the development of a better functioning energy system on Kökar without having to sacrifice the island's community spirit. Taking into consideration these findings, a distributed business model EC with centralised activities will most likely become the option to pursue on Kökar since it continues collaboration with the current energy system and implements new technical solutions (Figure 6-17).

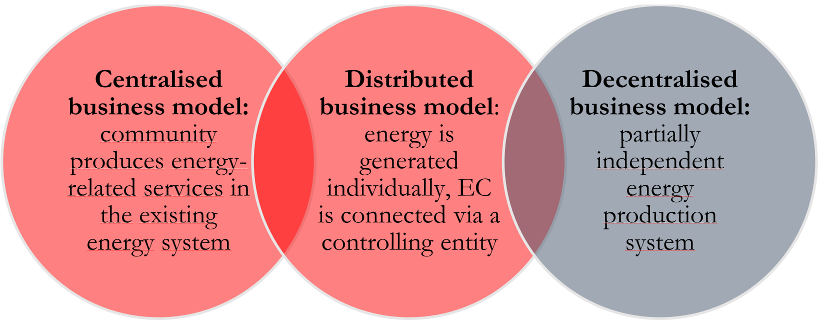

Figure 6-17. Business model spectrum based on Kökar's background factors.

Source: Adapted from Gui & MacGill (2018).

This section has outlined the suitable EC characteristics on Kökar, and their justifications based on the local background factors. Figure 6-18 summarises these characteristics and presents a potential EC for Kökar. The next section discusses these results, analyses the functionality of the EC enabling framework and provides recommendations for developers and policymakers aiming to enable EC development in their regions.

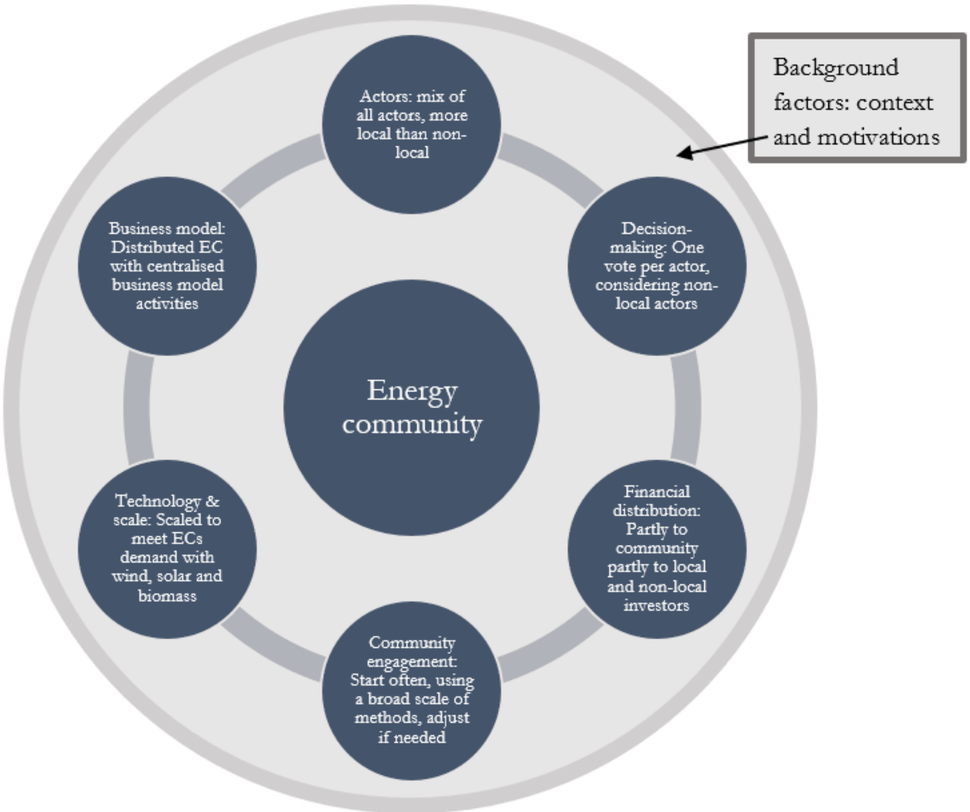

Figure 6-18. Preferred EC characteristics on Kökar.

Source: Adapted from Hicks & Ison (2018) and Gui & MacGill (2018)

7 Discussion

The previous section presented and justified the type of EC which could suit Kökar based on the background factors on the island. This section discusses the implications of the findings in two parts. First, through an analysis of the results in light of prior research. This sub-section is structured to answer the presented research questions and thus highlights the new knowledge which the findings produced. In the second phase, a critical reflection on the thesis results is performed.

7.1 Findings in light of earlier literature

This section analyses the findings in relation to earlier research outlined in the literature review. It is structured according to the research questions and their related study propositions, focusing on the second, third and fourth research questions. The first research question, i.e. What types of ECs are identified in earlier literature, was answered in the literature review. It identified eight EC types and presented their variations in the six EC characteristics to indicate how background factors affect the development of ECs. Even though these findings were from a relatively homogeneous region of North-Western Europe, variations were still discovered. Therefore, background factor studies should be highlighted in future EC development research, a point which was additionally proven in the case of Kökar, which is discussed next.

7.1.1 RQ2: What types of ECs could be developed on Kökar?

Figure 6-18 presents the six EC characteristics which construct the EC type suitable on Kökar. Below these characteristics and their suitability are discussed. The characteristics are grouped into three groups based on discovered correlation relationships and the findings' implications.

Actors, decision-making and financial distribution

Actors: A suitable EC on Kökar should have a mix of both local and non-local actors, the emphasis being on locals.

Decision-making: Decisions should be made on a 'one vote per actor' basis, similar to cooperatives and development trusts, to ensure democratic participation and local involvement.

Financial distribution: The profits from the EC's activities should be channelled mainly to individual local and potentially non-local investors, and partly to a community fund designed to develop the local community.

