COMMUNITY MICROGRID ATTRACTIVENESS - A DECISION-MAKING SUPPORT TOOL FOR PARTICIPATION AND INVESTMENT

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Copyright statement

Dedication

This thesis is dedicated to my parents and my friend Chela – real forerunners of the energy transition.

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Abstract

It is widely accepted that community microgrids (CMs) play an important role to support local energy transitions (e.g. Warneryd, Håkansson and Karltorp 2020; Valta, Mäkinen and Kirjavainen 2022; Behrendt 2023). To mainstream CM solutions and support a 'just' energy transition, it requires both the participation of citizens who will form energy communities (ECs) in microgrids and investment from sustainable investors to cover the high upfront costs of CMs. However, perceived complexities and uncertainties of CMs result in a lack of participation and investments.

The aim of this research is to disentangle the complexity of CMs through both the communities' and investors' perceived 'notion of attractiveness'. This research follows the objective to develop and detail the 'Community Microgrid Attractiveness' Framework (CMA) as a support tool for designing attractive CM solutions that intrinsically engage and attract ECs and investors to participate and invest in CMs. Hence, this research contributes to a better understanding of what would make participation and investment attractive to drive salient engagement decisions.

First, this research developed a conceptual framework through a literature review, the CMA. The CMA reveals that attractive CM solutions for communities and investors depend on purpose and context. With this perspective, the CMA presents a) the key pillars of CM concept for decarbonisation, decentralisation, digitalisation, and democratisation; b) the roles and responsibilities for communities and investors; and c) how these elements align to create attractive environmental, social, technological, and economic benefits under the local context. Second, the CMA was then applied using a case study research design in two island settings: the Orkney Islands (UK) and the Canary Islands (Spain). For each case study, data was collected using surveys, interviews, and secondary sources.

The research results demonstrate that the CMA supports local CM designs that are attractive to both EC and investors. Attractive solutions first identify the local baseline and contextual issues, with drivers and barriers, then identify and align motivations and priorities, and finally tailor and develop business model (BM) innovations. Overall, the research highlights the need for maximising shared benefits, creating value-bundles, increasing trust, and allowing engagement with time. In conclusion, the CMA serves as a tool to support the design of attractive CM and BM solutions that drive positive decision-making of ECs and investors.

List of selected publications

Journal articles (under review)

Galanakis, K., Heinz, H., & Marggraf, C., 2023. Place-based sustainable urban mobility: a conceptual framework to spark local designs. *Regional Studies.*

Policy papers

Heinz, H., Marggraf, C., & Galanakis, K., 2022. Achieving net zero carbon transport in our cities: Key issues for policy makers [online]. Independent Transport Commission. Available at: http://www.theitc.org.uk/wp-content/uploads/2022/11/ITC-Zero-Carbon-Cities-report-Oct-2022.pdf.

Conference proceedings extracted from this thesis and other research activities

Heinz, H., Galanakis, K., Bueno Vega, C. and Valero-Silva, N., 2020. Human-centric business models as an approach for financially viable positive energy districts. In: *British Academy of Management (BAM) 2020 Conference. "Conference in The Cloud", Online, 2-4 September 2020* [unpublished].

Heinz, H, 2020. Egni Co-op -Can energy cooperative business models contribute to PEDs? In: *III Congreso de Jóvenes Investigadores e Investigadoras de Canarias y el I Congreso Internacional de Jóvenes por la Investigación 2020, Online, 26-27 November 2020* [unpublished].

Heinz, H., Galanakis, K., and Valero-Silva, N., 2021. A decision-making support tool for Island Microgrid Finance. In: *2nd Nottingham Business School Doctoral Symposium 2021, Online, 21st June 2021* [unpublished].

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Heinz, H., Derkenbaeva, E., Galanakis, K., and Stathopoulou, E., 2021. Decarbonisation pathways: a foresight exercise in the Canary Islands. In: *ISPIM Connects Valencia – Reconnect, Rediscover, Reimagine Conference 2021, Valencia, Spain, 29 November – 1 December 2021.* Manchester. Available at: https://www.proquest.com/docview/2617202851.

Heinz, H., Galanakis, K., 2022. Fair and attractive energy flexibility business models for a just energy transition. In: *Unlocking Flexibility: A research, policy, and practice workshop, Newcastle University, United Kingdom, 16-17 May 2022* [unpublished].

Heinz, H., Galanakis, K., Valero-Silva, N., 2023. Tailored attractive business models for community microgrids to drive community and investors engagement and collaboration. In: *Online CBIM 2023 International Conference., Online, 12-13 June 2023* [unpublished].

Heinz, H., Galanakis, K., Valero-Silva, N., 2023. The attractiveness of community microgrids in islands for a just local energy transition. In: *RSA Annual Conference 2023 - Transforming Regions: Policies and Planning for People and Places., School of Economics and Business, University of Ljubljana, Slovenia, 14-17 June 2023* [unpublished].

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Heinz, H., 2021. Socially driven business models for people-oriented renewable energy communities in island environments. In: *Best practices in adaptation pathways for the energy sector*. [Webinar]. SOCLIMPACT [unpublished].

Heinz, H., 2022. The Canary Islands in Action. In: *Sustainable Islands in Action*. [Webinar]. Enlit Europe. Available at: https://youtu.be/NDvNwkRxJsQ?feature=shared.

Heinz, H., 2023. Orkney Islands Case Study – an attractive community microgrid solution. In: *Community Engagement in Energy Projects in the Orkney Islands.* [Webinar]. EPCR. Available at: https://youtu.be/GR1VNkoUkt4?feature=shared.

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List of Abbreviations

Abbreviation	Plural used	Definition
4 D	4 Ds	Decarbonisation, Decentralisation, Digitalisation and Democratisation
BM	BMs	Business model(s)
CHP		Combined Heat and Power
CM	CMs	Community Microgrid(s)
CMA		Community Microgrid Attractiveness Framework
DSO	DSOs	Distribution System Operator(s)
EC	ECs	Energy community (Energy communities)
ESG		Environmental Social and Governance
EU		European Union
EV	EVs	Electric Vehicle(s)
GHG		Green House Gas
IoT		Internet of Things
P2P		Peer-to-Peer
PPA	PPAs	Power Purchase Agreement(s)
PV		Photovoltaic
R&D&I		Research, Development, and Innovation
SBM	SBMs	Sustainable Business model(s)
UK		United Kingdom
V2G		Vehicle to Grid

1 Introduction

In the fight against global climate change and to limit CO_2 emissions[1], the European Union (EU) aims to achieve the so-called 4 Ds of the energy system: decarbonisation, decentralisation, digitalisation and democratisation (Soutar 2021). To enable a just energy transition, two of the pinnacle principles of this strategy are putting communities into the heart of the future smart energy system and leaving no one behind (Williams and Doyon 2019; Nolden, Barnes and Nicholls 2020; Smith et al. 2023). Thus, not only technology but also governance needs to adapt to enable successful energy transition pathways. Along these pathways, local environmental, technological, economic, and social challenges, enforced and caused by climate change, should be tackled simultaneously (Isaksen, Trippl and Mayer 2022). These issues pave the way for smart local community microgrids (CMs) as a fundamental solution for local energy transitions (Pullins 2019). CMs could become increasingly relevant as a tool to put these energy transition[2] ambitions into practice (Di Silvestre et al. 2018; Lowitzsch, Hoicka and Tulder 2020; Hoicka et al. 2021; Arvanitopoulos, Wilson and Ferrini 2022).

Based on long established and emerging definitions (e.g. Hatziargyriou 2013; Mauger 2022): The diverse abilities of CMs support local *decarbonisation* but also the decarbonisation of the connected main power grid. CMs are *decentralised*, smart local energy systems for local energy generation, consumption, distribution, and control. They combine and integrate various innovative, flexible, and renewable energy technologies within their electrical boundaries. *Digitalised*, active control and management allows for microgrids to flexibly operate connected or disconnected from main power grid, while always maintaining efficient local energy balances. It similarly allows the energy community (EC) - the group and multitude of residents, active and passive energy users and prosumers[3] that live and interact in a community microgrid (CM) – to indeed be at the heart of the system and engage and participate in decision-making and energy services (Bauwens et al. 2022; Tarpani et al. 2022). The communities' *democratic* participation is crucial to make the CM economically and environmentally sustainable, but is often challenged,

[1] The key targets in the EU for 2030 are reduction of greenhouse gas emissions by 40%, increase of share of renewable energies to 32%, and improvement of energy efficiency by 32.5% in comparison to 1990 levels. (Source: European Commission (n.d.). 2030 climate & energy framework. [online] ec.europa.eu. Available at: https://ec.europa.eu/clima/eu-action/climate-strategies-targets/2030-climate-energy-framework_en. [Accessed: 21/09/2023].)

[2] To support the energy transition, the EU created a common framework for all member states for promoting electricity from renewable sources: Renewable Energy Directive, Directive (EU) 2018/2001, (RED II).

[3] Prosumers can produce and consume electricity from their own renewable energy sources or consume from the main power grid. They can use and often store their produced energy locally or e.g., feed it into the main power grid for revenue. Prosumers can also consume electricity in certain ways to be beneficial for the main power grid. The concepts all depend on the adopted energy business models or legal frameworks of the country. Overall, prosumerism allows citizens to participate in (local) energy markets (Gui, Diesendorf and MacGill 2017; Mengelkamp et al. 2017).

as it requires the individuals to change from being 'passive' to being 'active' through effort, personal time, flexibility, and change in the ways they use energy. Through the CMs' synergy of technology and flexibility, different energy business models (BMs) can be applied. For instance, the energy produced can either be consumed and sold locally, or directly or flexibly sold to the main power grid. These aspects raise interest in the private sector (Enlit 2023). This interest is needed, as Hafner et al. (2020) imply that governments alone cannot finance CM solutions. As a result, reflecting on a just energy transition, investors with interests in sustainable energy investments are required to engage and cover the high upfront costs of CMs. Investors could be for instance, local private investors, utilities, grid operators, large companies and technology developers, and also local or investment banks and public sector funding bodies (Strahl, Paris and Vogel 2015; Clean Energy for EU Islands 2019a; Eras-Almeida and Egido-Aguilera 2019; de Gheldere 2022). Figure 1 shows the microgrid concept.

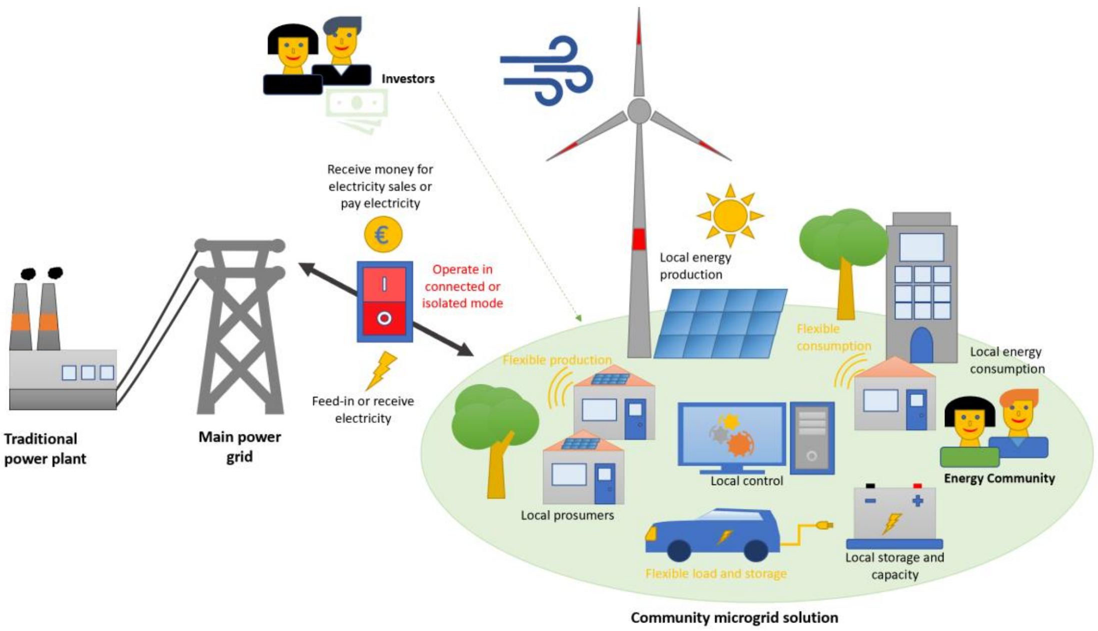


Figure 1. Microgrid concept: Key technology and business model elements in line with this research's focus.

The microgrid concept per se is not defined in European Law; however, this fact does not downplay the potential value of CMs for the energy transition. Legal researchers tie microgrids to other concepts such as smart grids, mini-grids, advanced distribution networks, or renewable and citizen energy communities (Mauger 2022; Behrendt 2023). There is no 'one-size-fits-all' approach for these concepts (Hoicka et al. 2021; Arvanitopoulos, Wilson and Ferrini 2022). There are still many definitions and applications of 'energy communities' (e.g. Bauwens et al. 2022; Reis et al. 2021; Gui and MacGill 2018). The variety is accompanied by a similar variety of involved actors and possible investors (e.g. Eras-Almeida and Egido-Aguilera 2019; Mihailova et al. 2022). How a final CM solution looks depends on the *local context* and its *purpose*

(Carpintero-Rentería, Santos-Martín and Guerrero 2019; Eras-Almeida and Egido-Aguilera 2019; Lode et al. 2022). That means CM solutions are configured according to, for example, the local resources, conditions, and regulations and, at the same time, are influenced by the objectives, drivers, interests, and roles of the involved stakeholders (Sachs et al. 2019). Involved may be any stakeholders from the energy value chain, including, for example, distribution network operator, energy utility, but also technology developers, local government, energy community, financial institutions and investors. Consequently, microgrid configurations differ; for instance, microgrids for rural areas seek pure electrification, for military facilities the purpose is the benefit from enhanced energy security, and for residential designs cost-savings are important (Hirsch, Parag and Guerrero 2018). For geographical islands, CMs enable self-sufficiency of the islands in the long term[4] (Anderson and Yakimenko 2017; Derkenbaeva et al. 2020). Therefore, microgrids end up having all kind of configurations and, as a result, are complex and cannot be standardised but rather allow for flexible designs (Martin-Martínez, Sánchez-Miralles and Rivier 2016; Warneryd, Håkansson and Karltorp 2020).

The lack of standardisation in combination with high complexity, unclear legal regulations of CM solutions, and relatively advanced energy grids, still limits deployment and adoption of the CM concept in Europe (Martin-Martínez, Sánchez-Miralles and Rivier 2016; Behrendt 2021; Mauger 2022). For investors, the high perception of risk trumps possible business cases; microgrids lack interest and investments from the private sector although their investment is needed (Burr et al. 2014; Strahl, Paris and Vogel, 2015; Williams et al. 2015; Williams, Jaramillo and Taneja 2018; Oueid 2019; Stadler and Naslé 2019; Nykvist and Maltais 2022). It is acknowledged that to unleash a CM´s full business potential in the long-term, needs flexible energy use and behaviour of the EC (Monti et al. 2016). However, not all people have the same opportunities, possibilities, or abilities to change and adapt their energy behaviour (Powells and Fell 2019). Also, discussions show that people are sometimes not even aware of the expected active role or involvement in future solutions such as CMs and need to be engaged (Mihailova et al. 2022; Smith et al. 2023). Therefore, for investors to not have a value gap in the potential financial results long-term engagement by the EC is required; and to allow inclusive participation, the EC needs financial engagement by the investors. Consequently, the EC and investors need to be attracted to participate and engage in a CM simultaneously.

Due to their entanglement, this research identifies energy communities and investors as key stakeholder groups to drive the adoption of CMs and support local energy transitions, while acknowledging all microgrid stakeholders (Creamer et al. 2018) (Table 1). This is in line with Avelino & Wittmayer (2016) and Norouzi et al. (2022) who state the need for a multi-actor

[4] Island microgrids – depending on the context – could either describe the whole island grid or be a solution integrated as part of the wider island energy grid.

perspective and context-based research to tackle the socio-technical problems of the energy transition and CM development. To investigate contextual influences, this research will follow a case study approach, focusing on two geographical island archipelagos: the Orkney Islands in the United Kingdom (UK) and the Canary Islands in Spain. As Pacheco et al. (2022) and Skjølsvold et al. (2020) show, islands provide distinct and related circumstances and geographical, electrical, and cultural boundness which make them wonderful contexts for this investigation. Hence, the 'island context' will permeate the discussions of this thesis.

Given the issues described above, the aim of this research is to disentangle the complexity of CMs, as a concept to support local energy transitions, through the lens of 'attractiveness' from the perspectives and perceptions of ECs and investors. That way, this research follows the objective to identify how and what gets ECs and investors intrinsically engaged and attracted to decide to participate and invest in CMs and how their perceptions align to create attractive CM solutions. Guided by this objective, the next section reviews and brings together relevant literature to create an overview of 'Community Microgrid Attractiveness' and highlights the research context.

Table 1. Summary and reasoning of research focus on energy community and investors.

Energy Community (EC)	Investors
Who? Group of people that live, engage, and actively participate in the CM. The EC consists of a multitude of individuals with different roles as part of the transition from passive users to active energy citizens.	**Who?** Group of stakeholders that are interested in sustainable investments, who can be local or other private investors, utilities or other energy distributers, distribution or transmission system operators, infrastructure investors or innovative technology developers, investment banks or other public funding bodies.
Why? Their participation is crucial for economically and environmentally sustainability of the CM. Individuals have different opportunities, possibilities, and abilities to get engaged and participate in the adoption of the technologies and energy flexibility business models.	**Why?** In addition to public funds, private sector investment is required to accelerate deployment of renewable energies and other solutions to drive the energy transition. Their investment is crucial to finance solutions such as CMs to allow the socially just participation of EC individuals.
How & What? Learn from local communities' perceptions and identfiy elements of attractiveness to create CM solutions where individuals will decide to participante and engage (bottom-up) in the long-term.	**How & What?** Learn from local investors and their perceptions. Identify elements of attractiveness to create CM solutions where investors overcome hesitations and will decide to invest (out of their own initiative).

1.1 Community Microgrid Attractiveness Overview

Following the objective of this thesis, this section presents relevant literature to establish an overview of ‘Community Microgrid Attractiveness’ that addresses i) *an attractive microgrid configuration at its core, as a synergy of technology, business models (BMs), and control*, addressing the European Union's 4 Ds; ii)) *the perceived notion of attractiveness* for energy communities (ECs) and investors and the *alignment and negotiation* of their perceptions; and iii) the overall influences of *local contextual baseline scenario and regulations*, given that community microgrids (CMs) are proposedly local solutions to support local energy transitions.

Microgrid research such as the study by Hossain et al. (2014) demonstrates that implementation of many existing microgrids has mostly been technology-driven. The research shows the technology configuration in a CM is complex, but solutions and understanding are available. Similarly, energy BMs and their application to microgrids have been researched, for example, with focus on prosumer BMs or provision of demand response and flexibility services to the main power grid and salient value generation (Martin-Martínez, Sánchez-Miralles and Rivier 2016; Hanna et al. 2017; Bryant, Straker and Wrigley 2018; Cornélusse et al. 2019; Brown, Hall and Davis 2020; Hamwi, Lizarralde and Legardeur 2021). These energy flexibility BMs will be key for future energy systems and their economies (Lowitzsch, Hoicka and Tulder 2020). Microgrid control aligns and enables technology and BM solutions for value stacking (Martin-Martínez, Sánchez-Miralles and Rivier 2016; Sachs et al. 2019). Overall, a microgrid configuration at its core, as a *synergy of technology, BM, and control*, contributes to energy decarbonisation, decentralisation, digitalisation, and democratisation. However, it remains a challenging task to create a synergy of CM elements that would engage energy community and investors, which this research aims to address. In line with Bauknecht et al. (2020), this research applies a ‘whole system’ perspective to identify and detail the elements to provide a synergetic solution based on attractiveness.

CM solutions demonstrate “complex values” (Hall and Roelich 2016, p.287). That is, microgrids provide *benefits* of different nature such as environmental (e.g. addressing environmental concerns and minimising greenhouse gases), social (e.g. improving the security of supply, reducing electricity costs, and providing jobs), and technological (e.g. increasing energy efficiency and integration of different (innovative) technologies), and economic (e.g. including cost-related and revenue-related issues for investors and community) (Hatziargyriou 2013; Romankiewicz et al. 2012; Stadler et al. 2016). While these benefits are great drivers, challenges such as legal and regulatory uncertainty and grid-connection issues pose barriers and perception of risk (Hirsch, Parag and Guerrero 2018). Perceptions and the salient decision for participation or investment in CMs are subjective, based on different elements such as culture, interests, priorities, and sense of social and environmental responsibilities, fairness, or risk-taking of individuals (Dierkes, Erner and Zeisberger 2010; Masini and Menichetti 2012; Gutsche and Ziegler 2019; Sachs et al. 2019; Derkenbaeva et al. 2022a; O'Connor, Fredericks and Kosoralo 2022). Final perceptions and priorities lead to different levels and forms of participation and engagement of the stakeholders (Mihailova et al. 2022). Nonetheless, research, policy, and practice debates highlight the urgency of EC and investors needing to take up and negotiate new *roles and responsibilities* for a feasible and attractive CM design and along its transition pathway (Avelino and Wittmayer 2016; Wittmayer et al. 2017; Mihailova 2023). This research contributes to these discussions through investigating the attractiveness of benefits and roles for ECs and investors to drive their positive decision-making for long-term participation and investment (Hackbarth and Löbbe 2020; Steffen and Schmidt 2021). Therefore, this research broadly understands the *notion of attractiveness* of microgrids as 'managing risks' and 'increasing benefits' for ECs and investors (Strahl et al. 2015). An attractive CM solution is expected to bridge outcome expectations and fairly distribute and share both risks and benefits (Ebers Broughel and Hampl 2018; Adams et al. 2021). Managing interests of community and investors through the notion of aligned attractiveness would support a mindset of creating maximum value for both (Edward Freeman 2010). It would further drive collaboration for co-creation, a shared vision, and mutually beneficial outcomes (Biggemann, Williams and Kro 2014; Tödtling, Trippl and Desch 2022). Consequently, this research contributes by investigating *alignment and negotiation of attractiveness* perceived by EC and investors as an attempt to capture the complexity of microgrids and to guide future CM designs.

Transition to a decentralised energy system and CM solutions naturally emphasises a local focus (Suitner, Haider and Philipp 2022). This focus highlights local circumstances and context for so-called 'place-based' solutions and policies to support stakeholder engagement and participation, tackle local challenges, and make use of local opportunities (e.g. Irshaid et al. 2021; Piterou and Coles 2021; Trippl et al. 2023). In that sense, CMs are an optimal solution for island energy systems (Bunker et al. 2015). Local *contextual and baseline conditions* (e.g. political, economic, social, technological, environmental, and legal factors) are a strong external influence on CMs' complexity and notion of perceived attractiveness (Martin-Martínez, Sánchez-Miralles and Rivier 2016; Sachs et al. 2019). Depending on the context and culture, these factors translate to drivers and barriers for deployment (Hirsch, Parag and Guerrero 2018). In island contexts, CMs address diverse island challenges and provide holistic benefits of environmental, social, technological, and economic dimensions to support island energy transitions (Eras-Almeida and Egido-Aguilera 2019; Parag and Ainspan 2019; Derkenbaeva et al. 2020; Haase and Maier 2021). Arvanitopoulos et al. (2022) and Isaksen et al. (2022) are clear that contextual factors that influence attractiveness of CM solutions and local transition pathways require further investigation to push forward with applications, which this research aims to address. Further, this research seeks to add to Hoicka et al. (2021) and Nykvist and Maltais (2022) by giving policy makers directions as to what will be required for a clearer and more supportive regulatory framework to enable attractive CMs for communities and investors.

Overall, this research takes into account that CM models and approaches may be different depending on the context and characteristics of the actors (Piterou and Coles 2021). In line with Hiteva and Foxon (2021) and Schaltegger et al. (2019), this research suggests the idea to emphasise common elements of 'attractiveness' rather than 'risks' when aligning and negotiating stakeholder perceptions or designing BMs and policies. Figure 2 provides an overview of Community Microgrid Attractiveness elements. This research will provide full understanding through complete conceptualisation and disentanglement of the microgrid's complexity through the notion of perceived attractiveness within island contexts. The resulting Community Microgrid Attractiveness Framework will serve as a tool to support the design of place-based, attractive CM solutions, business cases, and policies that encourage EC and investor engagement.

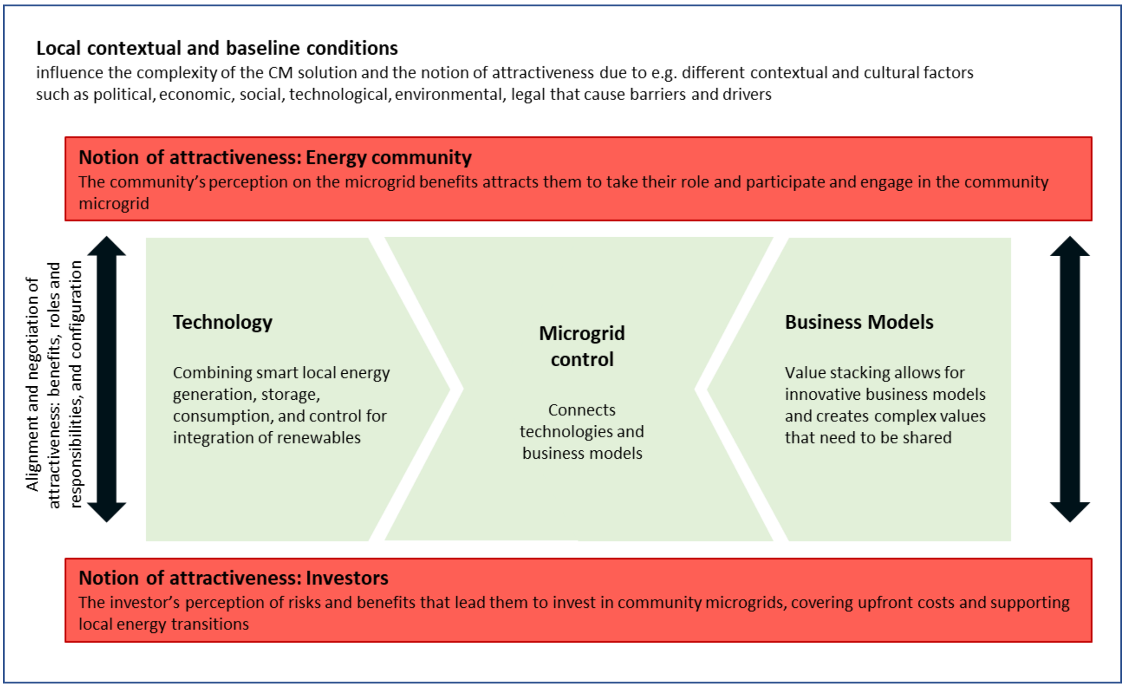


Figure 2. Overview of the Community Microgrid Attractiveness Framework.

1.2 Research objective and questions

There are many factors that need to be considered and require further research to design an attractive community microgrid (CM) that would encourage participation and investment. Therefore, the aim of this research is to disentangle the complexity of CMs through both the communities' and investors' perceived notion of attractiveness. This research follows the objective to develop and detail the Community Microgrid Attractiveness Framework (CMA) as a support tool for designing attractive CM solutions that intrinsically engage and attract energy communities (ECs) and investors to participate and invest in CMs.

Three research questions have been designed that guide this research:

1. What elements define an 'attractive' community microgrid solution; how are they interrelated; how do they align, for local energy community and investors to get engaged?

2. How do different local contexts influence 'community microgrid attractiveness' and the final CM solution?

3. How can attractive CM solutions be created that drive the positive decision-making of energy community and investors; how does the CMA support this?

1.3 Overall research contributions

The strengths of this doctoral research can be summarised as follows: first, empirically creating an understanding on stakeholder expectations and perceptions of what would make CMs attractive as few researchers have investigated EC and investor perspective let alone their alignment; second, exploring and unfolding the complexities found in the Community Microgrid Attractiveness Framework (CMA) - a holistic framework presented in Figure 2 above; finally, learning about the factors and contextual influences that could be considered in the design of CMs (that could make them more or less 'attractive' to certain stakeholders), from a case study design applied in two distinct island contexts in Europe.

This research contributes to *theory* as it captures, combines, and expands a wider set of research fields (Köhler et al. 2019). Hence, this thesis contributes to ongoing discussions on challenge-oriented, local, place-based/context-based, socially, economically, and environmentally friendly business opportunities and energy transitions. The conceptualisation of Community Microgrid Attractiveness to disentangle its complexity and perceived risks and benefits presents a new but simple lens for understanding needs and expectations. The CMA will help multi-disciplinary researchers to understand and respond to place-based attractiveness of business and technology opportunities and challenges in line with CM and EC concepts. This research demonstrates the usefulness of an island case study approach to explore contextual influences on both EC and investor perspectives – how they prioritise and align and tackle regional inequalities. Overall, this research supports regional studies, innovation, and energy transition research.

The results of this research contribute to *practice* as investors, technology developers, or business innovators need to change mindsets, roles, and business models that align with global societal and environmental challenges, and the developed CMA helps them to initiate this change. By demonstrating drivers, barriers, and attractiveness of CM solutions within the EU's 4 D framework, the CMA serves as a tool to stimulate ideas and support shared dialogue between the stakeholders. Thus, the CMA acts as a 'support tool' that will help investors (or potential energy community initiators themselves) in their design and negotiation processes to create tailored BMs for positive decision-making and engagement. Consequently, this research contributes to practice by driving participation and investment into concepts such as CMs, encouraging new consumer-investor relationships, and thereby enabling technology and business model innovations.

This research contributes to *policy* by helping to align people, technology, business, and regulations for transformative change. In the current energy policy discourse that dissolves from EU to local level, ECs and investors are the most relevant actors as ECs should take over a more active role and investors are needed as the public sector alone cannot finance the energy transition. This research provides evidence for mostly national level policy makers, urging for regulations that a) are easy and flexible for place-based, tailored solutions, removing ambiguity and bureaucracy; b) align with island needs and challenges; and c) support long-term certainty and collaboration between public and private sectors and network operators. In addition, this research supports a policy mindset that supports local and just energy transition of islands and translatable contexts to reach decarbonisation, decentralisation, digitalisation, and democratisation for long-term instead of short-term sustainable, inclusive, and economic growth goals.

1.4 Structure of the thesis

The first chapter presents a first overview on literature and research gaps to introduce relevant research contexts for Community Microgrid Attractiveness. The chapter concludes with research objective, questions, and contribution. Chapter 2 further develops and details the Community Microgrid Attractiveness Framework (CMA). Explorative literature review for theory building is used to create the conceptual framework guided by the overall research objective to address the research questions. First, the section captures CM attractiveness through the lenses of energy decarbonisation, decentralisation and digitalisation, and democratisation. Second, energy community (EC) and investor roles and responsibilities are discussed to highlight the need for and dimensions of their engagement. The next section presents the notion of attractiveness of CMs for both EC and investors and highlights the aligned notion of attractiveness between them. At the end of the chapter, the complete conceptual framework is presented as a tool to stimulate the creation of sustainable BMs and attractive CM solutions with a focus on island contexts. Thus, the detailed CMA disentangles the CM complexity. Chapter 3 critically discusses the methodological considerations. The first section states how these considerations led to the selection of a multiple case approach and a 3-stage research design. The next sections present the choice of two case studies, The Orkney Islands (UK) and the Canary Islands (Spain), to learn from their contextual differences and similarities. Furthermore, the chapter presents salient choice and procedure of quantitative and qualitative research methods for data collection and then data analysis to address the research questions. Chapter 4 and 5 present the two island case studies through the applied lenses of the CMA. Their unique contexts (e.g. location, culture, and energy system) enable the investigation of local perceptions of attractiveness and local propositions for attractive CM solutions that would drive the positive decision-making of EC and investors. Chapter 6 discusses the learnings and implications from the case study approach to fully answer all research questions. Finally, Chapter 7 concludes and ends this research by resolving the research questions, highlighting contributions, and setting out ideas for further research.

2 Community Microgrid Attractiveness Framework: The attractiveness of community microgrids for energy communities and investors

Microgrids are increasingly being discussed as a tool for the local energy transition to integrate renewable energy and innovative technologies and business models (BMs) at a local/community level. With improving technologies and policies, community initiatives will increase and so will the need for effective BMs (Piterou and Coles 2021). The participation of energy communities (ECs) and investors would be necessary to help design these BMs and accelerate the uptake of community microgrids (CMs). Thus, this research applies a multi-dimensional perspective on the concept of local CMs to drive engagement of community and investors and the collaboration between them.

This chapter details the Community Microgrid Attractiveness Framework (CMA) based on exploration of a variety of research fields and contexts. The first section captures the attractiveness of the CM concept for decarbonisation, decentralisation, digitalisation and democratisation. Section 2 describes the roles and responsibilities of EC and investors to design and ensure an attractive CM solution. Section 3 presents the lens of 'aligned attractiveness' of the values for community and investors, with which the framework in section 4 helps to develop directions of BM configurations that engage and attract community and investor participation and investment in CMs. Overall, the CMA presents elements that describe 'attractive' CM solutions for community and investors and how these elements align.

2.1 The attractive community microgrid concept

Microgrids are decentralised, flexible, and controlled integration platforms for different energy technologies, energy efficiency, and smart energy solutions. Onsite power generation and storage in combination with islanding ability allow for energy security and stress relief on the macrogrid while meeting local demands. All these features are highly valued in, for example, island contexts (Bunker et al. 2015; Thomas, Deblecker and Ioakimidis 2016; Anderson and Yakimenko 2017; Alves, Segurado and Costa 2020; Marczinkowski 2022). Therefore, microgrids are increasingly being seen as a tool for the local energy transition to integrate renewable energy and innovative technologies, business models at a local/community level (e.g. Pullins 2019). Adding to the discussion of the 4 Ds, this section elaborates current issues that the energy system faces and why and how community microgrids (CMs) are an attractive solution to tackle them.

2.1.1 Microgrid technology for decarbonisation

Since the EU Parliament declared the climate emergency in Europe and globally in 2019, decarbonisation and the energy transition have gained increasing priority in the public and private sector and in the public. Additionally, with the energy crisis due to the Russo-Ukrainian war, countries and islands want to accelerate their reduction of fossil fuel dependency (Escamilla-Fraile et al. 2023). Islands are often highly dependent on fossil fuels for energy generation, heating, and transport (Kuang et al. 2016). This dependency often goes hand in hand with even higher energy costs but lower incomes than on the mainland and is therefore sometimes tackled through special regulations (Uche-Soria and Rodríguez-Monroy 2018). At the same time, islands face environmental challenges due to climate change while needing to maintain the beauty of the environment, remain an attractive tourist destination, and ensure quality of life of the islanders (Riva Sanseverino et al. 2014; Díaz Pérez et al. 2019). Therefore, islands urgently seek to reduce fossil fuel dependency, protect the environment, and provide social benefits through decarbonising their energy system (Bunker et al. 2015; Anderson and Yakimenko 2017; European Commission 2020). Diversification of solutions and sector integration are the key for possibly achieving sustainability, self-sufficiency, and low energy costs on the islands (Marczinkowski and Østergaard 2019). Some islands already implement microgrids (Bunker et al. 2015; Shrivastwa et al. 2019); however, as they include fossil-fuelled back up sources the configuration does not fully align with the decarbonisation efforts.

Instead, ‘green’ microgrids are feasible, attractive solutions that integrate various renewable energy sources (RES) (Hossain et al. 2014; Anderson and Yakimenko 2017; Jirdehi et al. 2020). This concept is in line with Europe’s primary driver to install microgrids, which is the replacement of fossil fuel energy production (Obara and Morel 2017). Microgrids allow for a flexible combination of technologies for sustainability within their electrical boundaries (Strahl, Paris and Vogel 2015). Additionally, environmentally friendly and price-competitive advantages of these technologies support this trend (Soshinskaya et al. 2014). The technologies serve local electricity, heating, cooling, and are fitted and optimised to the local context and conditions (Mariam, Basu and Conlon 2016) – aspects that make the microgrids concept more attractiveness then stand-alone technology (Hatziargyriou 2013). Microgrids include decentralised RES which are often a combination of wind turbines and solar photovoltaic installations (PV), which however are non-flexible technologies (Jirdehi et al. 2020). Non-flexible means they are not dispatchable or manageable to ensure balance between generation and demand but rather generate energy if wind blows and sun shines. Therefore, flexible technologies which can be easily dispatched and controlled such as Combined Heat and Power (CHP), microturbines, biomass, or fuel cells would also be integrated to achieve a 100% renewable microgrid (Romankiewicz et al. 2012; Martin-Martínez, Sánchez-Miralles and Rivier 2016; Hirsch, Parag and Guerrero 2018; Shrivastwa et al. 2019). For the same reason, energy storage is most important to facilitate the integration of RES and cover both seasonal variations and variations between day and night (Santos et al. 2018; Alam, Chakrabarti and Ghosh 2019). In particular, hybrid storage systems can facilitate the transition towards 100 % RES microgrids in remote communities and islands (Hajiaghasi, Salemnia and Hamzeh 2019; Dawood, Shafiullah and Anda 2020; Santos et al. 2020). Systems with lithium batteries are the most attractive today (Jirdehi et al. 2020). Additionally, fuel cells, fly wheels and capacitor banks have been integrated in microgrids (Soshinskaya et al. 2014; Kuang et al. 2016; Mariam, Basu and Conlon 2016). Moreover, research emphasises the usefulness of hydrogen-based storage or vehicle to grid (V2G) electric vehicle (EV) charging solutions in CMs (Dawood, Shafiullah and Anda 2020). Thus, CMs equally integrate mature technologies and innovative technologies. Together, these aspects demonstrate that CMs are technology integration platforms, which allow for a flexible, attractive design of CMs in and for local contexts – as unique as islands – while supporting local decarbonisation.

To achieve this local 100% RES solution, technology is available and mature (García-Olivares 2015; Martin-Martínez, Sánchez-Miralles and Rivier 2016). The configuration can build upon existing infrastructure of the island and technology can be integrated in a step-by-step manner over time (Kuang *et al.* 2016; Marczinkowski and Østergaard 2019). Microgrid technology configurations demonstrate increasing commonalities; nonetheless, they are not supposed to fit a one-size-fits-all market (Asmus and Lawrence 2016). Instead, the diverse facets and the flexibility in their design increases their attractiveness for place-based solutions (see cases in e.g. Anderson and Yakimenko 2017; Bunker et al. 2015; Martin-Martínez, Sánchez-Miralles and Rivier 2016). In this way, for example, an island microgrid provides environmental benefits for decarbonisation locally and for the wider island energy system. In addition, the decarbonisation of the transport sector would be supported by a microgrid. A microgrid could either integrate EVs as part of its system or the microgrid's energy management improves the ability of the wider electricity network to cope with increasing levels of electrification and need for flexibility from EVs. Still, for energy efficient and reliable functioning, the interplay of these technologies requires high levels of smart control, automation, and management (Hajiaghasi, Salemnia and Hamzeh 2019).

2.1.2 Microgrids for decentralisation and digitalisation for local energy

Currently, energy systems are underpinned by a centralised grid structure. These grids face challenges due to the increasing electrification and integration of RES, often combined with old infrastructure. On an island level, these challenges are a huge barrier for the local energy transition. Islands face grid constraints, variations in energy demand due to seasonal changes of energy demand from the touristic sector, and electric isolation (López-González et al. 2017; Obara and Morel 2017; Papadopoulos 2020). To maintain grid stability, island distribution system operators (DSOs) often curtail local RES, which counteracts the environmental and economic benefits of the assets and the 'message' to the wider public (Derkenbaeva et al. 2022b). These issues increase the need for decentralised, digitalised energy solutions such as microgrids (Burke and Stephens 2017). Microgrids support the wider island grid challenges and modernisation through their high level of active management and control of decentralised energy generation and use (Hatziargyriou 2013; Hossain et al. 2014; Müller and Welpe 2018).

The control system acts as the central, connecting factor between BMs and technologies (see Sachs et al. 2019), allowing for decentralisation, decarbonisation, and democratisation (Soutar 2021). The technology side sets the need for active control. So, the control and optimisation align the technologies according to the adopted microgrid energy BMs and operation priorities. The automation and control and the ability of a microgrid to smoothly connect and disconnect from the main grid (through the point of common coupling) is a key difference to simple distributed energy feeders (Mauger 2022). That means the control system with integrated energy management systems applies various communication, management, and control strategies to manage and sell local resources, and interact with the wider energy market (Carpintero-Rentería, Santos-Martín and Guerrero 2019; Shayeghi et al. 2019). All technologies are always coordinated and controlled to maintain energy efficiency, resilience, and stability between local supply, storage, and demand (Hatziargyriou 2013). Research has studied diverse control schemes and energy management systems, which in interaction with the local prosumers and consumers can either be fully automated or semi-automated (Vera, Dufo-López and Bernal-Agustín 2019; Espín-Sarzosa, Palma-Behnke and Núñez-Mata 2020; Sahoo, Routray and Rout 2020). With the help of Internet of Things (IoT) technology and smart appliances, the system actively controls flexible loads of the residents, such as battery storage, heat pumps, lighting, washing machine and dishwasher, refrigeration, and heating and cooling (Romankiewicz et al. 2012; Kanakadhurga and Prabaharan 2022; Stanelyte, Radziukyniene and Radziukynas 2022). Similarly, EVs can act as flexible loads and contribute to the local system stability and security through the V2G technology (Martin-Martínez, Sánchez-Miralles and Rivier 2016; Sachs et al. 2019; Alves, Segurado and Costa 2020). At the same time, control assures energy security for critical loads that serve life support, data centres or security purposes (Romankiewicz et al. 2012). Improving and establishing trust in digital infrastructure at a household level will be crucial to allow for inclusive participation (Smith et al. 2023). Then, the effective operation between assets and tasks of the control system makes it possible and feasible to apply different energy BMs.

Microgrids control and combine local power generation, consumption, storage, and distribution which raises opportunities and technological benefits for energy communities and investors. These opportunities are for instance, testing place-based innovative, smart energy solutions, based on local needs to drive dissemination of smart technology (Skjølsvold, Ryghaug and Throndsen 2020; Plewnia and Guenther 2021). Working with and learning from communities to helps to identify system and local challenges, tackle them simultaneously, and support technology acceptance and awareness. A smooth functioning of the complex set-up is necessary to effectively create attractive value streams (Martin-Martínez, Sánchez-Miralles and Rivier, 2016; Stadler et al. 2016; Hanna et al. 2017). Energy storage enables reliability, resilience, and security of energy supply in a microgrid, and is therefore a key feature for efficient energy management (Santos et al. 2018; Jirdehi et al. 2020). These aspects together with grid-connection enable CMs' key values due to application and development of future innovative energy BMs, creating opportunities for the communities' democratic participation in the energy system.

2.1.3 Microgrids for value generation and democratisation

The energy market liberalisation in the EU initiated decentralisation and thereby democratisation of powers as the markets open up for new actors and market players. However, the existing and highly influential energy industry actors, utilities, and DSOs push back and lobby for regulations to maintain their market share and a centralised system (Ruester et al. 2014; Leal-Arcas, Lesniewska and Proedrou 2018; Lindberg, Markard and Andersen 2019; Bauknecht, Andersen and Dunne 2020; Roberts 2020). Revenues stay with these players and consumers depend on them for their energy supply. DSOs could abuse their monopoly and not grant permission for grid-connection for CMs (Valta, Mäkinen and Kirjavainen 2022). At the same time, bureaucratic barriers challenge prosumers and local energy initiatives on islands (Botelho et al. 2021). Indeed, islands are often overlooked in national energy transition agendas or confronted with policies that do not fit their specific requirements while heavily relying on funds for their financing (Riva Sanseverino et al. 2014; Clean Energy for EU Islands 2019a; Haase and Maier 2021; Marczinkowski, Østergaard and Mauger 2022). Islands are therefore left behind in many aspects (Giordano and Dubois 2019). It is important that benefits from local resources remain on the islands to support the local economy (Allan, Mcgregor and Swales 2011). Leal-Arcas et al. (2018) suggest that by applying a human-centric perspective on transition needs and positioning consumers heart of the energy system, private and policy actors support communities, such as island communities, to overcome bureaucratic, regulatory, or financial hurdles. An attractive CM solution for decentralisation and democratisation addresses these issues.

The energy system change describes a new mindset that puts people first and supports sustainable and inclusive growth in a bottom-up approach. The European directive provided a framework for renewable and citizen energy communities which take diverse shapes in the member states and result in different levels of engagement and uptake (Hoicka et al. 2021; Tarpani et al. 2022). The regulation, however, excludes the CM concept due to its potential economic and commercial activities which will increase in relevance with the energy transition (Behrendt 2021). Research often presents microgrids as *one* BM for prosumer, energy community, community energy BMs (Brown, Hall and Davis 2019; Nolden, Barnes and Nicholls 2020; Reis et al. 2021). However, according to Carpintero-Rentería et al. (2019), CMs need a holistic perspective on their business layer. The authors describe the ability of CMs to stack values and apply different ownership and investment structures, making all value dimensions more complex. Differentiation between investment and energy business model of a microgrid as part of the microgrid business structure supports the design of attractive CM solutions (Sachs et al. 2019). For increased energy democratisation, investment strategies for microgrids tend to be democratically driven (Burke and Stephens 2017). A microgrid can be fully financed through third party investments such as direct environmentally and socially responsible investments, loans, or fair ESCO models (Hamwi and Lizarralde 2017; Brown, Hall and Davis 2019; Oueid 2019; Reis et al. 2021), or community shared investments such as cooperative finance or crowdfunding (Hamwi and Lizarralde 2017; Caramizaru and Uihlein 2020; McInerney and Bunn 2019; Heiskanen et al. 2021; Reis et al. 2021). For instance, Cohen et al. (2021) found that for local community investors, local projects with cooperative structures are most attractive. Additionally, crowdfunding is a potentially attractive financing structure with a local focus (McInerney and Bunn 2019). Research on financing island energy transitions shows that renewable energy projects, including microgrids, often combine private and public financing (de Gheldere 2022). In most cases, CMs are financed through a hybrid investment strategy bringing public and private sector and community together (Reis et al. 2021). Community shared investments allow people to participate who otherwise could not, due to lack of resources e.g. financial, education and information, time, access to decision-making, or even lack of space to deploy the technology (Hamwi and Lizarralde 2017; Reis et al. 2021). A hybrid investment strategy, depending on the local context and stakeholders' priorities, allows the sharing of benefits and the management of risks among the different stakeholders, defines or creates sense of ownership, and supports alignment of attractiveness (Burr et al. 2014; Gui, Diesendorf and MacGill 2017; Ebers Broughel and Hampl 2018; Lode et al. 2022). In the end, for energy democratisation, hybrid investment where a third party financially supports the island community or complete community self-investment are attractive and feasible, as long as costs, values, and payback time are fairly distributed and negotiated (Li and Okur 2023).

Value is generated to pay back the investments from the CM's value stacking and multitasking ability (Hanna et al. 2019; Maloney 2020). This means a CM provides different types of values from energy resilience, local energy optimisation and efficiency, and energy BMs based on the ability to connect and disconnect from the main grid at the same time (Stadler et al. 2016; Brown et al. 2022). For instance, a microgrids' local energy optimisation and control increases or decreases local demand when needed. Energy resilience and security are values that are often difficult to quantify, but doing so increases attractiveness (Burr et al. 2014; Kelly-Pitou et al. 2017). The improved optimisation and energy efficiency at local level also decreases the need to buy expensive energy from the main grid. In the long-term, local energy usage will evolve to local energy markets or peer-to-peer (P2P) trading BMs and part of future smart microgrids (Mengelkamp et al. 2017; Sánchez Ramos et al. 2019; Plewnia and Guenther 2021).

Straightforward revenue streams derive from power exports, that is energy sales through, for instance, feed-in tariffs or Power Purchase Agreements (PPAs). The decentralised and digitalised nature of a CM would allow to sale of energy depending on regulations, agreements, and operation, which can be for instance just surplus energy or produced and stored energy when market prices are high. Then, microgrids will be able to offer energy flexibility services (e.g. demand-, supply-, or storage-based demand response or ancillary services) which potentially create the biggest attractiveness value for all stakeholders (Monti et al. 2017; Kanakadhurga and Prabaharan 2022). All these BMs are potential energy BMs for CMs. CMs provide these energy service BMs to the DSO to help stabilise the main power grid (e.g. Helms, Loock and Bohnsack 2016; Hamwi, Lizarralde and Legardeur 2021).

The communities' active participation in the investment and energy BMs contributes to energy democratisation, highlighting social and shared economic benefits. Nonetheless, to develop an attractive microgrid business case and disentangle the complexity of the CMs' business layer still needs a comprehensive overall BM design (Martin-Martínez, Sánchez-Miralles and Rivier 2016; Sachs et al. 2019). Sustainable business models (SBMs) capture economic, environmental, and social values – monetary and non-monetary (Bocken et al. 2014; Hamwi and Lizarralde 2017; Geissdoerfer, Vladimirova and Evans 2018) – and energy justice frameworks (Hiteva and Sovacool 2017; Williams and Doyon 2019). They are recognised as useful tools to address both customer needs and investors' risk-benefit evaluation for democratic value generation (Leisen, Steffen and Weber 2019). A SBM for a CM that trades-off stakeholder interests, shares benefits, and supports democratisation needs clear definitions of roles and responsibilities for community and investors (Sachs et al. 2019). These definitions support consideration of shares of benefits and interests among the stakeholder groups, which are crucial for microgrid implementation as trade-offs can become a challenge or a success factor (Soshinskaya et al. 2014). The next section investigates the current understanding of the evolving roles and responsibilities of communities and investors[5].

2.2 Roles and responsibilities for attractive microgrid solutions

Climate goals demonstrate a need to accelerate the deployment of distributed energy solutions such as community microgrids (CMs). The European Union drives the active role of citizens in energy communities (ECs) as part of the decarbonised, decentralised, digitalised, and democratised (4 Ds) energy system of the future (Gancheva et al. 2018; Soutar 2021; Easson 2022). In a CM, active participation and engagement of the community is required for the solution

[5] It has to be remembered that a CM development, operation, and management would include even more stakeholders than just community and investors. All stakeholders will have their stake in interacting, cooperating, and co-creating to capture value (Plewnia and Guenther 2021). However, as pointed out in the introduction, this research identified community and investors as key stakeholders for successful value creation and therefore focuses on these two stakeholder groups.

to be feasible and should therefore be attractive to the people that form this community. Similarly, the private sector has to change from passive to active actor, investing into net-zero solutions such as CMs and covering the high upfront infrastructure costs.