Although locals are generally interested in the possibility to join an EC, they are often busy with their own activities. Moreover, there is no local spirit pushing for EC development because their value is unclear due to lack of reference cases and information. To fill these gaps, non-local actors could provide the EC with information and clear social, environmental, and economic value propositions, aiming to develop sustainable ECs with a large membership base. In existing partnership ECs, non-local actors provided technical, financial and policy assistance. However, often this cost the local actors' decision-making influence, financial profits, and ownership share in the ECs. Even though Kökar has a local energy group focusing on the development of the island's energy system, non-local assistance on e.g. technical aspect is needed. Thus, a shift of profits and possibly decision-making to non-local actors, such as ÅEA and Allwinds, could be inevitable, especially with larger-scale installations. This should not pose a major problem since even though the locals considered citizen authority in decision-making and share in financial distribution to be important, they identified the right of non-local actors to collect their share of investment profits. Owing to Kökar's involvement in the Smart Energy Åland project, the costs related to non-local assistance may be smaller on Kökar than in the other examples.

In earlier research, an optimal EC is often referred to when the local community manages the project and receives its benefits. However, the findings from Kökar challenge the realisation possibilities of this simplified view. The results indicate that an EC with solely local community management and benefits is not possible due to lack of local actors' time, motivations, and resources. Therefore, non-local involvement e.g. in the form of DSO, aggregator, or funding partner is a necessity for EC development. Consequently, these non-local actors might seek a share of financial profits or decision-making rights for their investment, shifting this authority from locals to non-locals. Intermediaries or development organisations might enable ECs to maintain most of the community authority, but still, non-local actors will most likely have to be involved. However, if an EC should be first and foremost a citizen-led organisation, the necessity of non-local actors can question the need to develop ECs as the pre-mentioned EC benefits might not apply to the same extent in ECs which have high non-local involvement and authority. Thus, EC development, in reality, is often more complex than what theory suggests. These findings are especially relevant as most ECs are developed in rural regions, where their benefits are maximised (Berka & Creamer, 2018; van Veelen, 2017). As a representative of rural regions without previous experience or culture on EC development, the challenges evident on Kökar might also occur in other similar regions.

Community engagement

Community engagement: The EC on Kökar would engage its members in the beginning with various means and frequently. Communication methods and frequency should thereafter be adjusted based on the received feedback. Possible engagement channels could be social media, local monthly newspaper or face-to-face meetings and events. Significant findings in the community engagement characteristic could not be identified either from existing EC examples or from the case of Kökar due to data limitations and the absence of a pattern in responses. Therefore, while community engagement is an important part of EC development, it was identified to be a flexible variable which can be modified to fit any EC. Therefore, decisions on community engagement could be made at a later stage of EC development.

Technology, scale and business model

Technology: The EC should utilise wind power, solar power and biomass as renewable energy sources. It should complement these energy-producing technologies with energy storage, VPP and P2P trading solutions.

Scale: Energy production should be scaled to meet the ECs demand, in its aims to become increasingly energy self-sufficient.

Business model: The EC should engage in a distributed business model with centralised business model activities with the technologies mentioned above.

Existing ECs have mostly focused on centralised business model activities, i.e. energy production and consumption. By grouping themselves as an EC, individuals can invest in a larger-scale renewable energy installation, which provides them with cost savings as self-produced electricity replaces purchased electricity and additional income from possible energy exports. A suitable business model for an EC on Kökar would tap into these benefits by including centralised business activities, such as production, consumption and storage of renewable energy using wind and solar power, and biomass. The installation would be scaled to meet the ECs energy demand to fulfil the community's wishes to become increasingly energy self-sufficient and the Government of Åland's ambitions in developing an increasingly flexible and cost-efficient energy system. For transmitting electricity, the EC could utilise its own (EC crossing property boundaries) or the networks electric cable (distributed EC). With heat, EC development could be trickier due to the complex land ownership structure, lack of district heating infrastructure, possible excess heat production and poor transferability. A biogas EC was found to be unfeasible on the island. Centralised business models are functional as energy efficiency measures, but not necessarily disruptive to the current energy system, encouraging towards an energy transition. Furthermore, with the challenges posed in their profitability and dependence on volunteers, other business models could be utilised to complement them.

Centralised business activities could be supplemented with distributed business model solutions, e.g. VPPs and P2P trading, which would open new business opportunities, such as demand response for the EC. Including these solutions could contribute to the self-sufficiency plans of the EC by increasing the share of local energy on the island and allowing P2P trading. Aggregators managing the system would provide EC members or individual prosumers an easy means of joining as minimal effort is required. Thus, individuals who seek the social value of ECs could join the EC and the individuals who only wish to tap into the financial benefits could join the VPP as a prosumer. In these business models, questions are raised on the involvement of non-local actors, e.g. DSOs. The VPP on Kökar could even offer ÅEA cost savings in the form of demand-response and avoided grid maintenance costs. Nevertheless, ECs and other VPP members should to an extent participate in distribution costs to not raise the costs for non-VPP members. Novel power-based distribution tariff models could provide solutions for this dilemma (Pahkala et al., 2018).

With maturing legislation and technology, Kökar's EC could aim to become self-sufficient in energy. Legislative resolutions are expected soon in e.g. EC definitions, electrical safety, responsibilities, and taxation. The transition towards energy self-sufficiency could occur as a stepwise process working together with non-local actors. The first step would be to develop an EC engaged in centralised business activities, e.g. energy production, storage and consumption. Thereafter, a VPP could aggregate the EC's and other local prosumers' energy resources to provide them with access to additional business opportunities, e.g. demand-response and P2P trading. Both of these business models could provide ÅEA with load management services thereby avoiding grid maintenance costs and power outages. Finally, if applicable, the EC could either initiate a buy-in of the local electricity network in their ambition to become fully self-sufficient or provide energy resources for an increasingly self-sufficient grid powered by ÅEA. The network would then be operated via a centralised unit which could then be managed by ÅEA, a third-party actor or the EC. A transition towards a microgrid seems to be a long-term process. Still, as research suggests, a microgrid might be a more cost-efficient option in the long-term, for the EC and for ÅEA (VTT, 2018).

With the identification of the suitable EC characteristics on Kökar, it became evident that multiple background factors, such as energy independence ambitions and land ownership structure, affected the EC type suitable on the island. Similar results were found when analysing the existing ECs in the literature review. Based on these findings, the first study proposition is answered (Table 7-1).

Table 7-1. Study proposition findings.

Theme	Study proposition	Thesis findings
Background factors	Kökar possesses background factors which affect EC development on the island.	True. Kökar has specific characteristics, such as land ownership complexities and energy self-sufficiency ambitions which affect EC development on the island.