A CM manages different stakeholder purposes and objectives and adopts ownership, investment, and energy business models (BMs). Together, these configurations define how the CM makes business (captures value) and is operated (creates value) (Sachs et al. 2019). The coordination happens through the microgrid's governance structure. Microgrid governance establishes policies and rules for the microgrid operation, which also means stakeholder coordination, involvement, participation, and decision-making and salient negotiation (Gui, Diesendorf and MacGill 2017). All these elements make the CMs governance layer complex, and unclear roles of stakeholders remain a major barrier to the mainstream roll-out of possible local CM solutions as the unclearness affects the value creation process (Hall and Roelich 2016). Therefore, the next sections study the roles and responsibilities of first community and then investors as part of their notion of attractiveness of CM solutions.

2.2.1 Roles and responsibilities of the energy community in community microgrids

Energy communities (ECs) are an inclusive group of people with different backgrounds and abilities that capture different options of participation, energy justice and fairness (Heiskanen et al. 2021). A CM should enable citizens to transform from 'passive' to 'active' energy users and actors that take over multiple roles (Gui, Diesendorf and MacGill 2017; Berka, MacArthur and Gonnelli 2020; Brisbois 2020; Van den Berghe and Wieczorek 2022). Changing legislation supports the ECs' role and abilities (Hinsch, Rothballer and Kittel 2021). Few consumers are aware of the need to take up this role (Smith et al. 2023). The CMA perspective supports this change where citizens transform from *passive consumers* to *active users and prosumers* (Sanz et al. 2014; Nolden, Barnes and Nicholls 2020; Smale and Kloppenburg 2020).

In detail, in CMs, ECs have the responsibility to actively *manage, generate, consume, store, share,* or *sell energy* when and how it is needed to maintain local efficiency and provide services (Mengelkamp et al. 2017; Warneryd, Håkansson and Karltorp 2020). It is the responsibility of all EC individuals to *comply with the local, pre-set energy management and control settings, and consciously consume energy* to ensure energy efficiency and value generation.

Then, communities can also *trade their flexibility*, which means their ability to *flexibly consume or generate energy based on price-signals* (Hamwi, Lizarralde and Legardeur 2021). Again, the individuals effectively manage their local energy production, storage, and consumption to participate in so called incentive-based or price-based services. To support the communities' responsibility of providing flexibility on the agreed terms, processes are mostly automated and more attractive when planned ahead of time (Broberg and Persson 2016). This is necessary as, according to Leutgöb et al. (2019), people value comfort and energy availability more than economic incentives.

Managing and providing energy and flexibility will require behavioural change of the EC individuals (Baldassarre et al. 2017; Monti et al. 2017). It may not be easy for all to comply with these changes as individuals have different energy needs and general priorities (Calver and Simcock 2021). Powells and Fell (2019, p.56) call this issue the individuals' "flexibility capital", which describes the level to which individuals can economise their flexibility to different extents due to different factors. According to Calver and Simcock (2021), these factors can be for instance body capacity, affluence, time, household composition, materiality of housing and infrastructure, information provision, skills, and understanding. Therefore, Powells and Fell (2019) warn that energy flexibility BMs can create opportunities and risks for people, depending on the financial resources of the social segment. Hence, in line with Powells and Fell (2019), an EC needs to *evaluate economic, technology, and social implications on (dis)comfort, (in)convenience, and fuel poverty* to ensure an attractive CM design for all.

Given the variety of CM energy BMs and solutions, members of the community will be prosumers of different generation capacity or can just be active users (Powells and Fell 2019; Bauwens et al. 2022). Participation should not be exclusive; rather it is the role of the community to ensure the inclusiveness by empowering vulnerable community members to actively participate, providing the means to participate, or sharing benefits (Sperling 2017). An overall attractive, democratic CM solution should allow anyone to participate despite their capacity and resources. In fact, *reducing energy vulnerability*, which is often a key issue in island environments, through democratising and sharing of benefits can be associated with the overall responsibility of the EC (Caramizaru and Uihlein 2020b; Bauwens et al. 2022). The increase of social value in a CM will foster social acceptance and engagement of the community (Warneryd, Håkansson and Karltorp 2020).

At the same time, the community can become *investor* in and *initiator* of the microgrid project, facilitated due to existing relationships, common needs, and values in island communities (Nolden, Barnes and Nicholls 2020; Wilkinson et al. 2020; Walker et al. 2021; Mihailova et al. 2022). Consequently, ECs have a stake and ownership, and thus participate in decision-making processes from the beginning of the CM design and during its operation (Caramizaru and Uihlein 2020b). The multitude of individuals that form the community can take over different roles depending on their interests, motivations, and abilities. At the same time, the microgrid governance structure and ownership agreements set out whether individuals become *active members* or even *managers* of the microgrid (Derkenbaeva et al. 2020; Smale and Kloppenburg 2020). Therefore, it is the responsibility of the EC, its members or elected representatives to change from passive to *active interaction in decision-making or co-creation processes* to ensure community benefits (Highlands and Islands Entreprise 2020; Kallis et al. 2021; Mihailova et al. 2022). Participation also means *local solidarity* (NESOI 2020)*, learning from each other, getting support, and developing skills for the participation* (Creamer et al. 2018; De Clercq et al. 2020), and even *supporting policy decisions* through sharing experiences and providing local expertise.

Commonly, events, newsletters, surveys or interviews, as marketing and communication efforts have been used to engage and recruit citizens in energy projects (Jelić et al. 2020; Kallis et al. 2021; Del-Busto, Mainar-Toledo and Ballestín-Trenado 2022). The change from 'passive' to 'active' actors is easier said than done. It means going up Arnstein's "Ladder of citizen participation" (Arnstein 1969) with a changing notion of engagement from 'informing' to 'empowering' citizens (International Association of Public Participation 2018). The EC individuals will need to actively participate and engage in several roles. Thus, active participation and engagement means consumers put in time, effort, flexibility, and money, and change energy behaviour for CM benefits to unfold (Broberg and Persson 2016; Pires Klein et al. 2021). To empower the community and increase attractiveness to participate as prosumers and active users it is crucial to a) understand and align the factors that influence the willingness to provide demand flexibility and change behaviour; and b) focus on incentives and distribution of benefits (Jelić et al. 2020). For participation in decision-making roles, communities' engagement has to move beyond traditional communication and consultation to active, empowered, place-led participation (European Commission 2019; Kallis et al. 2021; Pacheco et al. 2022). However, sometimes regulations are not empowering directly, hindering uptake and of support local energy transitions (Huijben et al., 2016; Isaksen et al., 2022).

Researchers have found that island communities are more likely to engage in renewable energy projects than other communities based on similar values and motivations (Caramizaru and Uihlein 2020; Derkenbaeva et al. 2020; Kallis et al. 2021; Walker et al. 2021). It has been noticed that interested and informed people with similar values should be addressed to take part in these kinds of energy projects first – if they have not already initiated the project themselves (Wilkinson et al. 2020; Hall et al. 2021; Piterou and Coles 2021). Also, younger people or larger households are generally more attracted to participate in CMs and local energy markets (Mengelkamp et al. 2019). A lack of consumer participation is often not a matter of unawareness of climate change or a lack of knowledge but a matter of a lack of information of possibilities and of abilities (Bal et al. 2021). Including local representatives such as community officers, public authorities, organisational bodies, socially commercially owned activities, or social enterprises help to represent the wider citizen perspectives and needs and build trust to encourage the communities' engagement (Berka, MacArthur and Gonnelli 2020; Kallis et al. 2021). The local community should be involved in the development process from the beginning to create an attractive solution that is transparent and adapted to the local needs (European Commission 2019; Pacheco et al.

2022). With the increasing diffusion of information and experiences, and improved policies and incentives, which reflect an increasing level of acceptance for participation and engagement, the wider public and consumers will be able to follow and engage in future CM projects (Ellabban and Abu-Rub 2016; Wilkinson et al. 2020).

The evolving, participatory, and active roles of the community's individuals make them *energy citizens*. Through the plurality of their roles and responsibilities, they *actively promote the notion of energy communities* in CMs, which could legitimise *community-led, inclusive change* to move CMs out of their niche position (Mihailova et al. 2022).

Different objectives that drive communities in the energy system are effective motivators for (self-driven) participation and engagement (Jelić et al. 2020; Bauwens et al. 2022). Therefore, this research adopts the perspective of 'attractiveness' (see also Shen et al. 2019) with the CMA framework, supporting the understanding on how attracted and ready communities are to take over their roles and responsibilities for a sustainable CM.

2.2.2 Roles and responsibilities of investors in community microgrids

The roles and responsibilities of communities are closely entangled with the ones of the private sector (Creamer et al. 2018). To foster the communities' democratic and inclusive role, the primary role of *investors* for an attractive microgrid solution is to close the "financial gap" by covering the high upfront microgrid infrastructure costs (Blyth, McCarthy and Gross 2015; Hafner et al. 2020, p.26). Investors are commonly known to be *forward-thinkers and business strategists*. Investors strategically make decisions based on perceptions of risks and returns (Wüstenhagen and Menichetti 2013; Kannadas 2021). On the one hand, investors still perceive microgrids as complex, with no standards, and therefore very risky and unattractive for investments (Strahl, Paris and Vogel 2015). On the other hand, a forward-thinking and strategic investment decision in innovations such as island CMs depends on investment attractiveness, which is more than just a focus on profit and investment risks (Grosshans and Zeisberger 2018; Kozlova and Collan 2020; Petryk et al. 2020). Investment attractiveness is critically reviewed and depends not only on profitability but also on availability of resources and policies, the remoteness of the region, the maturity of the infrastructure, and the demand (Kozlova and Collan 2020). Nonetheless, to drive CM investment, investors have to move beyond this thinking and accelerate local energy transitions and support social justice, driven by the *environmental and social sustainability of CM projects* (Berry and Junkus 2013; Bolton and Foxon 2015). Consequently, this research aims to support the field of sustainable and socially responsible investments (e.g. Dordi et al. 2022; Gutsche and Ziegler 2019; Widyawati 2020) and to demonstrate how an investor perspective on 'attractiveness' rather than 'risk' could drive local energy transitions (e.g. Hafner et al. 2020; Nykvist and Maltais 2022).

For instance, financing island energy projects can come from various sources (Clean Energy for EU Islands 2019b), often partially community-financed or supported by the European Investment Bank (Clean Energy for EU Islands 2019a). Start-ups emerge for energy trading, flexibility, and demand response services (Sousa et al. 2019). Other investors such as oil companies, distributers, and utilities innovate and investigate BMs to *align their business strategy with the ongoing socio-technical transition* to not lose their market shares (Creamer et al. 2018; Judson et al. 2020; IEA 2021). Polzin and Sanders (2020) investigated the responsibilities of different financing sources for the energy transition. A major finding that can be applied to the investors' responsibilities in this context is that they will need to *recognise the changing financing environment and engage in innovative financing schemes*, which policy needs to provide (McInerney and Bunn 2019). For that reason, investors are advised to *strengthen a proactive, strategic forward-thinking mindset* instead of waiting for the public sector to act (Galeano Galvan, Cuppen and Taanman 2020).

Continuous innovation and technology development will support the energy transition, open up new markets, and lower technology costs (IRENA 2020). Thus, market need and growth with available bankable CM designs will demonstrate large opportunities for diverse investors and maximise CM attractiveness (IRENA 2016; Carrington and Stephenson 2018). Therefore, investors should not stop due to uncertainties in e.g. regulations, feasibility or demand, or due to conservative projections (Metayer, Breyer and Fell 2015; Eryilmaz and Homans 2016; Carrington and Stephenson 2018; Norouzi et al. 2022). Instead they should *recognise investment opportunities* using them to shape CM solutions (Gui, Macgill and Betz 2019; Isaksen, Trippl and Mayer 2022). CMs and their ability to provide energy flexibility will be necessary to further enable the integration of volatile renewable energies and the satisfaction of increasing energy demand, especially in island environments (Petrick et al. 2015). IEA forecasts that in 2050 there will be ten times the level of demand response capacity of 2020 with at least 15% of the annual energy demand possible to shift (IEA 2021). This timeframe underlines the fact that small and large-scale investors should be *prepared for long-term returns on investments* (Perez-DeLaMora et al. 2021).

Consequently, investors also take over the roles of *initiators*, *innovators*, and *experimenters* with their investments in CMs. Polzin et al. (2021) suggest that the private sector should *increase its engagement in research, development, and demonstration projects*. The island context presents great opportunities for deploying and testing CMs in challenging contexts as islands are known to be at the 'edge' and therefore support the development of innovative 'cutting-edge' technology (Watts 2019). Through engagement in public-private partnerships, islands, such as the Åland Islands (Derkenbaeva et al. 2020) or the Isles of Scilly (Hitachi 2023), demonstrate how unique contexts serve as platforms to initiate change and experiment with new technologies. Their challenges and local engagement present a testing-ground for 'extremes' where some learnings could be translated to the mainland or other business activities (Skjølsvold, Ryghaug and Throndsen 2020). To accelerate the energy transition in challenged contexts such as of islands, it is necessary to support sector coupling and *drive deployment of technologies which have not yet reached a technology readiness level* (Marczinkowski, Østergaard and Djørup 2019). In this sector, it is crucial that investors are *responsive to changing policies, communicate and collaborate with the public sector, and form alliances between equally minded actors*, while the public sector decreases regulatory and policy risk (Bolton, Foxon and Hall 2015; Gatzert and Vogl 2016; Polzin and Sanders 2020; Zhang 2020; Soutar 2021; Nykvist and Maltais 2022).

Ford (2021) argues that for any development on islands, investors are advised to *engage in the process of negotiation and shared dialogue* with the community for equality of roles. This crucial responsibility leads to alignment between community and investor purposes and their notions of attractiveness that determine the CM design (Ahmed and Sarkar 2019; Gui, Macgill and Betz 2019). In that sense, investors should *consider the local context/ place and the peoples' place attachment and resulting technology acceptance* to find solutions that are human-centric (Leal-Arcas, Lesniewska and Proedrou 2018; Tang and Beer 2021; Walker et al. 2021). Instead of just focusing on bringing innovative technologies forward or presenting ready-made project plans (Kallis et al. 2021). Research has shown that it reduces risks and increases benefits to involve the community and collaborate with the government from the beginning of the development process (Pacheco et al. 2022). In case of hybrid investment strategies and community ownership, it is beneficial if investors or banks who provide loans *support the community in the development of CM*s as the technology and business aspects are often complex and unfamiliar (Löbbe et al. 2020). Hence, investors act as *educators* and *supporters* for the local community to share from their experience in this complex business sector (Geddes and Schmidt 2020; Löbbe et al. 2020).

The action of a few influential financial stakeholders could already make the difference to accelerate the energy transition (Dordi et al. 2022). The microgrid market is still in the commercialisation phase – a niche which makes it difficult to find investors (Polzin and Sanders 2020) – that undergoes technological and social innovations which increase its attractiveness (Warneryd, Håkansson and Karltorp 2020). Along the path of the energy transition, as with other technologies such as PV, powerful actors should become *energy activists* who actively advocate CMs and the notion of ECs at professional and policy level (Raven et al. 2016). Strong sustainable leadership increases the level of sustainability adoption of the rest of the organisation, which would also support the business performance (Gopalakrishna-remani, Byun and Doty 2022). Hence, enthusiastic investors would need to holistically approach their roles and thus shield, nurture, and empower the development of tailored CMs (Huijben, Verbong and Podoynitsyna 2016; Raven et al. 2016; Ebers Broughel and Hampl 2018). Thereby, investors could accelerate investments in CMs, mainstream the notion of ECs, and attract further investors (Rajagopalan and Breetz 2022).

Once communities and investors are ready to take up, align, and negotiate their roles and responsibilities (see Table 2), it will be possible to create attractive CM solutions. Therefore, the CMA framework aims to support understanding on how attracted and ready investors are to take over their roles and responsibilities for a sustainable CM. Participation and engagement result in environmental, social, technological, and economic benefits that will be shared. How these benefits could be shared fairly and how this affects the CM design will be explored through both the communities' and investors' notion of aligned attractiveness in the next section.

Table 2. Summary of roles and responsibilities of energy community and investors for attractive community microgrid solutions – both during development and operation.

<table>
<tr><th></th><th colspan="2">Energy community</th><th colspan="3">Investors</th></tr>
<tr><td rowspan="2">Roles</td><td>Prosumers and active users</td><td>Managers, investors, and initiators</td><td>Investors, forward-thinkers, and business strategists</td><td>Initiators, innovators, and experimenters</td><td>Educators and supporters</td></tr>
<tr><td colspan="2">Energy citizens: actively promote the notion of energy communities and community-led, inclusive change</td><td colspan="3">Energy activists: actively advocate community microgrids and the notion of energy communities at professional and policy level</td></tr>
<tr><td>Responsibilities</td><td>- manage, generate, consume, share, or sell energy
- comply with the local, pre-set energy management and control settings, and consciously consume energy
- trade their ‘flexibility’
- flexibly consume or generate energy based on price-signals</td><td>- evaluate economic, technology, and social implications on (dis)comfort, (in)convenience, and fuel poverty
- actively interact in decision-making or co-creation processes
- demonstrate local solidarity
- learn from each other and developing skills for the participation
- support policy decisions</td><td>- invest in environmentally and socially sustainable projects such as island CMs
- align their business strategy with the ongoing socio-technical transition
- recognise the changing financing environment and engage in innovative financing schemes
- strengthen a proactive, strategic forward-thinking mindset
- recognise investment opportunities
- prepare for long-term investments</td><td>- drive deployment of technologies which have not yet reached a technology readiness level
- increase engagement in research, development, and demonstration projects
- be responsive to changing policies
- communicate and collaborate with each other and the public sector</td><td>- engage in processes of negotiation and shared dialogue
- consider the local context/place and the peoples’ place attachment and resulting technology acceptance
- support the community in the development of CMs
- provide constant communication, engagement, transparency, and information</td></tr>
<tr><td>Key points</td><td colspan="2">Active participation and engagement: put in time, effort, flexibility, and money, and change energy behaviour</td><td colspan="3">Proactive investments and engagement: apply innovative, supportive, and long-term driven behaviour and mindset</td></tr>
</table>

2.3 Alignment of the notion of attractiveness

The previous section demonstrated that community microgrids' (CMs) complex abilities and designs disentangle into environmental, social, technological, and economic benefits (Hatziargyriou 2014; Hossain et al. 2014; Stadler et al. 2016; Konidena, Sun and Bhandari 2020). These often rather 'ideal' values, however, well position CMs as attractive solutions within the EU's 4 D framework in the context of local energy transitions. That means, all the microgrid benefits sound very attractive and one may wonder why then it is not easy to get energy communities (ECs) and investors engaged.

The decision-making of individuals is influenced by subjective perceptions of risks and attractiveness (Weber, Anderson and Birnbaum 1992). Uncertainties of technology, socio-technological and socio-economic changes highly influences the community and investor perception of risk towards participating and engaging in a long-term project like a CM (Bolton and Foxon 2015; Derkenbaeva et al. 2022a; O'Connor, Fredericks and Kosoralo 2022). On the one hand, research has already investigated perceptions of risks of investors and communities (Nykvist and Maltais 2022; O'Connor, Fredericks and Kosoralo 2022) and barriers to the implementation and mainstreaming of solutions such as CMs (Norouzi et al. 2022). On the other hand, research has demonstrated the usefulness to turn this notion around to value-based studies with regard to community participation in energy projects (Lode et al. 2022), demand response services (Jelić et al. 2020), or local energy markets (Hackbarth and Löbbe 2020; Pires Klein et al. 2021).

For microgrids, the reality demonstrates that perceptions of individuals on these values depend on the stakeholders' perspective and local context. Values and benefits are strongly linked to purposes, objectives, motivations, and priorities for participation and engagement (Sachs et al. 2019). For instance, perceptions can be different depending on the context but also the social aims, and cultures of the stakeholders (Kelly-Pitou et al. 2017; Piterou and Coles 2021; Derkenbaeva et al. 2022a). In addition, regulatory barriers often hinder the deployment of microgrids and effect benefits, as regulations and policies are not yet ready for microgrids and their possible energy business models (BMs) (Soshinskaya et al. 2014; Ali et al. 2017; Plewnia and Guenther 2021; Mauger 2022). Therefore, the values of a CM are more complex than they seem at first sight (Hall and Roelich 2016). According to Hall and Roelich (2016) understanding values and their complexity supports business model innovation. Consequently, it will support the creation of attractive CM solutions that would drive willingness to participate and invest, as Adams et al. (2021) have shown for communities and Ebers Broughel and Hampl (2018) for investors. While this research focuses on the community and investor perspective, CM solutions are not exclusive of other stakeholders. For example, Plewnia and Guenther (2021), investigate the value proposition for energy community (energy consumers and prosumers), plant operators, system operators, other electricity consumers, component manufacturers, energy utilities, and other stakeholders.

This research contributes to these discussions, investigating the perceived 'attractiveness' and alignment of these benefits to drive participation and investment. Technology attractiveness influences the involvement and engagement of people, as Shen et al. (2019) have demonstrated for social e-commerce. Similarly, Banerjee and Bose (2022) and Belderbos and Somers (2015), respectively, used the notion of attractiveness to investigate consumer preferences and willingness to engage in crowdfunding, and regional influences to attract investments. The results demonstrate the different manifestations of attractiveness given different stakeholder perceptions. In line with Adams et al. (2021), this research focuses on the alignment of both the communities' and the investors' perceived notion of attractiveness to bridge outcome expectations, to tackle possible conflicts of interest, and to drive positive decision-making.

Aligning the notion of attractiveness, fairly sharing and distributing benefits supports a just energy transition (Williams and Doyon 2019). The CMA improves understanding of which CM benefits are attractive to communities and investors and which ones would be prioritised to align perceptions. These understandings, ultimately, form the notion of attractiveness that shapes CM solutions and drives decisions on participating, engaging, or investing. Consequently, the following sections present attractiveness alignment from the environmental, social, technological, and economic benefit perspective.

2.3.1 Attractiveness alignment from the environmental benefit perspective

Microgrid technology for decarbonisation *reduces fossil fuel dependency for the individuals* (Anderson and Yakimenko 2017). The reduced use of fossil fuels benefits the environment but also reduces economic risks which go along with the use of fossil fuels and possible future carbon regulations and costs (Hyams 2010). Hence, making this a key benefit that could drive the individuals' participation in a CM.

Investing in green microgrids could *contribute to the investor's/ organisation's environmental responsibilities* – a direct benefit in line with long-term horizons of sustainable investments, ESG metrics, and consequent behavioural changes (Widyawati 2020). Taking action in environmental innovations also positively supports a stronger environmental reputation (Tran and Adomako 2022), *benefiting brand value and brand affinity* (El Zein, Consolacion-Segura and Huertas-Garcia 2020). The brand could also be the 'sustainable island image', which could be an important driver for local investors (Del-Busto, Mainar-Toledo and Ballestín-Trenado 2022). Although environmental microgrid benefits are not necessarily monetary or only have long-term effects on the investor's portfolio or BM per se, they could maximise benefits (Gui, Diesendorf and MacGill 2017; Geissdoerfer, Vladimirova and Evans 2018).

The fact that microgrids support decarbonisation efforts and address environmental concerns similarly attracts community and investors. CMs directly integrate RES, improve energy efficiency, present a pathway to integrate more RES into the wider island energy system, and substitute fossil-fuelled power plants (Hatziargyriou 2014; IRENA 2016; Pullins 2019; Heinz et al. 2021). Consequently, a direct benefit is the r*eduction of the islands' fossil fuel dependency*. This benefit is attractive for community and investors not only because of the islands' improved sustainability and decreased GHG emissions but also for the islands' increased self-sufficiency (Martin-Martínez, Sánchez-Miralles and Rivier 2016; Santos et al. 2018; Derkenbaeva et al. 2020). These points directly *contribute to overall environmental benefits, clean air, and climate change mitigation for the island* (Martin-Martínez, Sánchez-Miralles and Rivier 2016). These environmental benefits support alignment of the perceived attractiveness as climate change concerns trigger people's interest in renewable energy in the first place (Fell, Schneiders and Shipworth 2019). According to Plewnia and Guenther (2021), there is shared value and an attached positive feeling in driving the energy transition and the effect on the overall energy system. At the same time, the indirect support of CMs to *fulfilling and complying with island decarbonisation goals* (Romankiewicz et al. 2013) is attractive to communities and investors as it limits risks of future carbon emission regulations and non-compliance fines but also environmental risks in the island (Hyams 2010; Parag and Ainspan 2019; Del-Busto, Mainar-Toledo and Ballestín-Trenado 2022).

It is said that island communities have a high level of sense for the environment and need for the energy transition (Bunker et al. 2015). At the same time, investors increasingly invest in sustainable projects, including at a local level (Wüstenhagen and Menichetti 2012; Hoicka, Conroy and Berka 2021). Environmental motivation can be one of a variety of drivers for energy decentralisation (Judson et al. 2020). Adding environmental value increases attractiveness and therefore willingness to participate (Hackbarth and Löbbe 2020), if not even being the main motivator (Smale and Kloppenburg 2020). In fact, the contrary would be unthinkable in the narrative of this century. As already mentioned in section 2.1.1, future CMs should be 100% renewable and progressively in scale. In conclusion, this section highlights the importance of focussing on an increased level of environmental benefits and attached emotional values for aligned attractiveness.

2.3.2 Attractiveness alignment from the social benefit perspective

A CM brings individuals together to undertake new responsibilities, follow common interests, and have more choice of energy supply (Hatziargyriou 2014). In a CM, community members would benefit from *forming part of an 'active' community*, which results in empowerment, personal development, collaboration and a sense of collectively and connectedness which can be perceived as attractive (Löbbe et al. 2020; Pires Klein et al. 2021; Plewnia and Guenther 2021).

Social relationships and social norms can have an effect on the energy behaviour (Hargreaves and Middlemiss 2020; Jelić et al. 2020). Social norms are however sometimes unsupportive to sustainable behaviour (Bal et al. 2021). However, in a community, the members can exchange information to equally benefit and support each other (Plewnia and Guenther 2021). Being part of the ‘active’ CM community allows everyone to participate in the social innovation process and to reduce risk of exclusion or being left behind (Hiteva and Sovacool 2017; Pellegrini-Masini et al. 2019). As described in section 2.2.1, there are individuals that value new, active, democratic roles and increased levels of social equity (Sousa et al. 2019; Wilkinson et al. 2020). Consequently, the participation of one enables the *active role and democratic say in (local) energy system for others as part of the energy community* (Smale and Kloppenburg 2020). This is a wider social benefit particularly for people who care more for the community than for their personal interests (Schwartz 2012; Creamer et al. 2018). As a result of the more democratic system, Plewnia and Guenther, (2021) emphasise the value for the community of having increased transparency and understanding of where the energy they use comes from and sharing energy within a like-minded community.

Also, investors support and benefit from the social notion of energy democracy by *enabling an active role and democratic say in (local) energy system for the energy community*. For instance, off-taking investments and focussing on a social notion of CM models supports accessibility and participation of financially more vulnerable households (Bauwens et al. 2022). Including the community and supporting local ownership increase community engagement as then the community values the project more (Pacheco et al. 2022). In addition, the EC is more likely to accept large scale installations (Gancheva et al. 2018). Seeking and making actual use of the communities’ perspective, knowledge, and experience for co-designing the project enhances both trust between community and investors and the success of the project (Kallis et al. 2021). Overall, this benefit is beneficial for investors as it limits the risk of the community members opting out or losing interest and instead maintains participation. The EC’s long-term participation supports the CM’s environmentally, socially, and economically sustainability. Investors can even translate these benefits into an *opportunity for their branding and green advertisement*. The multifaceted CM concept that adds value to not only shareholders but moreover to the local community and overall society addresses the triple bottom line approach (Bocken et al. 2014; Zafrilla et al. 2019). Schaltegger et al. (2019) point out that companies increasingly need environmental and social activities to positively contribute to their reputation and market position. As for environmental benefits, philanthropic investors value the resulting *impact and contribution of the social investment on their social and governance responsibilities* (Widyawati 2020).

Power outages could increasingly happen in an island energy system due to severe weather conditions, breaking transmission or distribution cables and system repairs, or system instability due to the fluctuations of renewable energy sources (RES) (Bunker et al. 2015; Stadler et al. 2016; Hirsch, Parag and Guerrero 2018; Parag and Ainspan 2019; Papadopoulos 2020). For example, on islands, where communities are often energy vulnerable and isolated and face increasing water scarcities, energy security is a key issue for their local energy transitions to ensure production of potable water from seawater (Eras-Almeida and Egido-Aguilera 2019; Köhler et al. 2019; Haase and Maier 2021). People are concerned about their security of supply when changing to local energy systems due to feeling disconnected from the traditional power supply (Adams et al. 2021). A secure energy supply is a public good and in particular affordability, accessibility and availability are crucial for a socially just energy transition (Valdes 2021). For energy security, local availability and reliability are incremental factors which support social justice as it mitigates the risk of, unequal economic development, energy injustice (Sovacool 2011; Sovacool, Sidortsov and Jones 2014). Therefore, attractiveness through the social perspective needs to emphasise that a grid-connected CM solution provides increased levels of energy reliability, quality, and security (in operation and islanding mode) (Romankiewicz et al. 2013; Hatziargyriou 2014; Soshinskaya et al. 2014; Santos et al. 2018). Apart from the technology, also the increased energy democracy in a CM supports high levels of energy supply security (Hargreaves, Hargreaves and Chilvers 2022). For the EC, controlling their own power generation and consumption creates a sense of self-empowerment (Botelho et al. 2021). A CM design based on consumers' needs highlights the social benefit of *providing power quality and reliability to the energy community and the island* (Kelly-Pitou et al. 2017). Nonetheless, power quality and reliability are difficult to quantify (Stadler et al. 2016; Parag and Ainspan 2019); it is possible, however, and then the strong social notion benefits increases investment attractiveness (Williams et al. 2015; Kelly-Pitou et al. 2017). According to Broberg and Persson (2016), a reduced risk of blackouts and increased energy resilience supports the communities' willingness to participate, which again is attractive from an investors point of view. Ultimately, providing energy resilience is also beneficial for the business brand (Pullins 2019).

Additionally, a major benefit of adopted CM BMs is the *facilitation of low energy costs for the energy community* (Romankiewicz et al. 2013; Stadler et al. 2016; Mengelkamp et al. 2017; Piterou and Coles 2021). For instance, the locally produced, clean energy is cheaper than the bought energy from the main grid. Moreover, electric utility bill charges reduce due to less energy sourcing (Hyams 2010). Lower energy bills ensure energy affordability and tackle energy poverty. These benefits are immensely attractive in island contexts, underlining the social notion where communities suffer from higher energy costs than in the mainland (Anderson and Yakimenko 2017). To share this benefit fairly within the community, a human-centric, tailored CM solution is critical. This means a solution takes different household compositions and their energy demand and flexibility into account (Powells and Fell 2019).

Furthermore, *by including vulnerable households*, these actions could *contribute to the islands' energy poverty strategy* (if present). In fact, more focus on the inclusion of fuel poor households is needed (Arvanitopoulos, Wilson and Ferrini 2022). However, clear structures for achieving this would be needed, as otherwise Smale and Kloppenburg (2020) found that the community alone might see limited possibility of supporting social justice. For instance, models where local authorities are involved in the role of investors often aim to tackle energy poverty (Foxon et al. 2015). Overall, actively tackling energy poverty through participation, engagement, and investment could be attractive for community and investors.

Directly supporting local energy affordability and including vulnerable households, decreases energy vulnerability and can positively change their lifestyles through decreased levels of illness, stress, and anxiety (Santos et al. 2018; National Energy Action 2023). Additionally, to decrease local social risks, researchers suggest involving the local community in decisions and community building and feeding benefits back to the community (Lode et al. 2022). This involves collaborating with, for example, local farmers who own land or WTs already, or who could source biomass (Sperling 2017). Furthermore, involving the community means educating locals to support in maintenance of the CM (Derkenbaeva et al. 2020; Bray, Mejía Montero and Ford 2022). Strengthening and involving the community potentially decreases operational risks in the sense of lack of engagement or unavailability or inaccessibility of staff or equipment for maintenance (Bray, Mejía Montero and Ford 2022). All these social benefits support one another, contributing to *local well-being, capacity building, economic growth, and jobs* (Sperling 2017; Derkenbaeva et al. 2020; Bray, Mejía Montero and Ford 2022), and *awareness and engagement* (Plewnia and Guenther 2021). In the end, all these benefits help tackling island depopulation (Anderson and Yakimenko 2017; Derkenbaeva et al. 2020).

In conclusion, although mostly indirect and not monetary, social benefits are attractive to both community and investors, presenting complementary views. Addressing this 'added value' in a CM design creates a win-win situation. It is important to minimise the communities' risk so that no consumers end up as losers or being 'worse off' (Wilkinson et al. 2020; Calver and Simcock 2021). In fact, according to Nolden et al., (2020) and Allan et al., (2011), community benefit is important for the projects' success. These aspects reduce investors' risk, by counteracting lack of participation of the community which could happen due to loss of interest, opting-out, or other private issues or conflicts among the community members. Hence, a social perspective supports aligning interests, objectives, and concerns between investors and communities (and even within the community as this can already be difficult) (Kirchhoff and Strunz 2019; Smale and Kloppenburg 2020). It is therefore recommended that a CM design addresses today's increasing social injustices, rising energy costs, and other social risks that result from global climate change.

2.3.3 Attractiveness alignment from the technological benefit perspective

The concept of smart CMs is still relatively new, but technological sustainability and benefits are appearing (Kirchhoff and Strunz 2019). As already mentioned in section 2.1.2, islands exemplify how communities participate in demonstrator projects and become testbeds of local energy transitions (Skjølsvold, Ryghaug and Throndsen 2020; Smale and Kloppenburg 2020). Communities benefit from *supporting the promotion, demonstration, and testing of technologies while and as long as their quality of life is maintained or even increased* (Ellabban and Abu-Rub 2016; Williams and Doyon 2020; Kallis et al. 2021; Nguyen and Batel 2021). Moreover, the control system, which manages the islanding ability, supports cost-optimisation of the technology resources, thereby decreasing initial investment costs, limiting risks and complexity of the system (Soshinskaya et al. 2014; Carpintero-Rentería, Santos-Martín and Guerrero 2019; Papadopoulos 2020). Apart from the automatic optimisation, community members directly benefit from the provision and *use of smart technologies for home device control* (Plewnia and Guenther 2021). This benefit is particularly attractive for individuals with innovation or technical interest (Löbbe et al. 2020). Communities value the opportunity to innovate and become innovators themselves (Romankiewicz et al. 2013; Wilkinson et al. 2020). The community benefits from being prepared for future smart-grid developments and energy services (Plewnia and Guenther 2021). Through learning by doing, this benefit is an opportunity to also overcome technology concerns regarding complexity, transparency, or data security and privacy (Adams et al. 2021; Hamwi, Lizarralde and Legardeur 2021; Norouzi et al. 2022).

Past microgrid developments show the perceived attractiveness for investors of the use of microgrids for *testing and demonstrating of new products or innovative technologies* such as smart technologies (Hossain et al. 2014; Strahl, Paris and Vogel 2015). Islands present unique and varying contexts with an ‘islandness’ that requires tailored designs and innovations to address challenges (Kallis et al. 2021). The islandness is also important for considerations such as those concerning accessibility of the technology and future replacements and maintenance on islands (Bunker et al. 2015). Consequently, demonstrators, testbeds, and success stories – also often related to working, collaborating, and engaging with communities – support the *promotion of the investors' technologies through applicability in challenging island contexts* (Anderson and Yakimenko 2017; Sperling 2017; Derkenbaeva et al. 2020; Kallis et al. 2021; Arvanitopoulos, Wilson and Ferrini 2022). According to Apajalahti and Kungl (2022), the investment in RES comes along with new knowledge and competencies which sooner or later have to translate to smart CMs. An island focus further enhances skills to find place-specific, that is place-based, solutions that fit the local island contexts instead of industry-specific skills, which were the trend of the current system (Corradini, Morris and Vanino 2022). Hence, for innovative investors these benefits are important and support alignment with the communities' perceived attractiveness.

That said, still, reliability of technology is a key factor in investors' decisions to invest (Masini and Menichetti 2012). At the same time, the communities' level of technology acceptance – which is a "complicated matter" – is highly influenced by the place and the perceptions of risks and uncertainty related to the technology (O'Connor, Fredericks and Kosoralo 2022, p.340). Therefore, in island CM testbeds, for the community, *pioneer participation in and access to low carbon, renewable energies, and energy efficiency at low cost and risk* (Wilkinson et al. 2020), and for investors the *provision of this access,* are side-benefits that support alignment of attractiveness. Communities and investors mutually benefit from an environment of reduced risks while exploring innovative technology solutions. For communities, who become early adopters, this can even support inclusiveness and create some sort of pride (Biggemann, Williams and Kro 2014; Karjalainen and Ahvenniemi 2019). Investors gain experience to lose aversion to technological risk (Masini and Menichetti 2012).

It is not surprising that all microgrid value streams are based on a key benefit, in comparison to for example a single wind turbine, which is the *local combination and provision of power production, consumption, and distribution and control* (Hatziargyriou 2014). This local energy can be provided to the community or the island depending on the scale of the microgrid (see Anderson and Yakimenko 2017; Bunker et al. 2015). In fact, studies found that from a community perspective, the 'local' scale should be between family, friends, and neighbours, to keep participation between trusted members (Fell, Schneiders and Shipworth 2019; Jelić et al. 2020; Löbbe et al. 2020). A small scale and "geographical embeddedness" of a CM could make investments unattractive (Creamer et al. 2018, p.7). However, the focus on smart 'local' energy solutions which support social coherence and democracy could decrease planning and operational risks such as through increased success in land planning (Creamer et al. 2018; Walker et al. 2021). At the same time, onsite power production and storge while meeting individual (rising) energy demands is considered a technological benefit by itself. In the end, developing local energy solutions that are built around local resources to address local needs are attractive for island communities (IRENA 2016; Anderson and Yakimenko 2017). Similarly, for investors it, for instance, reduces the demand for distribution and transmission facilities (Hatziargyriou 2014).

The reduced distance between generation and demand consequently *decreases power losses* (Soshinskaya et al. 2014). At the same time, effective microgrid management and BMs *decrease renewable energy curtailments on the island* (Petrick et al. 2015). The use of smart technology and optimisation allows for better integration of RES (Plewnia and Guenther 2021). Island-wide, a CM can be managed to increase demand and thus limit curtailment of individually implemented RES in the saturated island energy grids (Marczinkowski and Østergaard 2019). But also locally, enabled by local optimisation and energy storage, CMs limit operational risks such as non-efficient operation or curtailment (Papadopoulos 2020). Power losses through transmission or curtailment are unpleasant as they result in economic loss, which becomes a challenge when e.g. community ownership comes with responsibilities such as feeding economic returns to the community or paying loans (van der Waal 2020). That means, instead of worrying about curtailments and having high levels of uncertainty, community and investors want technology that provides energy security, stable operation, and economic returns (Ellabban and Abu-Rub 2016; Ebers Broughel and Hampl 2018). Therefore, these technological benefits of CMs are attractive for both community and investors.

Another technological benefit of a microgrid is its *ability to electrically connect or disconnect from the main power grid* (e.g. Hatziargyriou 2014). For instance, this ability increases local and island energy resilience as CMs can switch to island-mode to help sustain the wider grid's stability while securely operating and ensuring local energy. This ability is therefore beneficial e.g. for a community that seeks self-sufficiency or for investors that want to apply or test energy BMs (Warneryd, Håkansson and Karltorp 2020). Communities value grid-connection as it supports autonomy rather than autarky, which allows for BMs that can be negotiated with the DSO (Smale and Kloppenburg 2020). Grid-connection can be a long and costly process and discussion with the local DSO (Hanna et al. 2017; Oueid 2019). As a result, investors who want to limit risks to the project will require to adopt early engagement and strategies to make the DSO a key partner (Soshinskaya et al. 2014; Reis et al. 2021). In fact, in those matters, the investors' experience, knowledge, and support are important for community-led co-creation projects (Eras-Almeida and Egido-Aguilera 2019; Mihailova 2023). In the end, grid-connection is key for this benefit which enables a bankable CM (Strahl, Paris and Vogel 2015); hence, this benefit is mutually attractive for community and investors.

Attractiveness alignment from the technological benefit perspective shows that both community and investors do not want solutions that are risky or uncertain. Testing innovative technologies that are designed to the communities' needs also means robust, non-complex set-ups that are easy to maintain and operate (Plewnia and Guenther 2021). Learnings from diverse contexts potentially further decrease technological risks by identifying CM solutions that combine innovation with easy manageable, established, and mature technology, to limit the problem of being too complicated and unpredictable (Löbbe et al. 2020; Zhang 2020). Smooth operation within the CM and with the main power grid is only possible through the decentralised and digitalised technological grandeur of CMs over individual technologies, which makes CMs a future-proof technology solution that ensures long-term profitability and economic benefits.

2.3.4 Attractiveness alignment from the economic benefit perspective

Given the microgrids' value generation and democratisation elements, research points out the immense possibilities to create diverse economic benefits. For the community, energy cost decrease and revenue increase are of primary importance to stimulate their active participation

(Wilkinson et al. 2020; Adams et al. 2021). These broader benefits derive from various economic benefits of CMs for the community. First, in a CM, the community consumes less fuel and energy as a direct benefit from the local control and efficiency improvements and thus makes *monetary savings from high energy efficiency* (Hirsch, Parag and Guerrero 2018).

The emerging, active roles of the community in a CM in line with the democratic nature of the future energy system open the possibility to *explore and participate in both the local and the wider energy market* (Sousa et al. 2019). This exploration and participation will provide different economic benefits on its way, as it may happen in steps from uncoordinated self-sufficiency, to aggregated virtual power plant and microgrid models, to local P2P trading (Guerrero et al. 2020; Löbbe et al. 2020). How these benefits monetise and support the maximisation of local benefits would depend on the final negotiation of, for example, monthly costs and initial investments or flexibility capital and the overall BM design (Mengelkamp et al. 2019; Powells and Fell 2019; Wilkinson et al. 2020; Kallis et al. 2021). People would want to be compensated economically for discomfort that arises from energy flexibility BMs (Kubli, Loock and Wüstenhagen 2018). In any case, in a CM, the community individuals will have a better choice of energy supply and will be able to find a BM option that best fits their preferences and needs (Sousa et al. 2019). Existing local energy market models demonstrate that the motivator for participation in local energy market models is that the local energy price is lower than what it would traditionally cost, and that revenue remains within the community (Löbbe et al. 2020; Adams et al. 2021). Revenue has to stay with the local community to ensure attractiveness and acceptance of the solution (Allan, Mcgregor and Swales 2011). Local energy trading optimises and increases the use of local energy, limiting the need to buy energy from the main grid, which increases self-sufficiency and decreases energy bills (Plewnia and Guenther 2021). Hence, a major option to create economic benefit which does not lie far in the future anymore is active *energy trading within the energy community as it allows the establishment of monetary savings and revenues.*

Developments towards local energy markets support autarky, however, communities have been found to rather prefer autonomy (Adams et al. 2021). Autonomy still comes with increased *economic independence from existing energy companies*, which is often a main attractiveness element and driver for communities to participate in energy sharing (Hackbarth and Löbbe 2020; Löbbe et al. 2020; Adams et al. 2021). However, still having a connection to the wider energy system and the companies gives the community a greater sense of energy security (Adams et al. 2021). Additionally, Plewnia and Guenther (2021) warn that there is an emotional value attached to this independence and therefore the level of independence needs to be clearly communicated to not give the community a feeling of a false promise.

Increasing use of local energy and less fuel dependency goes hand in hand with *improvement of energy cost predictions*. That means microgrid energy is less effected by energy market price volatility and the community will be able to make long-term savings and evaluations (Hyams 2010; Anderson and Yakimenko 2017; Pullins 2019). These benefits reduce the risk of energy insecurity and price vulnerability, supporting energy affordability and transparency (Sovacool 2011; Plewnia and Guenther 2021).

Investors value economic success of their investments through increased sales, reduced costs, improved reputation, and enhanced innovativeness (Schaltegger, Hörisch and Freeman 2019). CMs address these points. CMs are platforms to stack several sustainable values through application of more than one innovative energy BM that make effective use of the bi-directional power flows. This aspect is important for investors, as an investment is attractive when there is *a sustainable business case, which creates profit, monetary value, and revenue, that makes economic sense and its longevity is ensured* (Farzan et al. 2013; Burr et al. 2014; Sachs et al. 2019). The CM's value stacking ability is crucial as regulatory barriers often hinder the full potential of the individual BM (Botelho et al. 2021; Plewnia and Guenther 2021). For instance, in many countries, such as the UK, feed-in tariffs no longer exist or are so low that a prosumer BM alone is not economically attractive (Brown, Hall and Davis 2019; 2020). This is a pity, given that that investors consider feed-in tariffs the most attractive policy instrument to attract investment (Masini and Menichetti 2012). Nonetheless, also other aspects of the CM configuration affect the business case. For instance, to reduce the risk of uncertain electricity demand and price elasticity, Williams et al. (2018) recommend including some reliable (larger-scale) customers with a steady energy demand into the CM. These could be the local government and/or a large energy prosumer e.g. from local industries or businesses, who ensure energy production and offtake. Another way to compensate would be to have some community members pay a minor premium for these benefits of autonomy and local energy (Kubli, Loock and Wüstenhagen 2018; Mengelkamp et al. 2019). These approaches reduce pressure on the overall communities' responsibilities and would therefore allow the tailoring of more human-centric designs for the individuals. A business case that is attractive for the community and ensures their engagements, consequently, supports long-term economical sustainability of the CM.

There are also indirect economic benefits which could be attractive for investors and be the reason to make investments in the first place. Strategic implementation of CMs in old electric grids, such as on islands, *reduces energy infrastructure costs*. Instead of investing in costly transmission and distribution system infrastructure to increase capacity or expand, microgrids present alternatives for these grid-reinforcements (Hatziargyriou 2014; Hirsch, Parag and Guerrero 2018). However, microgrids should rather complement and not replace the energy grids' transformations, given the urge to become smart and flexible (Konidena, Sun and Bhandari 2020; Enlit 2023). CMs will form a major part in future energy grids due to the microgrid's decentralisation, decarbonisation, digitalisation, and democratisation elements. Investors could benefit from the increasing transformation of the energy sector to break out of established path-dependencies of investment (Apajalahti and Kungl 2022). Investments in CMs are investments in future markets and possible grid services that may not yet be fully feasible but provide long-term benefits and support the energy transition (Foxon et al. 2015). Thus, the *exploration of and participation in new markets* by investing in and testing CMs reduces the economic risk of losing out in the future. That means as the energy value chain dissolves towards being more local and decentralised it is beneficial for energy companies to start creating direct contact with the community to not be left behind (Richter 2012; Frei et al. 2018; Plewnia and Guenther 2021). Ultimately, this is an opportunity that enables *long-term benefits through, for example, translation of 'testbed' experiences to mainland projects and markets*. This is a benefit that already attracts various energy companies or technology developers. The actors individually thrive innovation on CMs and BMs or partner up to create a full island technology testbed and living lab such as the Åland Islands (Mihailova et al. 2022) or the Isles of Scilly (Hitachi 2023).

Direct economic benefit, that is financial returns, remain an important factor to motivate participation and investment (Salm et al. 2016). However, environmental and social benefits also become increasingly important. The most straightforward way to create shared economic benefit is *through energy BMs such as power export/prosumer business models, demand response or ancillary services* (Stadler et al. 2016; Hirsch, Parag and Guerrero 2018; Konidena, Sun and Bhandari 2020; Hamwi, Lizarralde and Legardeur 2021). This is similarly attractive for communities and investors, as communities *establish monetary savings and revenues and* investors basically *explore these BMs and get direct revenue from the user's flexibility*. The regulatory landscape increasingly supports the evolvement of ECs and flexibility markets (Hinsch, Rothballer and Kittel 2021). The coordination of the different BMs, the variation in energy demand, flexibility, and production of the community members, and the bi-directional power flow with the main power grid can become complex and risky (Sanz et al. 2014; Leutgöb et al. 2019). Therefore, microgrid developers recommend a 'microgrid manager' who coordinates these issues, that is the local energy value chain. A microgrid manager interacts and negotiates the energy sales with the local service operator and a commercial aggregator (Borghese, Cunic and Barton 2017; Leutgöb et al. 2019). Generally, collaborating with an independent aggregator is also useful for small CMs to overcome the barrier of insufficient size (capacity) to participate in the energy market (Carreiro, Jorge and Antunes 2017). Having facilitators, aggregators, and managers in place that manage the community's energy and flexibility is important to allocate risks away from the consumers and align attractiveness with investors. When trusted stakeholders e.g. local government or known retailers take over these roles, it simplifies the solution and increases perception of attractiveness for both community and investors (Sperling 2017; Creamer et al. 2018; Bray, Mejía Montero and Ford 2022)

From current research it becomes clear that for some community members it increases attractiveness when they have the choice to take over diverse roles themselves and have a sense of ownership, for instance, due to partial investment from the community (e.g. Lode et al. 2022). The community can also be involved in construction, maintenance, or administrative work of the CM which would provide jobs in the otherwise economically vulnerable islands (Eurelectric 2017; Del Gatto and Mastinu 2018; Hutchinson and Eversole 2022). These democratic structures align economic benefits between the community and investors as they assure that economic benefits are not only shared but feed back into the community. For example, smart infrastructure investments contribute to regional competitiveness as they also attract other industries (Foxon et al. 2015). Ultimately, an overall economic benefit is the *contribution to local economic growth through capacity building and jobs* (Bray, Mejía Montero and Ford 2022; van Summeren et al. 2023). Local innovation and investments for successful CMs and expansion of the BM depend on local expertise and social capital (Ramirez 2021; Arvanitopoulos, Wilson and Ferrini 2022). Although this benefit, in comparison to the other economic benefits, is rather indirect, it was found to be a key benefit of CMs that supports alignment of attractiveness as it addresses the wider island community challenges with a long-term perspective (Bray, Mejía Montero and Ford 2022).

Economic benefits are probably the most affected by the existing regulations (Huijben, Verbong and Podoynitsyna 2016). Regulatory uncertainty and lack of political transparency are still the major barriers to the communities' and the investors' participation and investment (Hoicka et al. 2021; Nykvist and Maltais 2022; Enlit 2023). Investors' safety of investment is more important than returns (Kannadas 2021). Therefore, regulatory changes are still needed to allow energy flexibility and energy trading BMs and salient benefits in the short-term and to accelerate the profitability and attractiveness of CMs for investors in the long-term (Brown, Hall and Davis 2019; Mauger 2022). At the same time, regulations need to be more flexible and need to align with, for example, local needs of islands and their technology solutions (Hiteva and Sovacool 2017; Marczinkowski, Østergaard and Mauger 2022). In addition, policy has to facilitate communities' and investors' responsibilities, by taking their perspectives and thus enabling them to obtain their economic benefits (Bolderdijk et al. 2017; Hall et al. 2018). All these measures are important to balance risks and benefits for attractive value generation. CMs allow for enough economic benefits to share between community and investors (and potential other stakeholders) and to capture the value of CMs.