Source: Author's own illustration.

7.1.2 RQ3: What suggestions can be provided for EC development frameworks based on the findings from Kökar?

The findings from Kökar verify that the EC enabling framework could be utilised to identify suitable EC characteristics to aid EC development in new regions. The framework was found to capture most of the essential EC characteristics but could be adjusted for simplicity and efficiency purposes. First, the framework might be extensive considering the correlation between some of the EC characteristics, namely actors, decision-making and financial distribution as well as technology and scale, and business model. Thus, a simplification of the process might improve the efficiency of EC development when resource priority is assigned to more important characteristics. Second, community engagement characteristic was found to be less relevant in the EC development process. It does not mean that it should be removed, rather it is a flexible variable, which can attach itself to many types of ECs. Therefore, even though communication with potential EC members should be initiated early in the EC development process, the decision on what type of community engagement strategy will be pursued can wait until the other characteristics have been identified. The same qualities were found in a new characteristic, namely EC funding, the importance of which was highlighted in the collected data. Therefore, funding, as community engagement, should be included in the EC development process but might be assigned decreased priority.

With these points in mind, adjustment suggestions could be made for the EC enabling framework. In the framework of Hicks and Ison (2018), EC characteristics are presented at the same level. However, due to the multiple EC characteristic's correlation with each other, a combination of characteristics and a hierarchy between them could further improve their differentiation and simplify the EC development process. Additionally, a hierarchy could ensure concentration on the right factors, thereby improve process efficiency. In this suggestion, background factors should be identified first to guide the choice of EC characteristics. The background factors by Hicks and Ison (2018) were found to be sufficient. However, developing guiding questions for background factor identification could foster further EC development. Furthermore, when collecting data on background factors, EC developers should prepare by identifying potential value propositions and characteristics for the developed EC since knowledge within potential EC members might be limited. After background factors have been identified, two new combined EC characteristics, organisation and business models, would be analysed based on the acquired data. The last step would be to analyse the more practical aspects, such as community engagement and funding (Figure 7-1).

Figure 7-1. Suggested stepwise EC enabling framework.

Source: Author's own illustration.

Organisation

Organisation characteristic refers to the means of organising the EC and is created from the EC characteristics of actors, decision-making, and financial distribution. Both the literature review on existing ECs and the EC characteristic analysis on Kökar indicated that choices made in the actors spectrum were closely linked with the results found in financial distribution and decision-making spectrums. Additionally, the chosen organisation form (e.g. cooperative, partnership, development trust), was found to affect and be affected by all of the three characteristics. For instance, if an EC on Kökar would assume a cooperative structure, it would most likely have varying members of locals and non-local individuals, have a decision-making structure of one vote per member and distribute financial benefits for each individual based on their investment. A development trust would include local businesses on actors and have a similar decision-making structure to cooperatives but maintain profits in the local community's fund. Therefore, in a simpler model, the three characteristics could be replaced with one characteristic: 'organisation', illustrating all of them. In the Finnish legislation, multiple organisation form options exist for an EC on Kökar to adopt, including Mankala-company (non-profit organisation), foundation, registered association, housing company or cooperative (Airaksinen et al., 2019; Muukka & Huhtala, n.d.). Each of them has differences in their liability and bureaucratic rules, which should be accounted for in the choice. Further research explaining these differences would be beneficial for future EC development on Åland and in Finland.

Business model

EC business models, i.e. what EC's do, are another important aspect to consider when analysing EC characteristic suitability due to the need for ECs to become financially sustainable and attract an increased membership. A combined business model characteristic would combine the EC enabling framework's business model, and technology and scale characteristics due to their discovered correlation. For instance, locals on Kökar were found to prefer business models which would allow them to trade energy between themselves and if necessary, with the network. Additionally, they were found to favour a scale which would make the created EC energy self-sufficient. Thus, both the business model and scale characteristics are aiming to achieve the same goal. In this example, a distinction could be made whether the EC would use solar or wind power for energy generation, but the chosen scale is a result of the business model characteristics, or vice versa, i.e. to what extent locals wish to be a part of the common energy network. Therefore, a combined business model characteristic could capture both of these individual characteristics.

From the two new EC characteristics, a diagram similar to the seminal work of Walker and Devine-Wright (2008) can be constructed to illustrate their relationship (Figure 7-2). This diagram could act as a second step in the EC development process, following background factors. In it, organisation characteristic is presented vertically, where high citizen participation and authority (i.e. influence on decision-making and financial distribution) are on top and low citizen participation and authority on the bottom. Business model spectrum is presented horizontally with centralised business model on the left, distributed in the middle and decentralised on the right side of the axis. Furthermore, both organisation and business model characteristics can evolve during the EC's maturing process. Hence, an EC beginning its journey from the bottom-left box with low citizen participation and authority utilising a centralised business model, could in time transition to a position on the upper right corner where the EC is partially self-sufficient in energy and has high citizen participation and authority. None of the presented boxes are superior to others, as they merely present the variations of characteristics the ECs can assume based on the background factors the same way as the EC enabling framework does.