Fairly sharing the benefits and involving the community immensely improves the communities' acceptance and willingness to cooperate with investors (e.g. Allan et al., 2011). It will be key to mutually maximise benefits and reduce risks to align the notion of attractiveness. Table 3 summarises environmental, social, technological, and economic values for an energy community and investors.

Table 3. Summary of microgrid benefits for energy community (EC) and investors (I) with symbols '++' for benefits and '+' for benefits that indirectly reduce economic risk.

	Environmental	**EC/I**		**Social**	**EC/I**		**Technological**	**EC/I**		**Economic**	**EC/I**
+	Reduction of own fossil fuel dependency	**EC**	+	Forming part of an 'active' community	**EC**	++	Support the promotion, demonstration and testing of technologies while maintaining/ increasing quality of life	**EC**	++	Establishment of monetary savings from energy efficiency	**EC**
++	Impact on and contribution to environmental (ESG) responsibilities	**I**	++	Enabling an active role and democratic say in (local) energy system for others as part of the energy community	**EC**	++	Use of smart technologies for home devices control	**EC**	++	Exploration of (local) energy markets	**EC**
++	Possible branding and green advertisement opportunities	**I**	+	Enabling an active role and democratic say in (local) energy system for the energy community	**I**	++	Testing and demonstration of new products or innovative technologies	**I**	++	Establishment of monetary savings and revenue from local energy trading	**EC**
++	Reduction of islands' fossil fuel dependency	**EC/I**	++	Impact on and contribution to social and governance (ESG) responsibilities	**I**	++	Promotion of technologies through applicability in challenging context	**I**	+	(Economic) independence from existing energy companies	**EC**
++	Contribution to overall environmental benefits, clean air, climate change mitigation for island	**EC/I**	++	Possible branding and green advertisement opportunities	**I**	++	Pioneer participation in and access to integration of low carbon, renewable energies, and energy efficiency at low cost and risk/ Provision of access to low carbon, innovative, renewable technologies and energy efficiency	**EC/I**	+	Improvement of energy cost predictions	**EC**
									++	Enable long-term benefits through e.g. translation of 'testbed' experience to mainland projects and markets	**I**
+	Support of compliance with island decarbonisation goals	**EC/I**	+	Provision of power quality and reliability to energy community/island	**EC/I**	++	Provision of local power production, consumption, and control to community/ island	**EC/I**	++	Establishment of business case for profit, monetary value, and revenue and its longevity	**I**
			++	Facilitation of low energy costs for the energy community	**EC/I**	+	Support of decrease of power losses and renewable energy curtailments on island	**EC/I**	++	Reduction of energy infrastructure costs	**I**
			++	Contribution to related island energy poverty strategy through inclusion of vulnerable households	**EC/I**	++	Ability to electrically connect and disconnect from power grid (for self-sufficiency and business models)	**EC/I**	+	Exploration and participation in new market	**I**
			++	Contribution to well-being and strengthening of community through capacity building, economic growth, jobs, awareness, and engagement	**EC/I**				++	Establishment of monetary savings and revenue from business models/ Exploration and establishment of revenue from users' flexibility	**EC/I**
									++	Contribution to local economic growth through capacity building and jobs	**EC/I**

2.4 The complete CMA framework for aligned attractiveness and as a tool

The notion of attractiveness differs due to opportunities and place-based differences of local island contexts. At the same time, different stakeholder perspectives, objectives, needs, priorities, result in different perceptions of attractiveness and consequently different CM solutions.

This chapter disentangles these complexities of CMs to enable the development of solutions through the lens of aligned attractiveness. The complete Community Microgrid Attractiveness Framework (CMA) can be used as a support tool to develop straightforward, non-complex modular systems which increase benefits, trust, and acceptance and decrease costs and risks (Löbbe et al. 2020; Adams et al. 2021). That way the CMA supports decisions to participate, engage, and invest.

2.4.1 The proposed CMA Framework

The Community Microgrid Attractiveness Framework (CMA) (Figure 3) highlights that a CM solution addresses decarbonisation, decentralisation, digitalisation, and democratisation through effective core configuration of technology, control, and BMs. These core elements "enable" and "align" with each other (Sachs et al. 2019, p. 733). The configurational core elements are fixed but how they come together to address the local island challenges and priorities is flexible. The core elements give suggestions for solutions on how CM configurations solve island issues, supporting alignment of attractiveness. The CMA shows that where the perception of environmental benefits is most important the *microgrids' decarbonisation and decentralisation* elements should be emphasised for an attractive CM configuration. For a configuration where the social benefits are in the foreground, the *microgrid's value generation and democratisation* would need to be highlighted. Most technology benefits could be derived from creating a solution with an emphasis on *decentralisation and digitalisation technologies*.

The overarching *notion of attractiveness of CMs for both ECs and investors* describes a) the subjective perceptions and priorities of benefits that drive attractiveness and, similarly, b) the roles and responsibilities of the community and the investors. The CMA suggests that the notion of attractiveness finally determines the CMs composition. Environmental, social, technological, and economic benefits that can derive from CM configurations and form potentially attractive value propositions to the different stakeholders, here ECs and investors. For example, Mengelkamp et al. (2019) reveal that economic value is the primary motivator for the willingness to participate or invest. However, other values also drive engagement. The environmental and the social value of active participation or the "sustainable transition value" support building new relationships and following shared values (Adams et al. 2021; Plewnia and Guenther 2021, p. 496). Some people may even accept some level of inconvenience in exchange for not only economic value but also environmental (Kubli and Ulli-Beer 2016). All these values (to the individual, the EC, or the island) support, as the CMA presents, that individuals become energy citizens and actively engage in diverse roles with their time, money, flexibility, and in decision-making processes. Similarly, the CMA points out that investors expect value in return for their proactive, energy activist roles and responsibilities. Investors engage strategically and in a forward-thinking way to create economic benefit, while sharing other benefits with the EC and the wider society. Configuration and notions of attractiveness are influenced by the *island context and baseline conditions* which create both drivers for and barriers to local energy transitions and CM solutions. Context and baseline conditions are dictated by local regulations, culture, acceptance, and other conditions.

To support the *alignment and negotiation of the attractive benefits*, it is important to acknowledge and raise awareness of different and complementary perceptions and priorities of attractiveness that shape the EC and investor perspectives. The CMA demonstrates the need to create a shared understanding to maximise benefits through alignment of objectives, abilities, and needs of the EC and the investors and alignment with the local context (Gui, Diesendorf and MacGill 2017; Sperling 2017; Hiteva and Foxon 2021). Further, the CMA proposes that knowing objectives and priorities and the perception of attractiveness helps to share benefits and decrease risks between community and investors by creating shared “value bundles” (see Schaltegger et al. 2019, p. 202).

A key aspect for negotiation of an attractive CM solution is the *alignment and negotiation of EC and investor roles and responsibilities* with their a) experience, culture, and local context, and b) abilities and perceived attractiveness regarding levels of active participation, engagement, and collaboration. Derkenbaeva et al. (2022a) show that different cultures need different approaches to get involved and want different levels of involvement in the first place. Thus, the alignment is needed to support the co-creation of new sustainable CM business cases with an EC-investor partnership that create returns for all rather than competition and distrust (Foxon et al. 2015; Schaltegger, Hörisch and Freeman 2019). Fairness underlines the negotiation and acceptance process (Perlaviciute et al. 2018; Schröder and Gotzler 2021). This means, for example, for the EC considering individuals’ flexibility capital (Powells and Fell 2019) and initiating with interested and informed people (Derkenbaeva et al. 2020). For investors, this means, supporting long-term socially and environmentally responsible investments or transparently testing innovative concepts (Bolton and Foxon 2015; Kallis et al. 2021).

As a result, the CMA allows the creation of place-based, tailored value bundles, roles and responsiblities for an aligned notion of attractiveness. The CMA supports the creation of BMs that counteract scepticism and lack of engagement by creating a “joint purpose” value to engage ECs and investors (Kallis et al. 2021; Schaltegger, Hörisch and Freeman 2019; Plewnia and Guenther 2021, p. 483).

2.4.2 The CMA as a tool

The CMA helps to define elements for an attractive, place-based CM and the set of salient complex values for both community and investors. It thereby initiates the alignment and negotiation of business cases based on local opportunities, serving as a decision-making support tool for participating, engaging, or investing. The CMA is a tool that applies to different contexts and triggers discussions and modular solutions for final CM models. For this process, this research focuses on the notion of attractiveness to bridge outcome expectations and to create mutually beneficial outcomes by tackling conflicts of interest and thriving collaboration (Kallis et al. 2021; Piterou and Coles 2021).

The CMA directs BM designs by addressing sustainability and value dimensions of the BM framework. Bocken et al. (2014) differentiate between three value dimensions to create sustainable BMs: value proposition, value creation and delivery, and value capture. Following the definitions of Bocken et al. (2014), Plewnia and Guenther (2021), and Schaltegger et al. (2019), the value dimensions for attractive CM models are:

- value propositions: the generated environmental, social, technological, and economic benefits to the different stakeholders (here looking at particularly community and investors) and even the wider environment and society (here particularly the island environment, community, and energy grid);
- value creation and delivery: the aligned roles and responsibilities (here for community and investors) and how they create value for and with each other through taking over their responsibilities and using local island resources, technologies, and energy in the negotiated CM configuration;
- value capture: the balanced initial investment and cost structures with revenue streams from applied and future energy BMs, savings, and market opportunities based on the CMs governance structure.

It is crucial to tailor BM solutions to places and actors through alignment of attractiveness and negotiation of roles and values (Table 4). This goes beyond the perspective of seeing communities as customers but rather acknowledges new business relationships (Morgado 2021). BM design through the lenses of the CMA, will a) encourage community participation, ensuring the sustainability of the models; and b) trigger investor participation, supporting inclusive energy system change with increasing BM opportunities over time. That means the innovative BMs that the CMA supports to create can even be “stepping stones” for the future, where BMs become more and more complex and human-centric (Hiteva and Foxon 2021, p. 5)

Table 4. Translation of negotiation of aligned attractiveness to tailored business models (BMs) for community microgrids (CMs).

	CM model
Negotiation of aligned attractiveness	• Align the communities' and the investors' priorities and variety of perceptions of the wanted benefits to create shared value bundles and shared purpose for them. • Align roles and responsibilities and focus on equal and active participation, engagement, and collaboration for new BMs and innovative small- and large-scale technology, based on community individuals' abilities and needs and investors' sense for innovative business opportunities. • Create tailored, negotiated, and enabling technology, control, and energy BM configuration to the local context and attractiveness that maximise benefits and decrease risks.
BM Framework	• Diverse CM benefits create **value propositions** for the community, the investors and even the island and the wider energy system which underlines sense of collectiveness. • The investors and the community engage in active roles and responsibilities in a smart, grid-connected CM. They **create value** by becoming partners to develop and manage small- and large-scale infrastructure solutions and business activities. • **Value is captured** in a fair way through shared costs and return on investment, energy savings, and new market opportunities in line with governance structures.

The CMA stresses the importance of equally considering consumer and investor needs and their perception of fairness and attractiveness throughout the CM design from the beginning. Creating a CM model based on aligned attractiveness supports a fair and just energy transition, trust and transparency in the model solution and stakeholder relationships, and most importantly an attractive business case for community and investor engagement. In the future, people and investors will approach each other eager to participate. The CMA helps to initiate this pathway and provides food for thought in a toolbox way that communities, investors, and other CM business developers can use for communication, collaboration, and negotiation purposes for designing attractive CM BMs.

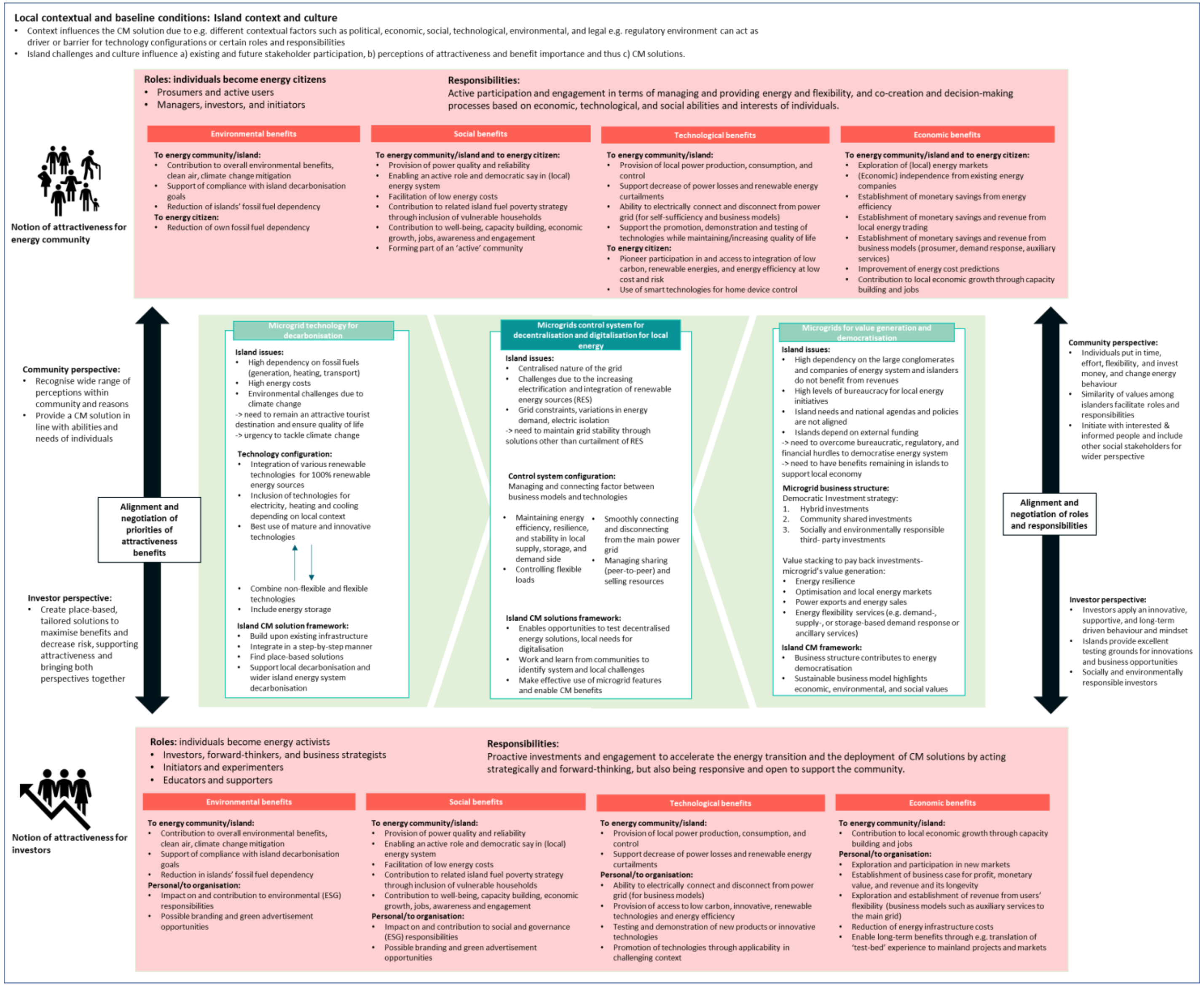


Figure 3. Community Microgrid Attractiveness framework – Support tool for developing an attractive community microgrid solution for both energy community and investors.

3 Research methodology

This chapter presents the overall research methodology and the characteristics of the research and evaluates strengths and weaknesses. This discussion leads to a case study approach with three stages: Stage 1 – overall understanding and theory building to build the conceptual framework, Stage 2 – methodology and method selection & data collection, and Stage 3- case study analysis, discussion, and conclusions. Accordingly, the first section presents the nature of the research that justifies the case study approach. The next sections describe the various forms of data collection and data analysis of this research.

3.1 Research philosophy, approach, and 3-stage design

Business studies combines a wide range of research fields to generate knowledge for theory and practice (Saunders, Lewis and Thornhill 2016). Saunders et al. (2016) further explain that business and management research involves various research philosophies (positivism, critical realism, interpretivism, and pragmatism) with the researchers applying qualitative and quantitative methods. Mixed methods are used for richness and triangulation of data collection and analysis. In the end, the choice of the methodological approach and methods depends on the researchers' research philosophy.

Natural scientists have a rather positivist perspective with a realist ontology and objectivist epistemology when it comes to research; they believe in a single reality which depends on natural laws. In contrast, social scientists often believe that no single reality exists (irrealist ontology) and that observations are theory dependent (subjectivist epistemology), which directs their research toward a constructivist research philosophy.

Disentangling the complexity of community microgrids (CMs) and entering into discussions of transition research, here in this thesis, research combines knowledge from different disciplines such as engineering (e.g. CM technology); business (e.g. CM business models, investment, and innovation); environmental psychology and social science (e.g. energy community and investor perceptions, roles, and behaviour); and regional studies due to the local nature of CMs and the island-focus of this research. Therefore, this research's research philosophy and methods are 'in-between' the previously mentioned philosophical 'extremes' oriented towards critical realism.

The nature of this research which a) requires an in-depth understanding of the elements of attractiveness of CMs including the salient perceptions of energy communities (ECs) and investors and b) emphasises the influence of the context on the research phenomenon opposes positivist research (Rashid et al. 2019). By trying to understand the underpinning mechanisms, relationships, and roles of elements and stakeholders for attractive CM solutions under the influences of distinct contexts, this research finds itself oriented towards critical realism. The definition and use of conceptual frameworks are common methodological approaches by crucial realists (Morgado 2021). Additionally, this research seeks to understand local perceptions and meanings of attractiveness. This is important as, for instance, EC individuals perceive attractiveness of policies differently (Bolderdijk et al. 2017). At the same time, investors perceive risk and attractiveness differently when making their final investment decisions depending on, for example, the individual's knowledge or attitude (Kannadas 2021). However, the 'community'- and 'investor'- bigger picture levels of analysis, instead of the individuals, emphasise a critical realist rather than an interpretivist lens of research (Saunders, Lewis and Thornhill 2016; Rashid et al. 2019).

Ultimately, the objective of this research is to develop a tool to support decision-making and engagement of ECs and investors to participate and invest, by synthesising elements and relationships of and for an 'attractive' CM solution. Hence, to achieve this task given the unique nature of this research requires the use of different research methods to capture the full picture of realities and perceptions, which critical realism enables (Saunders, Lewis and Thornhill 2016).

The more qualitative approach of this research differs from current research for decision-making in renewable energy investments, such as life cycle analysis, cost-benefit analysis, or multicriteria decision aid and salient mathematical models (e.g. Sharma et al. 2020; Ziyadin et al. 2019). Engineering scholars already have used simulation tools to investigate how to overcome lack of investment and perception of risk towards microgrids (Williams, Jaramillo and Taneja 2018) or have quantitatively evaluated microgrid configurations (e.g. Hossain et al. 2014). Similar to Sachs et al. (2019), by applying a business perspective and conceptualising the notion of attractiveness of CMs, this research will add a qualitative notion, further justified in the following paragraphs.

Outlined in the introduction, discussions go on about citizens' engagement and their roles in the future energy system and that investments are needed for the technologies. Consequently, this research aims to identify elements – and address them – that make participation and investment in CMs for citizens and investors evenly attractive. CMs are complex systems with many different stakeholders involved, technologies applied, and potential BMs that can be adopted. Additionally, different contexts and unique stakeholder attitudes and perceptions increase CM complexity influence ECs and investors willingness to participate. The conceptualisation of these various elements in this research, by capturing the narrative of attractiveness from an EC and investor perspective, disentangles the CM system's complexity and supports the research aim.

To synthesise various aspects of microgrids and disentangle complexity, literature review-based conceptual frameworks have been used, for instance, to demonstrate the roles of institutions in CMs (Warneryd, Håkansson and Karltorp 2020). Similarly, Gui, Macgill and Betz (2019) present a framework for the optimum CM configurations to support investment planning. Furthermore, a conceptual framework allows the synthesis of perspectives from multiple disciplines. Sachs et al. (2019), for instance, develop a framework for a complete microgrid configuration applying an engineering and business perspective.

Still, to disentangle the complexity of decision-making and find alignment for the complete CM design, it is important to listen to the narratives and priorities of different stakeholders (Hall et al. 2020). Walker et al. (2021) emphasises the need to understand different stakeholder perspectives and local context for place-based, local energy transition solutions. To study meanings of participants and relationships, qualitative research methods are suitable (Saunders, Lewis and Thornhill 2016; Rashid et al. 2019; Morgado 2021). Hall et al. (2020), for instance, conducted a decision theatre to understand priorities for changes in the energy system to drive business model innovation. Similarly, both Hall and Roelich (2016) and Hiteva and Foxon (2021) combine literature review with interviews and other qualitative methods to investigate business model innovation and values in energy systems. Sachs et al. (2019) conducted interviews with different relevant stakeholders to enrich and verify their conceptual framework of microgrid configurations. Researchers such as Bal et al. (2021), Lode et al. (2022), Mengelkamp et al. (2019), and Pires Klein et al. (2021) demonstrate the usefulness of quantitative surveys to investigate the perception of attractiveness of CM benefits. Applying mixed method qualitative case studies, social scientists have sought understanding of meanings of the people by looking at values and perceived fairness or attitudes (Perlaviciute et al. 2018; Bal et al. 2021). Heaslip and Fahy (2018) even directly investigated perceptions of individuals towards sustainability and energy related projects.

According to Yin (2018), case studies are used to research contemporary events when there is no substantial theory base for the phenomenon of interest, or when the phenomenon of interest demonstrates a high level of complexity. For example, Heaslip and Fahy (2018) use case study research to explore a phenomenon through transdisciplinary lenses, which helps to understand multifaceted and complex research phenomena. Hamwi et al. (2021) use a case study approach to demonstrate the use of a conceptual framework in a real-world context. Thus, case studies serve in-depth analysis of real-life and contemporary phenomena of interest to create a full picture and theory (Yin 2018). The level of flexibility of research application, epistemology, ontology, and methodology in case study research goes along with different philosophical paradigms including critical theory (Yin 2018; Rashid et al. 2019). In essence, case studies are increasingly used by researchers from different fields and can present a geographical focus. Regional perspectives are common to investigate dynamics and developments of niche technologies, industries, and innovations for sustainable transitions and path creations (Grillitsch 2019; Gibbs and Jensen 2021). Especially from “the peripheries”, lots can be learnt (Tirado-Herrero and Fuller 2021, p.

113). This research aims to contribute to these discussions by zooming out and in on local community and business perspectives and roles at different geographies which is essential to understand just energy transitions (Köhler et al. 2019). The microgrid concept aligns with this discussion as it allows for adaptation to different local, place-based needs and purposes.

Driven by local economic and climate change challenges, islands have been recognised to drive local energy transitions. While bureaucracy and financial resources are the main barrier to many actions, island communities are often self-driven and engaged in various energy projects (Kielichowska et al. 2021). This engagement is one reason why islands have been recognised as attractive 'testbeds' for public and private institutions to test energy technology and BM solutions (Skjølsvold, Ryghaug and Throndsen 2020). The vast number of initiatives and research projects with an island focus[6] demonstrate usefulness of learning from island contexts for this research.

As a result, this research followed a mixed method case study approach. This approach enabled the a) conceptualisation of elements and relationships that describe attractive CM solutions in the Community Microgrid Attractiveness Framework (CMA); b) demonstration of different facets of contextual influences; and c) description of what is perceived as an attractive CM solution from ECs and investors and how their perceptions align through applying the CMA.

First, in conversation with the research questions, data from theory and secondary sources was explored and synthesised into the CMA framework. In line with Yin (2018), the CMA guided and bounded case study selection, data collection, and analysis for a rigours methodological approach. The overall research design, appropriate to the case study approach, consists of three main stages that together fully answer all research questions. Figure 4 presents the three research stages.

[6] For instance, Microgrid Blue investigates the implementation of microgrids in the Canary Islands and Africa. REACT investigates the technical and business aspects, solving control and management issues to support the promotion of island energy communities. The COM RES project studies the uptake of energy communities in EU energy markets, including the Canary Islands, from a legal and socio-economic perspective. Other projects that focus on different technical and regulatory aspects of the energy transition of islands are H2020 SMILE, IANOS, GIFT, ROBINSON, INSULAE, MAESHA. Similarly, the Clean energy for EU Islands initiative aims to support local energy transition agendas, facilitating energy communities and demonstrating possible financing streams.