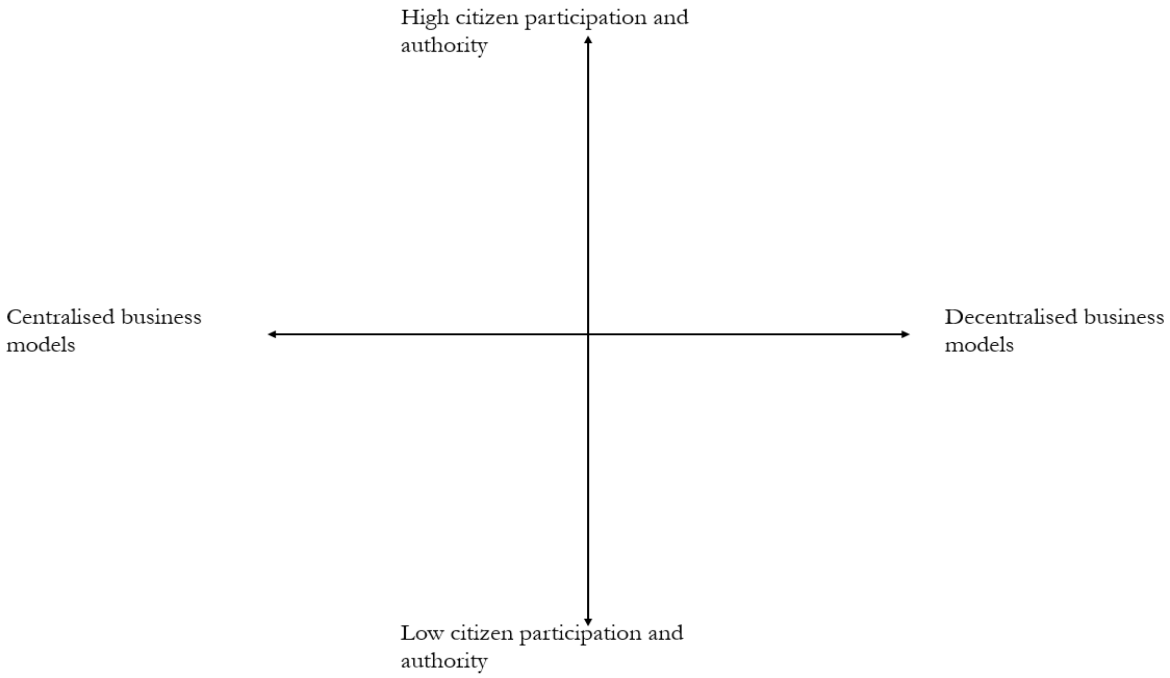

Figure 7-2. Diagram presenting the relationship between organisation and business model characteristics.

Source: Author's own illustration.

The highlighted importance of the two characteristics is justified as they incorporate most of the EC enabling framework characteristics and tackle the earlier presented significant challenges of EC membership and profitability. In the third phase of EC development, focus could be shifted to more practical aspects, areas which are important to recognise but in which decisions could be made at a later stage. These include community engagement and funding characteristics which can take varying forms to fit the EC. A good overview of other practical aspects in the Finnish context is provided by the work of the EU funded project Co2mmunity (Viljanen et al., 2020). The suggestions made in this section have advocated for a stepwise process in EC development in new regions due to the benefits gained in efficiency and simplicity. A simple stepwise process could decrease the potential perceived cumbersomeness of EC development processes. From this discussion, results on the second and third study propositions were developed (Table 7-2).

Table 7-2. Study proposition findings.

Theme	Study proposition	Thesis findings
EC characteristics	ECs are likely to differ in actors, decision-making, financial distribution, community engagement, technology and scale, and business models. No other characteristics should be found.	ECs differed in most of the characteristics. Combined characteristics of organisation and business model should be prioritised in EC development. No significant results were found from community engagement characteristic. It is a flexible characteristic which can, as the identified new characteristic of funding, be decided at a later stage of EC development.
EC enabling framework	The EC enabling framework should provide an indication of what types of EC characteristics would be the most suitable for Kökar.	The framework provided a clear idea of what type of EC characteristics would be suitable on Kökar. The suggested adjustments could be made to simplify and improve the efficiency of the framework and future EC development efforts.

Source: Author's own illustration.

7.1.3 RQ4: What recommendations can be given for EC developers and policymakers in EC development based on the findings from Kökar?

The previous sections have explained the type of EC suitable for Kökar and suggested adjustment to the EC enabling framework and future EC development efforts. This section presents recommendations based on these findings for EC developers and policymakers aiming to develop ECs.

Identifying the background factors is important to understand the specific EC characteristics suitable for each region. Thus, a study on background factors should be conducted before developing ECs. Preparation is needed for their study as potential members are most likely not familiar with ECs. These preparations include e.g. the identification of existing EC types and funding opportunities, as well as their impact on the EC. For instance, background factors on Kökar indicated that the island needed non-local assistance to develop an EC. Context and motivation by Hicks and Ison (2018) were found to be appropriate and profound enough for a background factor study. The data collection questions utilised in this thesis are presented in appendices, but additional research could be allocated to preparing question guides for background factor identification.

Further assistance is needed for EC dissemination, providing opportunities for multiple actors. When researching the case of Kökar, many factors point to the fact that the island is in a more fortunate state than any taken region in Åland or Finland. In addition to local leadership, sustainable mindset, and favourable conditions, Kökar is a part of the Clean Energy for EU islands initiative and Smart Energy Åland project, which provide the island with development assistance. The limited time, awareness, and resources of the local community indicated that non-local assistance was needed. Similar assistance is most likely needed in other regions aiming to develop ECs. Currently, due to the nascent form of legislation and technology, Finland does not have intermediaries providing information and aiding communities in EC development. Even though this situation is expected to change in time, more information, clear value propositions and development assistance are needed to enable an increased number of communities to discover ECs and their benefits. In other words, ECs should be commercialised for communities. Furthermore, the lack of reference cases is one reason for, and a contributor to, the inexistent EC development culture in Finland. Thus, local pilot cases should be developed to raise awareness of EC success stories. All of the described activities can be carried out by and provide opportunities for a range of actors including customer support groups (real-estate federation), governmental organisations (Motiva), private actors (aggregators) or specialised EC intermediaries.

The EC enabling framework with its adjustment could be utilised for simpler and more efficient EC development. The EC enabling framework provided a good base for EC development in new regions by identifying most of the necessary aspects. The new suggested adjustments to the framework aim to simplify and improve the efficiency of further EC development efforts. In the suggested adjustments, background factors should be identified first, followed by organisation and business model characteristics to create a strong membership base and financially sustainable operations. These two characteristics were found to solve the largest problems in EC development, and thus should be prioritised before assessing more practical factors, such as engagement methods and funding sources. However, it does not imply neglecting the practical factors until the end of the process. On the contrary, they are important when beginning the development of ECs and should be presented for possible EC members during the background factors study. While the EC enabling framework with its suggestions provides a base for EC development, new research should test, utilise, complement and improve the presented framework to create an increasingly functional and realistic EC development model.

7.2 Reflections on findings of the thesis

This thesis was conducted as a single case study on the island of Kökar, using the EC enabling framework, which has six EC characteristics based on the regions background factors. Therefore, its limitations are mainly related to the utilised framework, the chosen data collection and analysis methods and that it is a single case study which gives a limited amount of data. Additional reflections are issued to research the study's research questions.

The EC enabling framework with the background factors and EC characteristics included in it was adapted from two sources (Gui & MacGill, 2018; Hicks & Ison, 2018) obtained via a literature review. Although other sources on EC development concepts and frameworks could be found from EC support organisations (Roberts et al., 2014; Viljanen et al., 2020), the ones chosen to the EC enabling framework were one of the sole ones discovered in academic literature and found to incorporate the essential qualities for ECs based on the literature review. Still, the chosen EC enabling framework characteristics are subject to the limitations of the two chosen articles and their findings.

As mostly qualitative data collection and analysis methods were used, researcher-interpretation of data was required, possibly introducing bias. Mitigation strategies included e.g. illustration of the research process in the appendices and diversifying data sources. Although multiple data sources were used, the limited survey answers and focus group attendance could be subject to bias since most local respondents reacted enthusiastically to ECs, meaning that more critical respondents were not necessarily reached. This could lead to an overly optimistic view of ECs possibilities on Kökar. However, even though the results were obtained from a limited population, they indicate a clear will to develop an EC on Kökar. The EC could begin with a smaller membership and thereafter attract more members when its functionality is verified. Still, the results are directional since the real nature of EC development on Kökar can only be studied by a pilot case. It is a different case to indicate one's willingness to participate in a theoretical EC than to invest one's time or money in a realised EC.

A single case study was conducted on Kökar, meaning that statistical generalisation on the results cannot be made. Still, with the chosen methodology and the measures taken to mitigate research limitations, an analytical generalisation is possible. Thus, suggestions for EC development theory can be provided. Additionally, the results concerning suitable EC characteristics on Kökar, the EC enabling framework, and the recommendations proposed are of general interest both for academia and for EC developers and policymakers in regions similar to Kökar.

The utilised research questions formed a chronological structure, guiding the research process. Their development process was iterative, where the questions were given minor modifications during the thesis period based on the findings to ensure that the research direction was accurate. The questions were developed to be answerable within a thesis, specific enough to not need clarification and consistent with each other due to their chronological nature. Their relevance was guaranteed through these measures and continuous feedback from the thesis supervisor. Therefore, with these measures taken, all of the research questions were answered within the thesis research and found to suitable for a master's thesis.

8 Conclusions and recommendations

In the energy transition from centralised and fossil-fuelled energy production to decentralised and renewable energy production ECs offer possibilities in increasing citizen-led self-production of energy. ECs have a variety of individual and societal benefits attached to them. However, currently, their produced energy is minor and mostly focused on certain regions. With the introduction of the EU's Clean energy for all Europeans package, the EU is aiming to enable further adoption of ECs to fulfil their potential in the energy transition. Additionally, new technologies and actors on the energy market provide new opportunities for ECs which could enable their further diffusion in the new legislative environment. Current research has mostly focused on existing ECs in North-Western Europe, focusing less attention to the area of EC development in new regions without existing EC culture. The objective of this thesis has thus been to contribute to this work and the energy transition ambitions of the island of Kökar by analysing EC development on Kökar via a developed EC enabling framework. Moreover, it recommends future steps in EC development relevant for practitioners and academia. The next sections provide an answer to the research questions stated to fulfil this aim.

Firstly, when analysing earlier research, eight different types of ECs were identified. Even though the conducted literature review focused mainly on North-West European countries, variations between ECs on the six EC characteristics were still recognised. This finding showed that even in relatively homogeneous regions, variations between ECs exist, indicating the significance of background factor studies in EC development. This was confirmed on Kökar since important motivations and contextual anomalies could not have been found without a thorough background factor study. Background factor studies are especially relevant when aiming to develop ECs in new regions in the EU and beyond.

Secondly, from the collected and analysed background factor data, a suitable EC for Kökar was found. A suitable EC would emphasise local actors but include non-local actors as well. The emphasis on locality, stemming from the strong ambition for energy self-sufficiency on the island, has implications on the decision-making structure and financial distribution on the EC. A similar correlation between actors, decision-making and financial distribution characteristics was found in existing ECs. Decisions in the EC should be made on a 'one vote per actor' basis while the benefits would be channelled to local or non-local investors and partly to a community fund. Although ECs are often referred to as community groups, in the case of Kökar, the limitations of local resources meant that the inclusion of non-local actors and resources was necessary for EC development. This could lead to an increase in non-local actor influence in the EC's decision-making and financial distribution. Kökar's EC would engage its members by various means and regularly, e.g. via the local newspaper and social media, and adjust its strategy according to the received feedback. The relevance of community engagement was challenged due to lack of data points in both existing ECs and on Kökar, which has implications in the suggestions for future EC development. The chosen business model would utilise a distributed business model with centralised business model activities. The EC's wind power, solar power and biomass installations would be scaled to meet the EC's energy demand and complemented with technologies such as VPPs, P2P trading facilitated via collaboration with non-local actors. With future technological, energy market and legislative development, the EC could seek to become self-sufficient in energy. Similar to the first three characteristics, technology and scale and business model characteristics were found to correlate with each other, which has implications on the suggested future EC enabling framework.

Thirdly, correlations could be found between some EC characteristics while no significant results were discovered from others. This suggests that some characteristics could be combined, and a stepwise hierarchical EC development process created. Therefore, suggestions were made to adjust the EC enabling framework to improve EC development processes' simplicity and efficiency. The modified framework acknowledges the importance of background factors and maintains their position. Next, the combined EC characteristics of organisation (actors, decision-making, financial distribution) and business model (business model, technology and scale) should be analysed. Afterwards, the practical aspects, e.g. community engagement and funding, which can fit the results from the previous phases, should be addressed.

8.1 Recommendations for EC developers and policymakers

From the above-presented findings, recommendations can be produced for EC developers and policymakers aiming to develop ECs. These recommendations aim to contribute to further EC dissemination in new regions.

Identifying the background factors is important to understand the specific EC characteristics suitable for each region. Researching background factors and how they affect EC characteristics are vital in the process of EC development. These efforts should not be neglected and require preparation.

Further assistance is needed for EC dissemination, providing opportunities for multiple actors. ECs require support which could be provided by and offer opportunities for a variety of public and private organisations. Supportive activities include EC development assistance, information package and value proposition production, and reference cases.