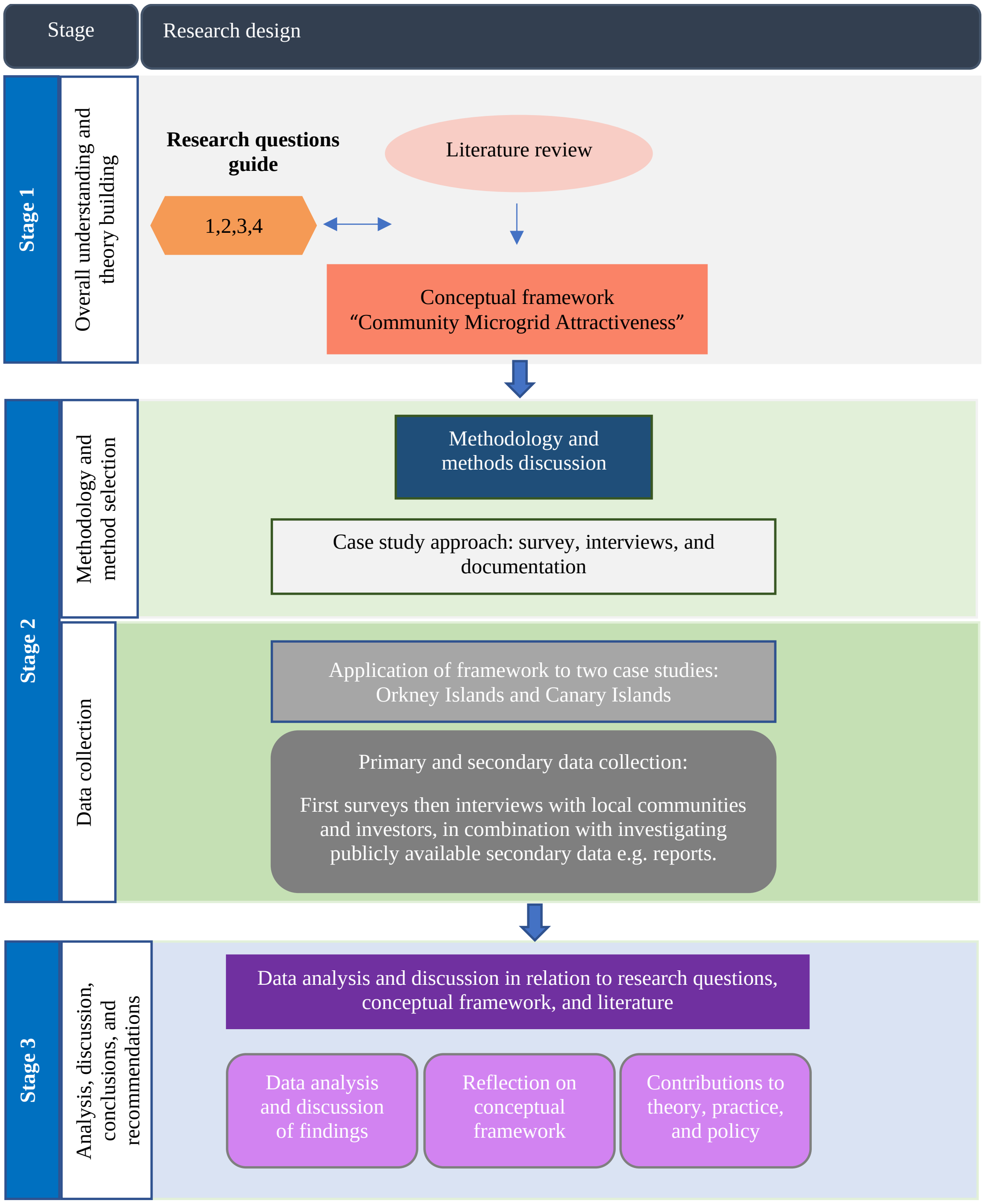


Figure 4. Overall research design demonstrating three main research stages.

The first stage represents the 'understanding of theory' through literature review from theory and practice in conversation with the research questions. According to Yin (2018), theory building, and the development of a conceptual framework is the first step in conducting a rigor case study. Hence, the development of the CMA builds the theoretical backbone of this research and contributes to partially answering the research questions.

The second stage presents the addressed considerations of methodological limitations and advantages to answer the research questions. Research question two emphasises the need to evaluate the influence of different island contexts on the ‘attractiveness’ of a CM. Similarly, research question one and three drive an investigation on the actual perceptions of ECs and investors on CM ‘notion of attractiveness’. Therefore, the second research stage describes the data collection for the two case studies (the Orkney Islands and the Canary Islands) to build the answers for these research questions.

The last stage brings all findings together to draw a complete picture. Two case studies improve rigour and create a wider set of learnings that contribute to answering all research questions 1, 2, and 3. The overall discussion and understanding lead to the demonstration of the CMA as a support tool for ECs and investors and to enable propositions to increase decision-making, thereby fully answering the third research question. To this end, stage three demonstrates the complete contribution to theory, practice, and policy.

3.2 Data collection

This section presents the data collection for this research according to the three-stage research design. The section first describes the data collection for theory building of the Community Microgrid Attractiveness Framework (CMA). Then, the section details the data collection for the case studies regarding methodological choices, case study selection, and final data collection strategy.

3.2.1 Data collection for theory building

The proposed conceptual framework, the CMA, was developed as a reflection of the literature review in conversation with the research questions. The research questions and the objective of this research guided the theory-building, explorative literature review. Academic and grey literature such as websites or research deliverables and webinars from different research areas were explored to address the complexity of this research. Themes that were explored through snowballing literature included microgrid technology, architecture, concepts, and finance and investment; sustainable and energy business models; and energy transitions (4 Ds) including social innovation, governance, and energy community concepts or focus on islands.

For extensive literature reviews it is common to develop conceptual frameworks. For example, Sachs et al. (2019) and Martin-Martínez et al. (2016) used this method to conceptualise microgrid design. Vallance et al. (2019) used a literature-based conceptual framework to capture the complex relationships of place-based leadership, local economies, and governance systems. Similarly, in this research, all information was synthesised to create a full picture of the elements and relationships that influence and describe an attractive CM solution for ECs and investors.

3.2.2 Case study data collection

The rich evidence base and combination of qualitative and quantitative data collection of the case study approach allows for effective application of the conceptual framework, the CMA. This stage discusses the data collection for a multiple case study approach, in this research two case studies, which present different conditions and environments. According to Yin (2018), at least two cases are needed for reliability of the study and the conceptual framework. Vice versa, the application of the CMA as a guide for the case study makes the research approach more systematic and thus supports validity and reliability of the research.

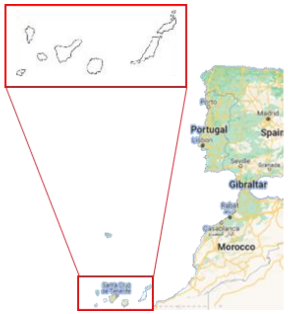
A. Case study selection

Case studies had to be selected to demonstrate applicability of the CMA to different contexts and, at the same time, to learn from different contexts (Mengelkamp et al. 2019). The context of *different* islands can cause *differen*t barriers and drivers for the implementation and influence the overall notion of attractiveness of CMs. Therefore, the identification of appropriate case studies to demonstrate the role and influence of the context to the 'attractiveness' is a pivotal step of this research.

For the selection of the case studies, a thoughtful screening process was conducted. Islands worldwide were identified which already have microgrids implemented, are actively working on their energy transition, or have received credit for their leading role in islands' energy transitions (e.g. Friedrich-Ebert-Stiftung 2016). Additionally, a preliminary screening of the contextual factors (e.g. drivers, barriers, geographical context, progress of energy transition and ambitions, diversity of technology solutions and infrastructure) was used to identify two case studies that present different contexts. In line with Yin (2018) and Stake (1995), based on the possible accessibility of the data and interest in the cases the decision was made to focus on two different island archipelagos: the Orkney Islands (the United Kingdom) and the Canary Islands (Spain).

The cases were chosen as examples of different size, geographies, climate and resources, culture, complexity, governance, and level of progress in their sustainable transition (Table 5). Both case studies present distinct – to some extent 'extremely' – but related contexts, with diverse set-ups of baseline scenarios, contemporary events, stakeholders, priorities and strategies for their energy transition and implementation of CMs. Nonetheless, both cases present high levels of experience and engagement in the energy transition, however, without a fully integrated CM. This decision served to investigate the notions of attractiveness and their alignment for developing attractive CM solutions according to the CMA.

Table 5. Selection of diverse case studies and some contextual relevant criteria.

Case islands\ Criteria	Location	Population and geographic insights	Economy and deprivation	Local energy system	Local energy transition targets, drivers, and pathway
Small-sized, sparsely inhabited, grid-connected islands – the Orkney Islands (UK)		**Small, sparsely inhabited islands with harsh climate:** - The Orkney Islands are a small island archipelago which consist of about 70 islands, of which 20 are inhabited. Approx. 22,500 (2020/21) inhabitants with 23 people per km^2 in an area of ca. 990 km^2. (OC1) - The population increasingly ages as the young population moves to the mainland. (OC2) - The islands face harsh, cold weather which makes them rich in wind and marine energy resources. (OC2, OC7)	**Low-income economy:** - Economic activities rely on agriculture, fishing, and tourism. (OC2) - In 2020 around 69.1 % of the islanders were in full time employment (slightly below the Scottish average of 72.9 %). (OC3) - Despite the relatively high economic activity, the Orkney Islands belong to some of the most deprived areas in the UK, with one of the highest fuel poverty rates. (OC4-6)	**Grid-connected, mainland-dependent energy system with high energy prices:** - Archipelago electrically connected and depended through one subsea cable to mainland. Limited land resources and grid constraints complicate the introduction of more renewable energy generation, hence the raising interest in smart energy flexibility solutions. (OC7) - Old infrastructure, little choice, and transmission charges cause second highest energy bills in the UK. (OC8-9) - UK provides facilitating framework for demand response and local flexibility markets, but less than 10% of households have smart meters. (OC10-11)	**Open pathway with ambitions and long-term targets:** - Full decarbonisation targets with the overall UK target of 2050, while creating ambitious targets for 2030. (OC12) - Already producing more than 100 % RES, Orkney's targets set out for 'a low carbon, innovative, and inclusive economy' with e.g. 300 % local renewable energy production. (OC12) - UK's established history of community energy that allows projects to be wholly or partially owned and controlled by communities. (OC13)
Larger-sized, populous, autonomous and disconnected islands – the Canary Islands (Spain)		**Most populous autonomous region:** - The Canary Islands consist of 7 main islands. Approx. 2,244,369 (2021) inhabitants with ca. 301 people per km^2 in an area of ca. 7,447 km^2 (CC1-2) - Population will slowly increase due to immigrants and expatriates. (CC1) - As an outermost region, the islands face extreme remoteness. Mild, energy rich climate, for wind and solar energy throughout the year due to their location close to the equator and the trade winds. (CC3)	**Challenged but flourishing economy**: - The population density is higher than mainland Spain, while the GDP is lower, which is a key economic challenge (CC4). - The islands are economically flourishing although economic activities are rather mono-dimensional with ca. 74.6 % in the tourism sector; followed by industry, construction, energy, and agriculture. (CC4-6) - Still, among the poorest regions in Spain. (CC7)	**Isolated systems with some independency and subsidised energy prices (CC8):** - These islands are geographically and electrically disconnected to the Spanish mainland. Just Fuerteventura and Lanzarote are connected. Increasing energy demand and integration of renewable energy technologies need innovations to maintain grid-stability and energy resilience. - The "unified price" subsidy maintains the energy price on the island rel. low. - There is no local wholesale market, no legal framework for demand response or flexibility services, although, all households should have smart meters installed since 2019.	**Ambitious but strategic targets and pathway:** - The Islands published a strategy "ESTRATEGIA CANARIA DE ACCIÓN CLIMÁTICA" with the target for full decarbonisation by 2040. (CC3) - In the whole Canaries the RES share is at ca. 21 % (CC12). Lagging in the transition, the archipelagos' isolation and dependency on tourism makes climate change an urgent priority. Extreme weather causes loss of biodiversity, health issues, potential water scarcity. (CC3) - Based on the EU directive, Spain established a legal framework for RE collective self- consumption within proximity of 2 km and permission to use the public grid. (CC8-9)

B. Case study methods discussion

Following Yin (2018), the process of multiple case studies foresees that each case study is conducted separately, which means data is collected, analysed, and summarised in an individual case. Each case study provides an in-depth picture of the perceived attractiveness of CMs and alignment between community and investors within its ‘real-world’ context. This in-depth picture requires multiple sources of evidence for a complete data collection. For the data collection of a case study, Yin (2018) presents six main sources of evidence which are commonly used, all presenting strength and weaknesses depending on the case (see Table 6). These sources are documentation and notes, archival records, interviews, direct or participant observations, and physical artifacts, and sometimes surveys (Yin 2018; Rashid et al. 2019). The continuous process of collecting documentation from different resources allows the identification of gaps in understanding until full saturation of evidence (Yin 2018).

Interviews are a powerful tool in qualitative case studies and are often used alone or in combination with other methods (Yin 2018). For example, interviews with experts have been used, for example, by Müller and Welpe (2018) to identify barriers and potential business models for sharing electricity storage at a community level or, as Hyams (2010) points out, to identify investors’ preferences of microgrid designs. In their case study, Bauknecht et al. (2020) use interviews to investigate drivers and barriers to Norway`s energy sectors’ energy transition. Hall and Roelich (2016) used mixed methods by conducting interviews and questionnaires with experts from the energy sector to capture the complexity of BM values. The variety of applications highlights the usefulness of interviews for this research to cover the complexity of the CMA when applying it to the case studies.

Surveys are commonly used in the context of emerging technologies and BMs to investigate perceptions of values, drivers, or barriers. For example, Aranda et al. (2018) conducted surveys in different countries, investigating the willingness to participate in demand response, the importance of incentives to drive participation, and the importance of barriers that challenge participation. Ebers Broughel and Hampl (2018) surveyed drivers and barriers to investment in community energy projects. Pires Klein et al. (2021) conducted a value-based survey for the community perspective within 3 pilot projects to identify if the values translated into real action. Bal et al. (2021) investigated people’s attitudes and beliefs regarding sustainability through surveys. Lode et al. (2022) conducted surveys with different actors, including investors, to investigate the attractive design of energy communities. Through their survey, Lode et al. (2022) investigated different objectives for participation and differences between perceptions and priorities for alignment.

Table 6 captures the presented methods, evaluating their strength and weaknesses in adoption from Yin (2018). This research chose several sources of evidence, namely secondary data (grey literature such as documentation, reports, and records) and primary data from surveys and in-depth semi-structured interviews.

Table 6. Sources of evidence and its strength and weaknesses and final choice for research design.

Source: adopted from Yin (2018, p. 114, Figure 4.1).

Source of Evidence	Strength	Weaknesses	Choice
Documentation	- Broad, publicly available resources that can help capture various themes and complexity - Can be reviewed repeatedly - Can include further references	- Specific angles of interest might be difficult to find - Biased selection of resources - Can be biased from reporting authors	**Yes**, grey literature/ secondary data enables capturing of complexity of nature of research and different elements of conceptual framework. Allows for contextual information and triangulation of primary data.
Archival records	- [same as documentation] - Can provide precise and quantitative data about island contexts	- [same as documentation] - Limited accessibility	
Interviews	- Targeted questions with direct relation to phenomenon of interest - Insights of perceptions and personal views of stakeholders - Stakeholders can give explanations and ask for clarifications	- Biased questioning - Response bias or interviewees say what interviewer wants to hear	**Yes**, needed to get in-depth information about case and perceptions of both stakeholder groups.
Direct and participant observations	- Can cover actions, behaviour, and context in real time	- Time and cost consuming - Broad coverage is difficult to observe fully - Participants might act differently because they know they are being observed	**No**, too time consuming, no current community microgrid existing, and travel restrictions. Survey used instead.
Physical artifacts	- Insightful into cultural features or technical operations	- Biased selection - Limited availability	**No**, no relevance of any physical artifact recognised in this research.
Survey (as part of embedded case study design)	- Standardised questions - Provides quantitative data - Allows the gathering of data from a large sample: representative picture of perceptions	- Lack of depth - Lack of flexibility to adopt questions to participants (e.g. knowledge and experience)	**Yes**, needed to investigate perception of attractiveness by large groups of EC and investors and to identify salient perceptions and priorities in both qualitative and quantitative terms.

The set of data is necessary to address different elements of the CMA and answer all research questions. The next section presents the different data that had to be collected for each case study, why it was collected, and how the data was accessed.

C. *Case study data collection strategy*

Following the institutional guidelines of NTU, this research received ethical approval.

This research used a mixed method case study approach for data collection. The collection was guided by a pre-set data collection strategy (see Appendix A) due to the interdependence of the data collection steps. S*econdary data collection* was conducted before and after the primary data collection process. Primary data collection consisted of first *online surveys* and then *semi-structured interviews*.

Data collection began with *secondary data collection* to describe the context and baseline dimensions of each case. Various secondary data was collected and studied for each case study from different sources, namely books and reports, webinars, websites, online newspaper articles, and other grey literature. This variety of data provides a richness that enables the creation of a full picture of the case, as the research of Kasabov and Sundaram (2016), Heaslip and Fahy (2018), and Hamwi et al. (2021) demonstrate. Secondary data collection was done pre- and post-primary data collection. The first, explorative round served a) to identify possible contacts and relevant stakeholders for the surveys and interviews, and b) as a basis for aligning interview questions and discussions to the participant and context. The second round was more strategic online research to a) identify triangulation points for the information given/points made by the participants in the surveys and interviews or b) directly include grey literature provided by the participants. Similar to Suitner et al. (2022), for readability and differentiation to the interview codes, the grey literature received a code – 'OC' or 'CC' for **O**rkney **C**ase or **C**anary **C**ase – with numbers for inclusion in the case study, see Appendix C.

Conducting *online surveys* first served to a) understand broad tendencies and priorities of communities and investors' perception of attractiveness of CMs, and b) identify key stakeholders for follow-up interviews. The surveys focused on the perceived attractiveness of CM benefits to encourage engagement and participation (see Appendix A for questionnaires). In the surveys, EC and investors were asked to rank potential environmental, social, technological, and economic CM benefits that had been identified in the CMA, by perceived attractiveness and importance to demonstrate prioritisations. Similar to Ebers Broughel and Hampl (2018), the questions were structured on a Likert-scale regarding perceived attractiveness of CM benefits from "very unattractive" to "very attractive" and salient levels of importance. Only some questions were open- ended to give the participants the opportunity to provide further evidence or explanation if they wished to. Overall, the surveys were developed to ensure reliability and validity, following instructions given by Hine et al. (2016). By quantitatively highlighting benefit priorities and perceptions the surveys provided insights regarding the alignment and negotiation of attractiveness as demonstrated in the CMA.

The questions were kept simple and applicable to both case study regions and all the different participants. For the same reason, the first question asked the participants to evaluate their energy literacy and knowledge on island challenges, as a way to categorise the participants. Smale and Kloppenburg (2020) found that the background of participants could influence their perceptions. For example, during their workshops some participants stated a lack of awareness of the energy system needs which could influence their perceived attractiveness of energy balancing services. Overall, the CMA guided the development and structure of the survey questionnaire. The questionnaires were discussed with fellow researchers and experts from National Energy Action (NEA). An introduction to the questionnaire provided participant information and a brief explanation of the research context and CMs. The introduction and questionnaires were developed in English and then translated to Spanish for the Canary Island case study. To develop web questionnaires, the online survey software “Jisc online surveys” was used. The final survey for was developed to take approximately 15 min for completion. Before launching and distributing the surveys, peer researchers and potential community and investor representatives tested the surveys. Then, the surveys were improved until they were finally distributed via email. The full survey questionnaires can be found in the supplementary material of Appendix A.

An EC is a collective of a multitude of individuals with many different capacities and abilities. Hence, to understand the communities’ perceived attractiveness, an inhomogeneous sample was needed to represent a possible EC. To achieve this, a) the direct target group were islanders that are already engaged or wish to be engaged in community or energy projects, energy cooperatives, or other initiatives for local energy transitions; and b) citizen representatives from, for instance, local authority, technology or community centres, NGOs, or other social organisations to provide a wider view on perspectives from citizens either still considered as ‘inactive or unaware’ of the energy transition urgency and technological solutions such as microgrids or considered vulnerable households.

In the same way, a different survey investigated the investors’ perceived notion of attractiveness. The survey questionnaire followed the same questions as the surveys for the community, but with slight variations to represent the investor perspective as discussed in the CMA. To capture the narrative of the investor perspective which could be different depending on the investor type, this research aimed to get a survey response from a variety of actors such as local or other private investors, utilities and other energy distributers, distribution or transmission system operators, infrastructure investors or innovative technology developers. In line with the CMA, this research targeted actors in key positions with an ‘active’ mindset who demonstrated wide knowledge of energy transition technologies, sector coupling, CMs, energy communities and possible energy flexibility business models. At the same time, special attention was given to target local renewable energy investors who demonstrated a high-level interest into sustainable energy investments.

To ensure the coverage of the above-mentioned holistic community and investor perspective and due to the complexity of the research, secondary analysis preceded the distribution of the surveys to identify key actors and organisations in both case studies. Furthermore, recruitment of participants happened through snowball sampling via online and offline channels using personal and workplace networks to reach contacts. Actors and their email addresses were identified through contact names of existing projects or organisations, private networks, and LinkedIn. For each case study, two lists (for community and investors) of key actors and organisation with contact details and reasoning for inclusion in this research were developed.

The target was to eventually achieve up to 100 responses for the community perspective and ca. 20 for the investor perspective in each case study. To increase the response rate, the survey link was distributed via individual emails to, for instance, different people of the same organisation. In the email the person was kindly asked to participate and to share the survey. The people had the opportunity to self-select to participate in the research by clicking on the link and after reading the information in the introduction. As the surveys were an important step to get contacts for interviews, distribution and reminders continued until positive responses for a follow-up interview from all key actors and organisations, which were previously identified, were ensured for each case study. In the end, the surveys had a lower response rate, but successfully received responses from a variety of people and backgrounds as the control questions on experience, interest, and energy literacy revealed (see Appendix B).

The aim of the *online semi-structured interviews* was to generate an in-depth understanding about the case to fully answer all research questions. Interview questions were guided by research questions, conceptual framework (CMA), and the preliminary analysis of the previous step’s data collection. That is, interviews sought to understand a) the perceptions and prioritisations of attractiveness elements from both EC and investor perspective; b) the links and effects of to the island contexts; and c) possible factors for alignment and negotiation of an overall attractive CM solution. Additionally, the interview gave room for the participants to expand on their survey responses. The nature of the research and the previous distribution of the surveys allowed for a maximum variation in the sample while purposively selecting participants with different characteristics and backgrounds (Saunders, Lewis and Thornhill 2016). Through including participants from different backgrounds, this research ensured the coverage of all themes of the CMA and addressed the holistic perspective on the notion of attractiveness to form a common 'community' and 'investor' narrative. The categorisation of the characteristics and backgrounds resulted from type of the local actors, organisations, and experiences in line with the roles and responsibilities for an attractive microgrid solution. People that were willing to participate in follow-up interviews were contacted to organise the approximately one-hour interview.

All interviewees gave consent. The language of the interview varied between English, Spanish, and German according to the interviewee's preference. Interviews were conducted online with MS Teams between September and November 2022. Interviews took between 30-90 minutes, were video and audio-recorded, and then transcribed and even translated. As a result, for the Orkney Islands, data collection consists of n=27 survey answers with n=11 follow-up interviews for the EC perspective, and n=11 and n=6 for investors respectively. For the Canary Islands, the EC perspective had n=43 participations in the survey and n=12 follow-up interviews; the investor perspective n=11 and n=6 respectively. At the end of this research, recordings were destroyed and anonymised material stored for future inquiries.

The tables in Appendix B present an overview of data collection process and participants including, for example, the nature of the interviewees and respective anonymised codes.

3.3 Data analysis

Data analysis was performed for each case study individually. The individual case study analysis was guided by the in-depth investigation of the themes given by the conceptual CMA framework. Overall, case study analysis allows for "playing" with the data to identify common themes and patterns (Yin 2018). This research presents the case study results through the synthesis of the data presented as a case study narrative in line with the research objective and questions in Chapter 4 and 5 (Rashid et al. 2019).

First, all four survey responses were downloaded and transformed into an Excel table. Each list of responses was checked for validity and only one response was deleted from the Orkney EC survey due to incompleteness. Evaluation of the participants' experience, interest, and energy literacy confirmed the variety of people and backgrounds that this data collection mode aimed to capture. Second, the surveys were analysed using descriptive statistics by visualising frequency of responses (Pires Klein et al. 2021). Graphically demonstrating the community and investors' perceptions of attractiveness of both environmental, social, technological, and economic benefits and salient prioritisations gave initial insights regarding the alignment of the individual attractiveness elements. Third, for each survey, the consensus between the participant's ordinal ranking of the overall attractiveness of benefits was evaluated using the publicly available python "ordinal consensus ranking problem (OCRP) solver" (Mazurek and Fiedor 2012). The survey data was transformed into a file according to the description of the solver developers and then run. The result shows the degree of agreement, the consensus, between the order of ranking between the participants. All four surveys were evaluated individually. Appendix D provides solver results and graphs of the descriptive analysis.

All interviews were transcribed and anonymised. Due to the large amount of data, the interviews were qualitatively analysed using NVivo 12, a commonly used assistant tool (e.g. Suitner et al., 2022). For immersion in the data, audio recordings were re-listened to, and transcripts re-read several times. Memos and notes that were developed during data collection and analysis process supported the coding process (Saunders, Lewis and Thornhill 2016). For each case study, the interview material was qualitatively coded in several circles, combining inductive and deductive coding (Hiteva and Foxon 2021; van Summeren et al. 2023): The first round of coding sought to explore the data, perform initial coding, and identify themes, although guided by the CMA. The next rounds of coding aligned and sorted codes to existing and emerging themes based on the CMA. The iterative nature of the coding process allowed the building of understanding, while breaking down the initial coding into "more manageable and comprehensible" themes (Saunders, Lewis and Thornhill 2016). Although coding for each case study was performed separately, the application of the CMA and the iterative process supported alignment of the different case study codes to ease the cross-case analysis (Raven et al. 2016). The NVivo coding tree was captured in a table format to provide an easy overview on the coded key CMA aspects, themes, and place-based attractiveness aspects. While the key aspects and themes predominately derived from the CMA, the case study provided themes relevant to the place, which were therefore called 'place-based attractiveness aspects'. Overall, this approach provided structure to the subjective nature of qualitative analysis. Appendix E provides example screenshots of the evolvement of coding trees in the case of the Orkney Islands and final coding tables for both case studies. Coding tables can be found in Appendix E.