The EC enabling framework with its adjustment could be utilised for simpler and more efficient EC development. A simple stepwise process allows for more efficient resource allocation in EC development while still including the important factors. Future research can utilise, complement and improve the EC enabling framework to develop a simple and comprehensive EC development model.

8.2 Academic contribution and recommendations for future research

With this thesis, academic literature is provided with a case study on EC development in a region without existing EC culture. This is especially relevant in the current energy transition aspirations as new legislation (Clean energy for all Europeans package), technologies (VPP, microgrid, P2P trading) and actors (aggregators) are emerging, and thereby increasing ECs' relevance on the political and academic agenda. As ECs have mostly been studied in North-Western European countries, research on other nations is welcomed. Furthermore, this thesis adds to the studies on EC development, which have been studied less in earlier literature. By utilising and improving the EC enabling framework, the conducted research contributes to the development of ECs in new regions, and the academic field studying this development.

With the case of Kökar, this thesis has provided a test case for EC development in regions without existing EC development, meaning that more research is needed for a comprehensive EC development model. For instance, future research could focus on analysing potential EC organisation forms in Finland or EC funding opportunities. In general, the development of legislation and technology surrounding ECs requires researchers to follow this process and analyse the implications of the suggested and realised events on EC development. Additionally, as this thesis was conducted as a single case study, other studies on similar regions are needed to assess the generalisation potential of its findings. Moreover, the suggested adjustments in the EC enabling framework will have to be evaluated by further studies. Lastly, to analyse whether the EC enabling framework functions in practice, one research area would be to test it in a pilot case on Kökar and thereby create practical legitimacy for it. Locals on Kökar seem prepared for this as some of them yearned for concrete measures rather than continuous research. A pilot case on Kökar could further increase the locals' motivations to join an EC.

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Appendix

Appendix A: List of keywords used in the literature review

Category	Keywords	Database
Academic literature	Energy community • Community energy • Grassroots energy • Local energy • Community renewable energy Combined with • Business model • Typology • Development	Scopus Web of Science ScienceDirect EBSCOHost Google Scholar
Grey literature	Energy community/ Community energy & business models Energy community/Community energy & types/typologies Energy community/Community energy & development	Google.com

Appendix B: List of interview respondents

Interview respondent	Position	Organisation type	Date	Duration (min)	Interview method	Main theme
Respondent 1	CEO	Private sector	5.3.2020	60	Phone interview	Åland's and Kökar's energy system (Institutional context and motivations)
Respondent 2	Senior Adviser	Government	6.3.2020	30	Online-interview	Finnish EC legislation and energy markets (Institutional context)
Respondent 3	Project manager	Private sector	9.3.2020	60	Online-interview	Åland's and Kökar's background factors and Kökar's energy transition ambitions (Communal context and motivations)
Respondent 4	Associate professor	University	9.3.2020	60	Online-interview	Finnish EC legislation and energy markets (Institutional context and motivations)
Respondent 5	Executive Director	Association	11.3.2020	60	Online-interview	Finnish EC legislation and energy markets (Institutional context and motivations)
Respondent 6	Project coordinator	Association	14.3.2020	90	Face-to-face interview	Kökar's background factors (Communal context and motivations)
Respondent 7	Project coordinator	Association	14.3.2020	60	Face-to-face interview	Kökar's background factors (Communal context and motivations)
Respondent 8	Electricity inspector	Government	23.3.2020	60	Online-interview	Åland's EC legislation (Institutional context and motivations)
Respondent 9	Project manager	Private sector	31.3.2020	60	Online-interview	Kökar's background factors and Kökar's energy transition ambitions (Communal context and motivations)

Respondent 10	Professor	University	23.4.2020	30	Online-interview	EC and microgrid opportunities in Finland and Åland (Institutional context and motivations)

General interview guide

Interview questions were tailored for each interview respondent from a set of general questions. These questions and the general interview guide is presented below.

- Presentation of author
- Presentation of research
- Presentation of how obtained data is used and protected as well as the right of the respondents

There are three question themes (institutional contextual factors, community contextual factors and motivations). Some of the interview respondents were asked only two of the question themes while some will answer on all of the questions.

Institutional context:

The purpose of this section was to understand the structure of the energy market, regulatory environment, laws governing legal structures, renewable energy policies, culture within existing energy and other relevant institutions.

- Could you describe the structure of Kökar's/Åland's/Finland's energy market?
    - What actors are involved?
    - How do they work together?
    - Are there any small-scale or citizen-owned organisations and what is their role?
    - Does someone have more leverage than others?

What regulations relevant to energy communities exist?

- How do they affect the energy market?
- What is their current schedule?

How do you see Kökar's/Åland's/Finland's energy market changing in the future, with Åland's energy transition ambitions?

- What role does your organisation have in this transition?
- What opportunities and benefits does the transition provide you?
- What challenges do you face because of the transition?

What do you know about energy communities?

- What role could your organisation have with energy communities?

- Do you know of other organisations which could assist in the creation of energy communities? Assistance could include e.g. inspiration, technical advice, and financial support.

Communal context:

This section aims to gain insights on the local history and culture especially in terms of communal collaboration and energy aspects. Additionally, it seeks to identify relationships and social capital in the community, skills, and knowledge available, and perceptions of and acceptance towards certain technologies.

Background information

Narrative & culture

- How is life on Kökar?
- How do people discuss sustainability, community action or renewable energy on Kökar? Why is it like that?
- Are there other values or aspects you think are worth mentioning?

Assets on Kökar

Relationships and social capital

- What is the community spirit on Kökar like? Is there an active community?
- What kind of community activities are there?
- Why is the community active?
- What areas would you include in this community? E.g. Does it include only certain villages, the whole island or also other islands?

Skills and knowledge available

- What skills do people have? I.e. What are the professions of people? Is there any experts in communication, energy, environment, technical aspects, politics?

Perceptions

Energy market status

- How do you perceive the current energy situation on Kökar?
- Would you want to change something in it?
    - If yes, why?

Acceptance

- What do you think about renewable energy, e.g. wind and solar, burning biomass?
- What do you think about the possibility of Kökar becoming 100% renewable?
- Are there challenges that a change in the energy sector, e.g. increase in renewables, could create?