The triangulation of secondary and primary data allowed for a rigorous case study analysis (Rashid et al. 2019). The complete case analysis ensured the discussion of both cases in a structured way according to the CMA and the forming of a clear narrative. Finally, the synthesised learnings from both cases increased the internal validity of the case study approach and thus the conceptual framework. According to Yin (2018), a cross-case analysis is not to be mistaken with a comparison of the cases. Although similarities and differences between the cases were discussed, the aim was to learn and draw conclusions that reflect and contribute to the theoretical background, here the CMA (Yin 2018). Based on the complete analysis, this research draws policy recommendations.

4 The Orkney Islands Case Study – an attractive community microgrid solution

The Orkney Islands are situated in the north of Scotland. The islands are electrically grid-connected to the UK mainland. The application of the Community Microgrid Attractiveness Framework (CMA) in this case reveals high alignment of community and investor preferences from an 'attractiveness' point of view and thereby the possibility to maximise socio-economic benefits. The energy community (EC) and investors recognise a community-led community microgrid (CM) as an opportunity to tackle local challenges and regional inequalities while creating new revenue streams.

4.1 Baseline scenario: contextual drivers and barriers as factors for attractive CM solutions

The islands align their full decarbonisation targets with the overall UK target of 2050, while creating ambitious targets for 2030 (OC8). For the local development of CMs, however, there are drivers and barriers that address i) all CMA elements *universally*; or just ii) *decarbonisation* elements; iii) *decentralisation and digitalisation* elements; or iv) *democratisation* elements.

For bringing CM attractiveness forward, a <u>universal driver</u> is the *high level of 'island senses'*, which according to the interviewees is the high sense of community and for the environment (e.g. OK_C_EC_11; OK_C_EC_8). The community helps each other (e.g. OK_G_EC_7). Interviewees agree that these senses have been great drivers for past engagement for renewable energy development and will be drivers for the future (OK_Inv_5). Another key driver for CM developments, identified by several interviewees, is the local "*long history of innovation*" (OK_Inv_1). Also, Watts (OC7) states that the islanders always innovate and create local solutions to survive. The Orkney Islands have been decarbonising for over 40 years. In the early 1980s, the first wind turbine was installed at Burgar Hill for research purposes (OC14). Today, many large companies visit the Orkneys (drawn by the European Marine Energy Centre (EMEC) and the active local community) to learn about innovations and possible investment opportunities (OK_C_EC_8). The notion of being an island testbed is not new to Orkney (e.g. OK_Inv_4; OK_T_EC_10). In fact, it is one reason why the local government wants to focus on this aspect to receive investments (OC8). A key reason for the sense of community and ongoing innovation is the *high level of fuel poverty*. Fuel poverty levels worsen due to the rising energy prices given the energy crisis, which started in 2022, as 11 interviewees stress. Interviewees hope "the quadruple fuel poverty" raises awareness across all stakeholder groups and for needed regulatory changes to drive a local Orkney CM solution (e.g. OK_SR_EC_6; OC7). "Energy prices are at an all-time high" (OK_Inv_5). The need for heating due to the Orkney climate in combination with high energy costs and poor building stock efficiency contribute to high levels of fuel poverty (OK_EG_1). However, retrofitting is not always possible due to, for example, monument protection or simply accessibility (Easson 2022). Many households are thus kept in the fuel poverty trap, paying the second highest average energy bills (after Shetland) that easily range between £2500 (OC15) and more than £4000[7]. Estimations from 2022 predict that the situation is getting worse, with bills rising to £10,300 in Shetland (OC16), not leaving a doubt that in Orkney it will be any different (OK_SR_EC_6). Solutions need to urgently be found not just despite but rather due to current times of uncertainties (OK_Inv_3).

As main, universal barriers to change, CM implementation and benefits, all interviewees, both representing EC and investors, identify the current *regulatory environment, grid and market structures* (see also Mauger and Roggenkamp, 2021). The islanders repeat that they do not benefit from the energy they produce and instead pay some of the highest electricity fees in the UK (e.g. OK_CT_EC_9). OK_C_EC_11 puts it this way: "The grid was designed to only transmit energy into Orkney, not for generations happening on the islands and being exported south." Regulations are not aligned with island needs (OK_Inv_3; OK_C_EC_8; Marczinkowski et al. 2022). It is not possible to sell energy locally because it would need a licenced supplier (OK_Inv_2). Nonetheless, few island community wind turbines aim to bring benefits to their island communities. However, these benefits are mostly indirect, as regulations do not allow otherwise (OK_CT_EC_9). Investors complain about the uncertainty caused by the regulatory environment. For example, changes in use of system charges causing investment to become unpredictably high (OK_Inv_2) or the two-year maximum for electricity contracts challenging CM solutions (OK_Inv_1).

Other universal barriers to CM attractiveness are *local grid constraints and the non-supportive Distribution System Operator (DSO).* Throughout all the interviews, limitations of the grid due to old infrastructure, active network management (ANM), limited connection to mainland in relation to ownership and management remain highlighted key issues. People experience power cuts despite the island producing more renewable energy than it can consume or feed to the mainland, because the capacity of the sub-sea cable is not great enough (e.g. OK_SR_EC_6). Grid constraints hinder individuals' energy efficiency and infrastructure improvements (OC17). There is "a little bit of a chicken and egg" (OK_Inv_3) problem of the insufficient connection cable to the mainland. On the one hand, any new installation would get curtailed to a non-predictable level, so investors are not even willing to install (OK_Inv_2). This aspect is emphasised by survey responses, which show that 18 % of the investors are not planning to invest, and 27 % are

[7] Value taken from Energy Performance Certificate (data 2021) of an exemplary Stronsay building (detached house with electric storage heater) (Data available at: https://www.scottishepcregister.org.uk/).

interested but not investing. On the other hand, Scottish and Southern Electricity Networks (SSEN), the DSO, does not invest in grid reinforcement and a new cable, while there are no new installations (OK_C_EC_8; OK_Inv_5). It is difficult to cooperate and get responses from the DSO (OK_Inv_1). Furthermore, the DSO does not want others to add battery solutions, as they say this would disrupt their network (OK_C_EC_11). Given these factors, local and national decarbonisation efforts are slowed down (OK_C_EC_8; OK_EG_1).

Nevertheless, there are several <u>drivers for local decarbonisation</u> solutions such as CMs. As both EC and investor interviewees stress, the local harsh weather conditions come with *great natural resources* to harvest renewable energy (e.g. OK_R_EC_4; OK_Inv_1). Interviewees point out that particularly the local opportunity for wind, wave, and tidal energy is attractive for CM designs. At the same time, the still *high level of fuel dependency* for transport (ferries and planes), and for heating which needs to be reduced drives CM developments (OK_C_EC_8; OK_Inv_3; OK_T_EC_10). Additionally, all interviews demonstrate community and investors follow a *joint purpose as driving force* for decarbonisation. The need for change and environmental concerns are aligned driving forces across local stakeholders for approaching local energy transition and tackling climate change (e.g. OK_T_EC_10).

The interviews also revealed <u>local barriers to decarbonising</u> CM solutions. Interviewees stress the *need to balance limited space and visual impact* (e.g. OK_Inv_5; OK_EG_1). The Orkney Islands are a small island archipelago, with land and even World Heritage Sites that the islanders eagerly protect (OC7). The limitation of land challenges implementations, requiring innovative and alternative decarbonisation technologies. At the same time, some interviewees critically highlight the *lack of a local supply chain and infrastructure* (OK_EC_3; OK_Inv_1) could be a barrier to the development of CMs. For instance, due to the 'islandness' of the archipelago, logistics and planning gets more complex and even housing for workers would not always be provided (e.g. OK_EC_3; OK_Inv_1; OK_T_EC_10).

The Orkney islands context presents large <u>drivers for decentralisation and digitalisation.</u> To ensure grid stability, the system suffers *high levels of renewable energy source (RES) curtailment (incl. community turbines).* The ANM, which was one of the first smart grids (OK_Int_1; OC18), now causes inequalities as often community turbines are curtailed first (due to a 'last in, first out' rule) (e.g. OK_C_EC_11; OK_SR_EC_6). Interviewees report that actual curtailment percentage is much higher than initially anticipated, resulting in immense losses of opportunity, energy generation, and revenue for the communities (e.g. OK_EC_5). The severity of this situation is underlined by the stress and mental suffering of the local volunteers responsible for the community wind turbines (WTs) (OK_C_EC_11). Unsurprisingly, limitation of RES curtailment is a key driver for decentralised CM solutions.

Already, motivated by this driver, research projects such as H2020 SMILE, ReFlex, Project TraDER, and Heat Smart Orkney have sought to address this issue (OK_EC_5; e.g. OC19/20). Now, the *variation of existing and past projects and technology opportunities* present a driver for CMs by itself. Previous projects tested smart control and demand response with e.g. batteries and heat pumps at a household level (OK_EC_5; OK_TP). The ReFLEX project was the first project, that tried to achieve a 'system-wide' view and configuration in the sense of a virtual power plant (e.g. OK_EC_5; OK_Inv_1). Thinking about decentralisation and digitalisation, OK_EG_1 thinks that "that's Orkney, we're a community microgrid". OK_C_EC_8 agrees that it is *"*very much a common theme for us [Orkney]*"*. Hence, learning from these projects and building upon them can drive further developments of decentralised, digitalised CM solutions. All EC interviewees either state *that existing digital exclusion* is an issue in the islands or are victims of it themselves. Tackling this factor through smart CM solutions could quickly turn into a driver for community participation (OK_EG_1). However, the *lack of internet infrastructure and digital connectivity* – e.g. internet speed 141 % lower than the UK average (OC21) – could also be a barrier to smart, digital CM development (OC22). Similarly, *low energy demand and seasonal changes* which the Orkney Islands are confronted with could make the CM decentralised management more complicated and revenues uncertain (e.g. OK_EC_2; OK_T_EC_10).

Ultimately, local energy democratisation is driven by *island community challenges* such as depopulation, fuel poverty, and curtailment of community WTs, and disconnection (e.g. OK_EC_3; OK_R_EC_4). The interviewees emphasise that the islanders are tired of not seeing a benefit of the supposedly cheap, local, and sustainable RES production. For example, OK_T_EC_10 states that "the communities within Orkney see that we've got huge potential there, but they don't see the benefits to them." Driven by wanting to overcome the currently *perceived 'unjust' energy transition* (OK_EC_2), islanders state that they are willing to participate, as long as they stop being the energy transition's guinea pigs (OK_C_EC_11).

However, interviews revealed two key barriers to democratisation through a CM solution. First, reflecting on the needs for both the whole island archipelago and the individual, the interviewees are aware of the *high investment costs* as a potential barrier. They highlight the large initial investment for the CM (OK_T_EC_10; OK_C_EC_8; OK_EC_2) and grid-connection (OK_Inv_2). OK_Inv_1 underlines the regional inequality that comes with the cost of remoteness. Additionally, general *resignation within the community* could slow down democratisation processes. Interviewees point out disappointment paired with bad experiences from previous engagement, e.g. where after investing time and effort local opinions were not considered or did not result in any community benefit (e.g. OK_G_EC_7; OK_Inv_5).

4.2 The notion of attractiveness for an Orkney energy community

This section creates the Orkney EC narrative describing their perceived notion of attractiveness, where the local context emphasises a high social notion. The case study revealed that the community would i) *be ready to take up active roles for a successful CM, being active prosumers and users, managers, members, initiators, and investors* while ensuring fairness in complying with responsibilities; and ii*) prioritise socio-economic benefits, followed by environmental and technological benefits*, always putting community benefit before individual gain.

The islanders already form an <u>active community.</u> Underlined by the local drivers such as 'high island senses' and 'island community challenges', the interview participants describe the island communities as active, caring for each other and the environment, engaged, with "a can-do attitude" (OK_EC_2; OK_Inv_1). In the Orkney Islands it becomes clear that "community is a verb, and not a noun" (OK_C_EC_11). Also, the Orkney Sustainable Energy Strategy builds on the community's participation as a key pilar for the local transition (OC8). The survey results highlight a high level of interest in participation, but little empowerment in their current energy context (e.g. 46 % interested but not currently participating, and no participant with a leading role).

All interviewees are convinced that if enabled, the islanders would become <u>active prosumers and users</u> in a CM, although mostly active users due to the financial barrier (OK_T_EC_10). The interviewees talk about "users" to highlight the direct local energy use (OK_CT_EC_9 OK_EG_1; OK_T_EC_10). Already, people *demonstrate high level of engagement and interest* not only in each other but also for energy topics (OK_EC_2). Survey responses underline the general knowledge regarding energy technology and island energy system, but less knowledge regarding energy BMs. There is a high level of energy interest and consciousness among the citizens (OK_EC_5; OK_R_EC_4). Having the highest number of electric vehicles (EVs) per capita in Scotland supports this point (OK_C_EC_8; OC30). People get "consumer power", that is, control and knowledge where energy comes from and a good feeling from active consumption (OK_EC_3). All EC interviewees demonstrate a general belief in the communities' long-term *high willingness to participate and engage in any CM energy action* and behaviour for benefits in return (e.g. OK_T_EC_10). However, the interviews also highlight immense awareness of the local multitude of individuals with different possibilities and needs. Consequently, interviewees stress the need for fairness and diverse options for participation that align with the individual abilities and flexibility capital (OK_CT_EC_9; OK_EG_1; OK_EC_3). That said, some participants (such as OK_G_EC_7) are convinced that people would participate in everything that would improve their situation. Although trading energy flexibility and changing energy behaviour still seems more abstract to people (OK_CT_EC_9; OK_EC_3), "people are fairly open and willing to accept new challenges, new change" (OK_G_EC_7). Whether wind, hydrogen, tidal or wave power, "we see it as quite a niche of cutting-edge technologies and a cutting-edge industry that we are right at the heart of it. And that's why people here I think do embrace it." (OK_C_EC_8). As a result, there is a generally *high acceptance of RES*. Acceptance even increases by limiting visual impact and clearly explaining benefits (OK_C_EC_11). In fact, in previous energy projects there have been more people interested in participating and becoming active prosumers and users than could be financed (OK_EC_5).

Therefore it can be seen that, while there is general willingness to participate, active engagement will only happen "if they can see direct benefits for the community. And that's not necessarily money." (OK_C_EC_11). Interviews and surveys, in line with the islands baseline condition, highlight the local <u>prioritisation of social and economic benefits</u>, which are somehow entangled (OK_EC_5). In the survey, participants perceive economic benefits as more important than social benefits. However, as the EC always looks out for fair and stable benefits for the whole community rather than the individual (OK_EC_2), social benefits are key to engaging the island community. In fact, interview discussions align with survey findings that *addressing fuel poverty* (38.5 %), and *provision of low energy costs* (19.2 %) are most important for their decision-making. Decreasing fuel poverty, "is probably the biggest concern, I think, that people have at this point in time more than anything else" (OK_T_EC_10). For example, OK_R_EC_4 states: "I'd be quite happy to have it [and participate] as long as I'd got electricity out of it at a reduced or free rate." Furthermore, interviews suggest that energy affordability and accessibility, should come with *energy security and reliability*, as presented in the CMA, as a socio-technological benefit (OK_C_EC_11; OK_SR_EC_6; OK_EC_2; OK_T_EC_10). Interviewees link these aspects to the desire for more energy independence and for cheaper electricity due the local, unjust regulations and grid constraints (OK_CT_EC_9; OK_SR_EC_6). In fact, survey findings underline this point, as *economic independence from existing energy companies* is very attractive for 53.8 %, and most important for the decision-making of 38.5 % of the participants.

OK_C_EC_11 is convinced that in Orkney, people want to be heard and actively participate and *have a say in decision-making processes for the communities' best*. However, for only 11.5 % of the survey participants, would "having an active say" be most important to drive decision-making. Nonetheless, the Orkney community presents a mindset that would foster fair CM <u>managers</u> (e.g. OK_EC_3; OK_R_EC_4). Given their priorities, they would want to close the gap between energy rich and energy poor (OK_EC_2), ensuring the inclusiveness of a CM and for community <u>members</u> (OK_CT_EC_9). All interviewees stress the inclusion of vulnerable households and the need to take an island perspective regarding distribution of benefits, risks, and scale of implementation (OK_EC_3; OK_EG_1; OK_C_EC_11). Existing technology or social organisations (e.g. European Marine Energy Centre, Community Energy Scotland, Heriot-Watt

University's island technology test centre, Orkney College UHI, Orkney Renewable Energy Forum, THAW Orkney, and Voluntary Action Orkney) demonstrate this established mindset of guiding, thriving, and volunteering in and for the community (OK_R_EC_4; OK_G_EC_7). Unsurprisingly, interviews suggest, in line with the CMA, the *use of existing representatives and involvement of the local authority* to de-risk, increase trust, and support acceptance (OK_EC_2; OK_G_EC_7). Furthermore, as suggested in the CMA, interviewees agree that to establish a successful CM, it will need even more *enhancement of local knowledge, skills, and experience* to eliminate all potential barriers to participation (OK_C_EC_11; OK_EG_1). As a result, these existing experts can share knowledge and create links between stakeholders resulting in, for instance, the Orkney Research & Innovation Campus or the Community Power Orkney Partnership (e.g. OK_C_EC_8). EC interviewees link this to *local well-being, economic growth, and jobs*, highlighting the importance and attractiveness of these benefits. The perceived attractiveness is supported by the survey results (socially, 65.4 %; and economically, 69.2 %). While previous projects demonstrated that promised jobs remain "a myth", interviewees envision job creation as part of the development towards a smart local CM (OK_SR_EC_6). For instance, community members could act as local persons for "face to face" support (e.g. OK_EC_3).

Furthermore, current context and future visions presented in the interviews showcase the communities' sense for becoming <u>initiators and investors</u>, which could further *drive a more social CM design* (e.g. OK_SR_EC_6). While the Orkney community is used to participating in consultations (e.g. OK_G_EC_7), OK_CT_EC_9 stresses the need for bottom-up approaches for a complex network such as a CM. The local community is an expert in and on its place (the islands) and does not want to be experimented on (OK_C_EC_11). Therefore, OK_C_EC_11 stresses that to overcome the barriers to CM energy democratisation, it will be necessary to recognise this expertise and engage the community in "real" shared dialogue and co-creation, as the CMA suggests. Interviewees positively refer to existing community investments and the community trusts, highlighting the success and immense community benefit (e.g. OK_EC_3). OK_C_EC_8 thinks that "folk are willing to invest their own personal capital in order to minimise the running costs." Community investments, ownership, and benefit would even help to *develop 'relationships' with technology*, increasing efficiency and participation in a CM (OK_C_EC_11). Consequently, interviewees are sure that a community-led, -invested, and -initiated CM would encourage participation (e.g. OK_EC_2).

The surveys' overall ranking would suggest that for some people in the community, <u>environmental benefits</u> would be the main driver for deciding to participate and engage in the roles and responsibilities. However, the social notion is omnipresent as also there, the reduction of the islands' fossil fuel dependency was perceived "very attractive" by 61.5 % and most important by 42.3 % against 'own' fossil fuel dependency, with just 53.8 % and 11.5 %

respectively. Then, also, the *contribution to overall environmental benefits* is “very attractive” for 50 % and “most important” for 38.5 % of the community members. Interviewees agree that there is a high sense of *environmental consciousness* among the islanders that a CM should address (e.g. OK_T_EC_10). In the end, however, environmental benefits are not the local priority (OK_EC_5; OK_EC_2) and often misused as “buzzwords” (OK_CT_EC_9).

In line with the survey findings, interview participants generally gave technological benefits the least importance. For the community, to *ensure local power production, consumption, and control* is the most attractive (53.8 %) and important (34.6 %) aspect to drive the perception of attractiveness. The interviews similarly highlighted the attractiveness of a “local” CM (e.g. OK_SR_EC_6), which “should power the people on the island first” (OK_R_EC_4). The interviewees envision that through a local CM, they would overcome current universal system barriers (OK_T_EC_10), although implementation may involve several steps and time until the complete island energy system forms one CM (OK_C_EC_8; OK_CT_EC_9). Maintaining grid-connection remains important for the interviewees as it ensures the socio-economic community benefits from energy exports while having increased autonomy (e.g. OK_CT_EC_9). The interviewees also link other technology benefits to their socio-economic priorities. First, they see smart devices as tools to reduce worries, help to pay less, and *support efficient use of electricity* (OK_EC_2). Second, the control supports not wasting RES potential and helps with *reducing the curtailment of local community WTs* (OK_EC_3; OK_EC_5). Survey responses show that decreasing curtailment is attractive (42.3 % “very attractive; 15.4 % “most important”) in line with the stated general driver for decentralisation and digitalisation and CMA. Third, the island benefit of becoming a testbed through implementation of a CM (e.g. OK_EC_3) allows islanders to *become early adopters* and pioneers, with cheap or free access to smart or energy efficient technology (OK_EC_5). However, surveys and interviews show that this aspect is twofold. For 19.2 % of the respondents, supporting the promotion, demonstration, and testing of new technologies is the most important driver for participation. Other responses suggest that this may not be attractive for everyone as, for example, 15.4 % of the participants perceived the use of smart technology as “very unattractive” (the highest response in that direction of the entire survey). OK_C_EC_11 explains that this is because there needs to be transparency of what is involved and how things are being solved when they go wrong, because no one wants to be worse off. This desire is unsurprising, given the worries about issues such as local supply chains (OK_EC_3). At the same time, OK_C_EC_11 thinks that changing the narrative from supporting developing a ‘testbed’ to a ‘lighthouse’ island encourages community engagement. Although the islanders are open to having smart technology integrated (OK_EC_5), they will want technology that is reliable, improves quality of life, is easy to use, and is convenient (OK_EC_3; OK_EG_1). The attractiveness of *becoming a lighthouse island* smart energy system derives from the consequent *decrease of depopulation and creation of jobs and capacity building* structures e.g. in maintenance (e.g. OK_R_EC_4; OK_SR_EC_6) and *economic growth* due to incoming industries (OK_EG_1); hence, these perceptions link back to the ECs' socio-economic priority.

4.3 The notion of attractiveness for Orkney CM investors

This section creates the narrative of the perceived notion of attractiveness for possible investors in an Orkney CM. The local context demonstrates vast investments in renewable energy production and innovation. The case study revealed that investors i) *have a clear forward-thinking mindset to become investors, educators, supporters, and innovators* while financially supporting community-led investment; and ii*) prioritise economic benefits*, but their thinking is strongly driven by *social and environmental benefits* for the island and community and the economic notion of *technology benefits* – all influencing their decision-making.

The local government calls for "smart, supportive infrastructure investments" (OC12). As the many local and international Orkney investors before (e.g. OC14), the case study presents the available investor mindset of becoming forward-thinking investors**,** despite or maybe because of the evaluation of risks and returns (OK_Inv_2; OK_Inv_4). Interviews suggest that CMs are generally attractive. According to the interviewees, the CM's complexity or the need to develop a tailored island solution is not what hinders their investment, but rather the uncertainty of regulations and grid development (e.g. OK_Inv_5; OC23). For instance, OK_Inv_2 stresses the risk of directly and only selling energy to the community individuals who can legally opt-out the contract at any time.

For now, investors in the larger infrastructure and research projects in Orkney have been the local authority, the network operator, public funds, and private companies (OC25; OC26). The interviewees are aware that investors that invest in the island are either people with interest in sustainability and social impact, or for innovative niche technologies (OK_Inv_2; OK_Inv_3; OK_Inv_4). Ultimately, the interviews highlight the fact that potential CM investors *demonstrate a strategic, forward-thinking mindset*.

> "The world is becoming very heavily saturated in some grids with wind and solar, so it's never been more apparent than now that there is value in diversity of source of supply, but most importantly diversity of timing. (…) I think there's a market there. If you think that there's a market, there and [then] somebody is going to create a solution for it." (OK_Inv_4)

A survey comment emphasises the usefulness *of recognising business opportunities* and having a "blueprint" of a project that shows bankability in a real-life context to make CMs even more investable in the future. OK_Inv_4 is convinced that soon big companies will have integrated solutions and adequate sales pitches to sell CM solutions. For example, the ReFLEX project started off as a research project and turned into a business (OK_Inv_1); or Orbital Marine Power demonstrates international interest in the 'Orkney Energy' (OK_Inv_4). At the same time, both were *innovatively financed through different resources* and collaborations (OK_Inv_1; OK_Inv_4). Today, the ReFLEX project facilitates memberships and EV leasing to the islanders, providing locals inclusive solutions to financially participate (OC24). The interviewed investors are aware that for small- and large-scale technologies and grid connection of an Orkney CM, investment costs are much higher (OK_Inv_1; OK_Inv_2). Therefore, private investments will be needed to *cover upfront costs* so that no islanders are left behind in the energy transition and community-investment becomes feasible (OK_Inv_3). Philanthropic or social impact investors would be the right investors to support island communities in their investment (OK_Inv_1; OK_Inv_3). Investments in the Orkney's need to recognise the co-benefit of tackling regional inequalities (OC28). These investors *invest environmental and social sustainability of island CM projects*, as presented in the CMA. Investors will need to take risks as we now live in times of uncertainty (OK_Inv_3). OK_Inv_1 underlines, in accordance with the CMA, that investors need to *prepare for long-term returns on investment*. Secure long-term revenue streams could derive from selling energy that is being generated from a WT to the main grid (OK_Inv_2). Revenue is crucial as "investors are motivated by making money, fairly bluntly" (OK_Inv_1), despite the fact that, in the survey, the calculated consensus gives the first impression that environmental and social benefits dominate investment decisions.