Explain my view of energy communities to the respondents, then ask:

- What do you think about energy communities?
- Would you like to be a part of an energy community?
    - Why/Why not?

Motivations

The purpose of this section was to find out what motivations exist on Kökar in joining possible energy communities. Then with questions on the six EC characteristics the respondent would create a picture of the type of energy community they would see suitable on Kökar.

Motivation

- What benefits would you see being a part of a sustainable community group like an energy community on Kökar?
    - Let them answer first, but possible responses could be e.g. autonomy, control, community identity, environmental, social, economic, technological, and political
    - Do you see any barriers here on Kökar for such a group to form?

You are now in a situation where you are a part of an energy community on Kökar. Cross the option which you think is the best in each characteristic. Then explain why you chose that option.

Actors in the energy community:

- Who should be the members of an energy community on Kökar? Select only one option.
    - Only local individuals
    - Local individuals, organizations, government, and companies
    - Mix of all actors, more local than non-local
    - Mix of all actors, more non-local than local
    - Only non-local organizations, government, and companies
    - Other

Decision-making:

- Who should make decisions in the energy community? Select only one option.
    - One vote per member
    - Some actors get more, less or no votes
    - Limit shareholding to ensure no single controlling interest
    - Actors' votes correlate to level of shareholding
    - One actor has all the votes
    - Other

Financial distribution:

- How should an economic profit be distributed among the members? Select only one option.
    - Community fund to be used for communal benefits

  - Partly to community, partly as dividends to local investors
  - All to local investors
  - Partly to local investors, partly to non-local investors
  - All to non-local investors

Community engagement:

- Using which methods (e.g. newspaper, email, social media, etc.) and how frequent would you want the energy community's communication to be? Select only one option.
  - Occurs often and with a board range of methods
  - Occurs often, but is sporadic using less methods
  - Occurs via various means but only during key times of the project
  - Occurs only at key times, using limited methods
  - Occurs rarely and via very limited methods
  - Other

Technology and Scale:

- How big do you think renewable energy production should be on Kökar? Select only one option.
  - Should partially meet the energy community's demand
  - Should fully meet the energy community's demand
  - Should cover the entire island's demand
  - Should cover the entire island's demand and export
  - Other
- Which technologies do you consider the most suitable for Kökar? Select all that apply.
  - Wind
  - Solar
  - Biomass (wood)
  - Water
  - Store energy in e.g. batteries
  - Other.

Business model:

- How do you think the energy community should handle surplus electricity? Select only one option.
  - Sell surplus electricity to the network.
  - Sell surplus electricity between Kökar's residents, municipal buildings and to the network if needed.
  - Sell surplus electricity between Kökar's residents, municipal buildings. Kökar has its own network.
  - Other

Conclusion

- Thank the respondent
- Explain the next steps in the research
- Repeat respondent rights and how the interview results will be used

Appendix C: Focus group events and energy group meeting on Kökar 12.-14.3.2020

Meeting	Time	Place	Attendance	Purpose	Structure
Focus group 1	12.3.2020 15:00 – 18:00	Municipal office, Kökar	7	Communal context and motivations	Presentation of thesis and open discussion on ECs and survey questions
Energy group meeting	13.3.2020 15:00 – 17:00	Municipal office, Kökar	7	Discussing Kökar's energy ambitions (Communal context and motivations)	Presentation of thesis and involvement in the discussion
Focus group 2	14.3.2020 12:00 – 15:00	Sommarlängan (elderly home), Kökar	2	Communal context and motivations	Presentation of thesis and open discussion on ECs and survey questions

Focus group announcement in the local newspaper.

The text was translated from Swedish to English by the author.

Hi!

My name is Joonas Söderholm, and I am a master's student at Lund university in the program of environmental management and policy. I am 26 years old and from Sipoo. In my spare time I enjoy sports, traveling and hiking in nature. Currently, I am writing my master's thesis with Flexens on the opportunities of energy communities on Kökar. In my thesis I will research different types of energy communities in the world, investigate how they would fit on Kökar and then analyse what should be considered when energy communities are being realized on Kökar.

An energy community is a collaboration between stakeholders (e.g. local individuals, companies, and municipalities) where they produce, consume, and sell their own renewable energy with the primary purpose of creating benefits for the local community and the society. There are different types of energy communities which vary in their participating actors and investment amounts. Energy communities in other countries (e.g. the Scottish isles) have reduced energy costs and enabled new investments into the local community.

I am interested in what you as residents think about possible energy communities on Kökar. Therefore, I will visit Kökar 11.3.-14.3. During this time I will organize two different events where I offer coffee and buns, where you can meet me, answer some questions about energy communities on Kökar and express your opinions:

- Thursday 12.3. in Kökar municipal office, Karlby between 15:00 and 18:00
- Saturday 14.3. in Sommarlängan, Hellsö between 12:00 and 15:00

In addition, if you want to answer questions by phone or e-mail, or book time with me between 11.3 - 14.3, here are my contact information:

- Email: XX@XX.XX
- Phone: XXXXXXXX

All information I receive is handled anonymously. The information I get will only be used in my master's thesis, which will be published in Lund University's database.

Thanks in advance to all of you and hope to see you on Kökar!

Joonas Söderholm

Appendix D: Survey structure

Survey announcement and presentation in Facebook.

Translated from Swedish to English by the author.

Hey all!

My name is Joonas Söderholm, and I am a 26-year old master's student at Lund University, in the program environmental management and policy. Currently, I am writing my master's thesis with Flexens on the potential of energy communities on Kökar. In my master's thesis I will research different types of energy communities in the world, explore how they could fit into Kökar and analyse the conditions for creating an energy community on Kökar. That is why I am interested to hear how you as residents think about the possibilities of a potential energy community on Kökar. All the answers in this survey would be very helpful. The survey is mostly aimed at permanent residents and summer residents who stay on Kökar for longer periods, but I gladly receive all the answers I can get :)

All information will be handled anonymously. The result will only be reported in my master's thesis, which will be published in Lund University's database. It takes about 5-10 minutes to answer the questionnaire.

PS. In addition, I will visit Kökar between 11.-15.3. I wrote a little message about this in the last Kökarinfo. Hope to see you next week!

Link to the survey: XXXXXXX

Survey structure

Translated from Swedish to English by the author.

My name is Joonas Söderholm, and I am a 26-year old master's student at Lund University, in the programme environmental management and policy. Currently, I am writing my master's thesis with Flexens on the potential of potential energy communities on Kökar. In my thesis I will investigate different types of energy communities in the world, how they could fit into Kökar and analyse the conditions for creating an energy community on Kökar. That is why I am interested to hear how you as a resident think about the possibilities of an energy community on Kökar. All information will be handled anonymously. The result will be reported in my master's thesis, which will be published in Lund University's database. It takes about 5-10 minutes to answer the questionnaire.

An energy community is a collaboration between local stakeholders (e.g. locals, companies, and municipalities) where they jointly produce, consume, and sell their own renewable energy in order to benefit the local population and the community. There are different types of energy communities and they vary in how much commitment is required from members and the amount of investment needed. An energy community can be e.g. a wind power cooperative like Middelgrunden in Denmark or a development organization like North Harris Trust in the Scottish Islands. In other countries, energy communities have contributed to reduced energy costs, increased the local community's control of energy production, and enabled new investments in the local community.

Section 1

1. What benefits do you see with an energy community? (You can select multiple options). Select all that apply.
    a. Cheaper energy
    b. The local community is given more control over both energy production and use
    c. Additional income to the municipality / community
    d. The use of renewable energy reduces carbon dioxide emissions
    e. Enables joint activities among local residents
    f. Other
2. Are you interested in becoming a member in an energy community?
    a. Yes (Continue to section 2)
    b. Yes, if it does not require any extra work (Continue to section 2)
    c. No (Continue to section 3)

Section 2

3. Why do you want to be a member in an energy community?
    a. Open answer (Continue to section 4)

Section 3

4. Why do you not want to be a member in an energy community?
    a. Open answer (Continue to section 4)

Section 4: Energy community types

Energy communities can differ between regions. They can vary depending on how the following factors look in a place: which actors are there, how decisions are made, financial distribution in the energy community, size, technology used, local community commitment methods and frequency, and business models. The following questions represent these characteristics.

5. Actors in the energy community: who should be the members of an energy community on Kökar? Select only one option.
    a. Only local individuals
    b. Local individuals, organizations, government, and companies
    c. Mix of all actors, more local than non-local
    d. Mix of all actors, more non-local than local
    e. Only non-local organizations, government, and companies
    f. Other
6. Decision-making: Who should make decisions in the energy community? Select only one option.
    a. One vote per member
    b. Some actors get more, less or no votes
    c. Limit shareholding to ensure no single controlling interest
    d. Actors' votes correlate to level of shareholding
    e. One actor has all the votes
    f. Other
7. Financial distribution: how should an economic profit be distributed among the members? Select only one option.
    a. Community fund to be used for communal benefits
    b. Partly to community, partly as dividends to local investors
    c. All to local investors

    d. Partly to local investors, partly to non-local investors
    e. All to non-local investors
8. Community engagement: Using which methods (e.g. newspaper, email, social media, etc.) and how frequent would you want the energy community's communication to be? Select only one option.
    a. Occurs often and with a board range of methods
    b. Occurs often, but is sporadic using less methods
    c. Occurs via various means but only during key times of the project
    d. Occurs only at key times, using limited methods
    e. Occurs rarely and with very limited methods
    f. Other
9. Scale: How big do you think renewable energy production should be on Kökar? Select only one option.
    a. Should partially meet the energy community's demand
    b. Should fully meet the energy community's demand
    c. Should cover the entire island's demand
    d. Should cover the entire island's demand and export
    e. Other
10. Technology: Which technologies do you consider the most suitable for Kökar? Select all that apply.
    a. Wind
    b. Solar
    c. Biomass (wood)
    d. Water
    e. Store energy in e.g. batteries
    f. Other.
11. Business model: How do you think the energy community should handle surplus electricity? Select only one option.
    a. Sell surplus electricity to the network.
    b. Sell surplus electricity between Kökar's residents, municipal buildings and to the network if needed.
    c. Sell surplus electricity between Kökar's residents, municipal buildings. Kökar has its own network.
    d. Other

Section 5: Demographics

12. Are you?
    a. A woman
    b. A man
    c. Other
13. How old are you?
    a. 18-29
    b. 30-49
    c. 50-69
    d. Older
14. Do you live on Kökar all year?
    a. Yes
    b. No, I am a summer resident
    c. No, I am a visitor / interested on Kökar and its events
15. What is your profession
    a. Open answer

Thanks for your reply, it is now registered. If you have any more questions or would like to discuss more about energy communities, you can contact me by emailing XX@XX.XX or phone XXXXXXXX.

Appendix E: NVivo coding structure

<table>
<tr><th colspan="2">First cycle coding: Structural coding</th><th colspan="2">Second cycle coding: Pattern coding</th></tr>
<tr><td rowspan="8">Context</td><td rowspan="3">Physical: Topography, energy infrastructure and renewable energy resources. Subgroups of Kökar and Åland.</td><td rowspan="3">Actors</td><td>Citizen groups</td></tr>
<tr><td>Local administration and economy</td></tr>
<tr><td>Non-local actors (ÅEA; Allwinds, Government of Åland, intermediaries)</td></tr>
<tr><td>Technological: Cost and maturity of technology. Energy demand and profile of community. Subgroups of Kökar and Åland.</td><td>Decision-making</td><td></td></tr>
<tr><td>Institutional: Structure of energy market, culture between institutions and regulatory environment. Subgroups of Kökar, Åland and Finland.</td><td>Financial distribution</td><td></td></tr>
<tr><td rowspan="3">Communal: History, culture, social capital, skills and knowledge in the region. Only Kökar.</td><td>Community engagement</td><td></td></tr>
<tr><td rowspan="2">Technology and Scale</td><td>Scale</td></tr>
<tr><td>Technology (solar power, wind power, biomass)</td></tr>
<tr><td rowspan="6">Motivations</td><td rowspan="6">Social
Economic
Environmental
Political
Technological
Only Kökar.</td><td rowspan="6">Business model</td><td>Funding</td></tr>
<tr><td>Centralised business model</td></tr>
<tr><td>Distributed business model</td></tr>
<tr><td>Decentralised business model</td></tr>
<tr><td>Heat ECs</td></tr>
<tr><td>Biogas ECs</td></tr>
</table>