The interview analysis clearly demonstrates the importance of economic benefits and underlines the strategic, economic business thinking throughout the investor perception of attractiveness. Whether local investors or other third-party investors, *revenue and profitability* of the project are key, as otherwise no investment will happen (OK_Inv_4). Supplying energy to the EC, the consumers, would be regulated to provide revenue (OK_Inv_1; OK_Inv_2). The CMs' BM needs to ensure a payback that is enough for paying back dept, maintenance, and profit, but also community benefit (OK_Inv_2; OK_Inv_3). Additionally, CMs *make increasing 'economic sense'*, which investors could make use of (OK_Inv_4). That is, prices of technologies are going down already, and a smart CM would further allow for an increase in power production and a decrease of costs (e.g. OK_Inv_5). Together, creating a business case turned out to be the most important factor for driving investment decisions for only 3 out of the 11 participating investors (27.3 %) in the survey. As suggested by the CMA and in line with their mindset, interviews reveal that a local Orkney CM is attractive for investors to *explore and be ready for future markets.* Investors make projections for the future (OK_Inv_1) and evaluate cost-benefit (OK_Inv_2). Economic benefit would derive on the one hand from a modular system approach which would allow replication in other communities (OK_Inv_3), and on the other hand from entering flexibility markets (OK_Int_1; OK_TP). However, survey responses of energy literacy highlight that the focus is still on technical rather than business aspects. Furthermore, Orkney investors highlight the benefit of *supporting economic growth, capacity building, and jobs* on the islands (e.g. OK_Inv_3). In the surveys, the benefit of 'contribution to local economic growth and jobs' struck as the key attractive (72.7 %) and important (54.5 %) economic benefit for their decision-making. OK_Inv_4 suggests that the CM solution should "create long term jobs around installation, servicing and maintaining of those assets" to socio-economically benefit both investors and community.

Indeed, the importance of social benefits for the investors' decision-making is highlighted in their survey responses. Tackling fuel poverty through inclusion of vulnerable households is the most attractive social benefit with 90.9 % perceptions as "very attractive". As other benefits are also attractive, the importance ranking reveals that for the respondents, tackling fuel poverty, providing low energy costs, and providing power quality all equally (27.3 %) support the attractiveness of the investment. It comes down to the awareness of all interviewees of the need to *tackle fuel poverty* in the Orkney Islands (e.g. OK_Inv_5). In line with these responses, OK_Inv_1 envisions a fairer energy system through a CM design that remains grid-connected but prioritises local energy supply. The interviewees explain that green investments are not only attractive because it addresses the green agenda but also because climate change is the biggest concern of society which will further increase social inequalities in the future (e.g. OK_Inv_1). Therefore, investing in an 'Orkney CM', is somewhat attractive in order to *create benefit for the island but also the overall society* (OK_Inv_3). Obviously, the investors are aware that by *creating social impact, it improves their image*. Connecting actions to their ESG targets increases perceived attractiveness as a CM is "not that much more expensive and you're not producing all this carbon therefore you're doing the right thing" (OK_Inv_4). So, investors can "tell that story and say, we invested in that, look at us, we're doing a great thing" (OK_Inv_3).

To create impact, whether by directly investing or supporting community-led investments, investors act as educators and supporters (e.g. OK_Inv_3). The interviewees recognise that addressing people's social and environmental consciousness helps to engage the community, thus minimising risks and ensuring benefits (OK_Inv_2; OK_Inv_5). In the same sense, there is always "some impact upon the local environment. So that's really important; that is done sympathetically, and the community are involved in that decision", and community representatives are part of the CM governance board (OK_Inv_2). OK_Inv_3 adds that the more the community can do themselves, the more benefits will stay in the community instead of them only paying a different bill. "Giving them an opportunity to invest and see a return from a wind farm I think is a good social thing to do" (OK_Inv_1). The local community has already demonstrated willingness to invest – individually in domestic WTs or collaboratively in community WTs through Community

Development Trusts (e.g. OC27). The local community trusts are an example not only of community-led investment but also of the increased, long-term, focus and success of feeding benefits back to the community. While the abilities of the trusts are limited, the social governance structure and ambitions help the few communities to benefit from the local production (OK_Inv_2). Hence, the interviews align with the CMA aspects of *following bottom-up engagement and a shared dialogue*. The local communities' open mindset and expertise is attractive (OC23; OC28); however, the interviewees recognise that island community members will have *diverse levels of interest, knowledge, or financial capabilities* (e.g. OK_Inv_1). The investors know that they would have to actively *support community in development of a CM* and "hold the hands" (OK_Inv_3). That means supporting the bureaucratic and planning process (OK_Inv_2), helping set up a community fund and a system that skills-up the locals to do jobs needed for the CM (OK_Inv_3), and creating a BM or market that attracts further investment, or directly providing modular solutions (OK_Inv_4).

Consequently, the interviews show that future investors in a smart, local Orkney CM would take over the role of and benefit from being social and technological <u>innovators</u>, which goes hand in hand with skills, equity, and experience (e.g. OK_Inv_1). For example, the ReFLEX project, made a workaround by collaborating with many different stakeholders and companies to diversify their skillset (OK_Inv_1). Other interviewees agree that it is best to *share or aggregate roles and responsibilities*, *learn from each other and others*, and potentially "understand how to integrate these different technologies and (…) offer a wrapped solution" (OK_Inv_4). Watts points out in her book that big players and national government seem to forget about the learnings from the island context and the role the islands could play in the energy transition. OK_Inv_3 points out that economically it becomes more complicated when various technologies with different life cycles are involved. To trial and *demonstrate future technologies*, driving R&D and innovation within a testbed environment in interaction with end users in an Orkney CM "actually de-risks future investment (…) if you've been able to demonstrate that [the concept is] being used in that challenging context" (OK_Inv_5). Orbital Marine Power is an example of innovative, experimental technology demonstration and business success (OK_Inv_4). Given Orkney's baseline scenario, overall, the investors' perspectives demonstrate that engaging in investment could tackle *island challenges through innovation* and would need innovations as a *workaround to existing regulations* that could support the overall energy transition (OK_Inv_1; OK_Inv_2 OK_Inv_3; OK_Inv_5).

Consequently, <u>technological benefits</u> complete the picture, which, in the surveys, reflect the socio-economic notion as their votes all relate to the EC/island level: 'provision of pioneer technology' (72.7 %), then 'local power production, consumption, and control' (45.5 %), and 'limitation of curtailment' (45.5 %) were perceived as "very attractive" and equally the "most important" (27.3 %) for their investment decision. Investors are attracted by the ability to *demonstrate future technology solutions* as it potentially adds revenue streams (e.g. OK_Inv_1; OC23). Facilitating regulations for energy flexibility allowed for initial innovative approaches to test aggregation of demand-response services (OK_TP; OC10). The interviewees recognise that there could be increased attractiveness *from a CM's local production, consumption, control and optimisation of energy flows* and revenue stacking (OK_Inv_1; OK_TP). Prioritising direct use of local energy could potentially *limit curtailment* which would increase revenues of current wind energy investors (OK_Inv_2; OK_Inv_3). Finally, environmental benefits are attractive as *"implied in terms of the whole investment piece"* but they are not the main driver for decision-making (OK_Inv_5). In the end, the survey results highlight the socio-economic thinking of the investors *as reduction of the island's fossil fuel dependency* is the most attractive environmental benefit for investors (81.8 % "very attractive" and 45,5 % "most important").

Overall, the findings present a tendency towards a socio-economic model that is community-led. The interviewees recognise the urgency to advocate change, becoming energy activists. OK_Inv_3 concludes by saying "if you worked as an investor, and you felt that your company should be doing more: lobby!".

4.4 The Orkney community microgrid negotiated proposition

This section presents the alignment of the ECs' and investors' perceived attractiveness. Based on the CMA, this section highlights i) the aligned *socio-economic priorities* for decision-making; ii) the present *sense of collectiveness and equal participation for a community-led CM*, regarding their roles and responsibilities; iii) the *universal, decarbonisation, decentralisation and digitalisation, and democratisation elements* for a negotiated proposition for an attractive Orkney CM that would engage the EC and the investors; and finally iv) the Orkney *business model* proposition.

The EC and the investors align in their socio-economic priorities as part of the shared value and purpose bundle with other benefits. The case study emphasises that economic benefits are crucial because they contribute to social benefits and vice versa (e.g. OK_EC_5). Interviews demonstrated awareness of each other's priorities as e.g. the EC knows the investors need for revenues and would therefore be happy with just affordable and not free electricity. The interviewees support that "there's mutual benefit" for the EC and the investors (OK_C_EC_11), and in the end, both want just stable revenue and costs (OK_EG_1). The high level of community participation will ensure fairness and inclusivity to tackle fuel poverty through cheaper electricity prices and to enable local jobs for economic growth and energy security. Investors know that "the community wants to see some return coming back to it" (OK_Inv_2) and the EC agrees that community benefit encourages participation (OK_EC_2; OK_C_EC_11; OK_CT_EC_9). At the same time, there is a focus on equal participation and collaboration for new business models and innovative small- and large-scale technology. For instance, 13 interviewees discuss hydrogen and highlight the attractiveness of using the CM solution and benefitting of the islands' location and experience to become a hydrogen hub (e.g. OK_Inv_4; OK_C_EC_8). All CM solutions must be based on community individuals' abilities and needs (e.g. OK_T_EC_10) as *"we have to be realistic about that [priorities, abilities, and needs]"* (OK_Inv_1) to ensure participation.

In line with that thinking, the notions of attractiveness support a <u>community-led solution</u> as it helps to ensure well-being of community (e.g. OK_Inv_4; OK_R_EC_4). The application of the CMA to the Orkney Islands shows that community and investors would be ready to take over their roles and responsibilities for an attractive microgrid solution. In addition, the application of the CMA demonstrates that the community is aware of the need to fulfil their role in becoming 'active' while also recognising the need for organisational and financial support from other stakeholders – investors and government (e.g. OK_C_EC_11). Similarly, Orkney investors demonstrate a forward-looking, innovative mindset (OK_Inv_1; OK_Inv_5). The local island context drives the focus on social benefits, equal participation, and innovation. When EC and investors become partners with equal powers, "you're much more likely to get a system that compromises and works for everybody" (OK_T_EC_10). Also, "if you're serving the needs of the people of Orkney we need to provide that infrastructure to allow the business models, to allow the development" (OK_Inv_5). And for investors it could further support attractiveness to demonstrate successful collaboration with a community (OK_EG_1). Thus, investors are aware of the need to engage with the community and to keep discussions and decisions open and visible (OK_Inv_2). Transparency and building trust will be key to encourage the EC in the long term (OK_C_EC_11; OK_T_EC_10), helping investors to dissolve uncertainty of the human risk factor (OK_Inv_3).

Learning from the perspectives and considering the islands' size and population, <u>universally</u>, a negotiated CM solution would achieve an island scale. EC and investors envision the *achievement of a smart local energy system* that builds upon existing infrastructure (e.g. OK_Inv_1; OK_EG_1). To overcome barriers, a "microgrid is definitely the way to go" (OK_R_EC_4). The CM would evolve from smaller scale to larger scale over time, due to costs (OK_Inv_1; OK_Inv_4) and engagement of people (e.g. OK_CT_EC_9). This pathway would be achieved through demonstrating the aligned interest of maximising and prioritising local benefits.

Following the existing <u>decarbonisation</u> pathway, a CM would include *a mix of technologies and possibly innovations* that could be set-up in a modular way (OK_Inv_4), as "there's no one size fits all" (OK_SR_EC_6). Local acceptance and resources support the use of wind, tidal, bio, and hydrogen energy as large-scale generation assets (e.g. OK_Inv_2; OK_C_EC_8). Small-scale solutions for households could include flexible technologies such as energy storage (for electricity and heat) and EVs but also energy efficiency measures and modern, electrified heating devices such as heat pumps (e.g. OK_EC_5).

The technologies will support local decentralisation and digitalisation and vice versa. The CM development would mainly contribute *to learning from local technological issues*, starting from learnings from existing projects and widening the test scale and options (e.g. OK_C_EC_11). However, first, it will need island-wide digitalisation to make the smart grid possible and inclusive (e.g. OK_TP). Then, automation and control should be designed for simplicity and convenience to allow everyone to participate and make everyone participate in the long-term (OK_Inv_1; OK_Inv_3; OK_EC_3; OK_EC_5).

The case study showed the importance of democratisation. Alignment highlights that the *creation of a community-led Orkney CM* would be key. Priorities of the EC and the investors align in prioritising energy resilience followed by local energy trading and engaging in energy flexibility models in the future (e.g. OK_SR_EC_6). For the EC and the investors, it is important to facilitate community investment, ownership, and governance to ensure maximisation of benefits and engagement (e.g. OK_Inv_5; OK_EC_2). Additionally, fair, transparent, and tailored price and participation structures are a crucial aspect for inclusiveness and long-term success of the concept to thrive (e.g. OK_EG_1).

From a BM perspective, the application of the CMA reveals that an attractive Orkney CM solution would follow a community-led, socio-economic BM design. In a nutshell, prioritisation of diverse *value propositions* to community, island, and even investors underline the sense of collectiveness. Investors and communities *create value* by becoming partners to design and manage tailored, simple, small- and large-scale infrastructure solutions and business activities. *Value is captured* through stable, shared return on investment, energy savings, limited curtailment, and new market opportunities.

In conclusion, the CMA demonstrated aligned expectations and visions, and showed that possibilities are available in Orkney to provide a business case (Figure 5). “The microgrid concept would sort of create some sort of social fairness (…) but to harness these resources you need money and that’s where the problem comes in” (OK_SR_EC_6). The Orkney community will find a way to continue its energy revolution (OC29); it remains for brave investors to take action, help accelerate the local transition and regulatory change, and tackle regional inequalities.

Orkney Islands context

- Drivers focus on social benefits, equal participation, and innovation.
- Barriers derive from islandness, underlined by lack of alignment of regulations and lack of engagement from local DSO.

Notion of attractiveness: already active energy community

Economic benefits are important but need to be shared with the whole community, which highlights the dominant social notion.
Open to take risks (if transparent) to 'survive'.

Focus on community benefit and tailor shared value bundles to needs.

Technology

Combining large scale wind, tide, and hydrogen technologies with small scale technologies to smart local energy systems. Electrification of heating and innovation are key.

Microgrid control

Existing projects demonstrate possible control approaches. Internet connection needs upgrade.

Business Models

Priority on energy resilience followed by local energy trading and future energy flexibility. Project community-led for local benefits and transparent participation.

Tailor participation structures to abilities and needs; innovate; and reduce barriers to participation.

Notion of attractiveness: forward-thinking investors that support and innovate

Without economic benefit there is no action. Understanding the need for social, community benefit.
Community-led projects decrease risk.

Figure 5. The Orkney Islands business model: a socio-economic model that highlights sense of collectiveness, equal participation, and shared benefits.

5 The Canary Islands Case Study - an attractive community microgrid solution

The Canary Islands are an outermost region of Spain with electrically isolated island systems. The application of the Community Microgrid Attractiveness Framework (CMA) to the Canary Islands context presents alignment of energy community (EC) and investor perspective regarding their priority towards economic-environmental benefits, while scepticism, individualism, and lack of trust enforce differences. The CMA reveals that an attractive Canary Island community microgrid (CM) would be based on individual solutions and services provided by a company, supporting the need for innovative, new business models (BMs) and customer models.

5.1 Baseline scenario: contextual drivers and barriers as factors for attractive CM solutions

The local island government aims to decarbonise the islands by 2040 (CC3). While the local strategy supports a just energy transition and considers development towards smart grids and demand response, the transition target is ambitious (Heinz et al. 2021; Escamilla-Fraile et al. 2023). The case study shows that there are drivers and barriers to the local development of CMs, that i) apply *universally*; or concern the CMA*'s* ii) *decarbonisation*; iii) *decentralisation and digitalisation*; or iv) *democratisation* elements.

The interviews pointed out that a universal driver for attractiveness of CM solutions and participation is the *rising of the energy prices due to the 2022 energy crisis.* The energy prices have increased and left the islanders with a feeling of uncertainty, as the interviews reveal (e.g. GC_R_EC_4). "It's clear that right now, electricity prices are soaring. Here [in the Canary Islands], we have hardly any options other than electricity" (GC_T_EC_3). While fuel poverty or building stock efficiency has never been a big issue in the Canaries due to its climate, it is often directly related to poverty (CC7; OC26). A recent study in La Palma found that almost 15 % of households struggle to pay their electricity bills (CC10). At the time of the study, 2022, the average annual energy bill in the Canary Islands could reach ca. €970 (monthly median: energy costs €80,78; income €1648,16) (CC10) while the annual average in 2021 was €625 (CC11). Still, LP_R_EC_12 and GC_EERR_EC_2 think that the energy crisis somehow provides a necessary increase in prices as otherwise, due to the subsidised and relatively low energy prices, there would have been no incentive for people to think about engaging with alternative, renewable energy solutions.

Key universal barriers to decarbonisation, decentralisation, digitalisation, and democratisation elements for an attractive CM are *regulations and market structure*. For fairness reasons, the local energy prices are subsidised to be the same as in the mainland (e.g. GC_R_EC_6). It is true that some people think the subsidy slows down engagement and thus the local energy transition (GC_EERR_EC_2). However, the subsidy is needed as there is no local energy market in the Canary Islands (e.g. LP_EC_7), hence “the price we pay for energy (…) does not cover the real cost of generating electricity” (C_N_14). In fact, consumers are confused because the abundance of visible wind energy generation is not reflected in their energy bills (e.g. GC_R_EC_4; C_Inv_3). At the same time, investors receive less revenue for their generation as they depend on the mainland market, where production times are different (e.g. C_Inv_4). Also, as there is no legal framework for flexibility markets, prospective BMs from a CM are not applicable (e.g. GC_Inv_6; CC8). Additionally, regulations regarding the microgrid and energy community concept remain unclear (e.g. GC_T_EC_3). Changes would be needed but interviewees are pessimistic as they have not perceived much action from the government before (e.g. GC_Inv_7). Regulatory changes are slow and not aligned with local needs (GC_EERR_EC_2; C_Inv_3; Escamilla-Fraile et al. 2023). Additionally, a strong, energy lobby further slows down progress (e.g. GC_T_EC_13; C_Inv_4). Instead, regulatory sandboxes to test frameworks that work in the islands would be needed (C_N_14).

Indeed, a perceived barrier, from both community and investors, for CMs is the *non-supportive Distribution System Operator (DSO).* “The problem is ENDESA. ENDESA owns practically the entire distribution grid. This makes it very difficult to carry out this transition as easily as we would like” (C_Inv_3). From experience the interviewees say that it is difficult to know where and if your installation gets connected to the grid due to the DSO’s lack of information, transparency, and engagement (e.g. GC_Inv_7; C_N_14). For example, a local community project was challenged because of an unexpected cost increase due to a needed cable for grid connection which after implementation will belong to the DSO (LP_EC_7).

At the same time, the government makes projects more difficult and creates problems due to immense *bureaucracy* for grants and permits, as 9 out of 17 interviewees stress. “When the authorities start to ask you to fulfil a series of requirements, things get quite complicated and, in the end, you say, I prefer to carry on as I am, even if I have to pay more, or I’ll find another way to do it.” (GC_EC_V_5). If an EC or individuals would like to benefit from government incentives, they either require knowledge, or need to put lots of time and understanding into the process (e.g. T_Inv_5). Investors contract people to help with the paperwork which, however, needs economic resources; this helps to get grants but still does not guarantee that the permit will be received (GC_Inv_7).

A <u>driver for decarbonisation</u> is the islands-wide *need to reduce fossil fuel dependency*. “The problem we have in the Canary Islands is that we depend too much on fossil fuels, and in the future, oil supplies could run out for X reasons, we are islands, and we must be self-sufficient" (GC_T_EC_3). Additionally, this is good for the environment (e.g. GC_R_EC_4; GC_R_EC_6), with *climate change* being a huge driver for the islands' general decarbonisation efforts (CC3; CC12). The *great natural resources* would allow CMs and the islands to be fully renewable and self-sufficient (GC_Inv_1). The Canary Islands have huge wind, solar, hydro, geothermal, and tidal resources for any CM hybrid technology solution and choice (e.g. LP_R_EC_12).

A potential barrier to CMs for decarbonisation, which requires the deployment of diverse technologies, is the need to *balance this process with the limited space* available. "The available surface area of the islands is more restricted than in mainland Spain. (…) That doesn't mean there's not sufficient space available", but it needs strategic land use (T_Inv_5). The many protected areas and land use restrictions guide the implementations (C_TP_EC_10). Wind turbines take up less surface area than a solar PV park (GC_Inv_7). Nonetheless, C_Inv_3 thinks that already-used land should be used first for any solution and development before using new land. Consequently, as the islands have many large cities where there is little to no space, the CMs will require roof-top solutions (GC_T_EC_3).

At the same time, a driver for decentralised, digitalised control and solutions is the *high curtailment of renewable energy sources (RES)* that happens especially during the night when the energy demand is too low in comparison to the large renewable energy generation (e.g. GC_Inv_1). Wind turbines are being curtailed even though the producers could, instead of feeding the energy to the main power grid, use the energy for self-consumption (C_Inv_3). Reducing the economic impact and solving the pressure on the main grid makes this issue a driver for solutions such as CMs (GC_EERR_EC_2; C_Inv_4).

Overcoming the islands' *grid constraints* is therefore another driver for CMs by itself. The Canary Islands energy system can be described as stand-alone and isolated electric power grids for each island, apart from Fuerteventura and Lanzarote which are connected (GC_LA_EC_9; CC12). Interviewees explain that this isolation and the old infrastructure constrain implementation of RES. Their energy grids become increasingly 'fragile' with the increase of RES penetration and energy demand (e.g. due to electrification of transport) and decrease of conventional power production (e.g. GC_A_EC_8). While CMs could provide a solution, GC_T_13 stresses that the current mesh grid structure will make it impossible to implement a CM according to definition 'with electrical boundaries and just one connection to the main grid'.

Unsurprisingly, there is a *variation of existing and past research projects* that investigate decentralised and digitalised solutions. Learning from these developments could further drive the attractiveness of local Canary CM solutions with different scales. For example, the island El Hierro, which produces 100 % renewable energy for ca. 60 % of the year due to its wind-hydro power station, could be seen as a microgrid (C_Inv_4; IRENA 2016), demonstrating larger-scale solutions. In La Gomera, the Canary Islands Institute of Technology investigates the development and interconnection of numerous rural microgrids with demand response ability to the overall island grid (CC13). In Gran Canaria, renewable energy communities in industrial areas are being developed and investigated (GC_T_13; C_Inv_3; C_Inv_4; CC14). On a small scale, for example, the Horizon 2020 REACT project investigated decentralisation and digitalisation solutions for a small community in the island of La Graciosa (C_TP_EC_10).

GC_T_13 points out that a huge barrier to a decentralised, digitalised solution will be the present "*comfort-loving society*". It is "rather complicated" for people to save energy or actively consume energy as they are not willing to give up their comfort (GC_LA_EC_9). Linking this perception to lack of information among the citizens, the EC and the investors are reluctant regarding the feasibility of digital CM solutions (Heinz et al. 2021).

In addition to this aspect, a barrier to a local democratic CM is *the individualistic and conservative nature* of the Canary Island society as all interviewees to some extent pointed out. According to the interviews, people are moved by their personal interests and are selfish with no sense of community or cooperative culture (GC_V_EC_5; GC_T_13; GC_T_EC_3; GC_Inv_7). "You won't see that [cooperation] in Spain. You won't see it because of what we Spaniards are like. We're individualists" (C_Inv_4). People would hesitate to participate in a CM as part of an EC as they "associate communities with problems" (GC_A_EC_8). They know it is difficult to get agreement among people, and to trust each other (e.g. T_Inv_5). Thinking about an EC that supports social justice becomes even more difficult as people would rarely sacrifice for others, and instead look for individual gain (GC_R_EC_6; C_Inv_3). Furthermore, there is a strong belief that people would misuse the system and, for example, social contributions (C_N_14). Consequently, there is a notion of general reluctance towards engagement in democratically structured CMs.

Yet, the interviews show that there are two main drivers for local democratisation. First, the concept of *collective self-consumption* acts as a driver for democratic community engagement (CC8; CC15). The interviewees notice that this concept is supported by an increasing environmental awareness (e.g. GC_Inv_1) and confidence in solar energy technology (e.g. GC_R_EC_4). Second, interest from communities and investors derives from *affordability* of photovoltaic (PV) installations (GC_EERR_EC_2) and direct local government support and incentives to invest in local and collective self-consumption photovoltaic PV (e.g. GC_Inv_7; LP_EC_7). Moreover, "large companies never actively listened to citizens or users, (…) it is a weapon that they [now want] the roll-out of energy communities and self-consumption."

(C_N_14). All these aspects demonstrate the available seeds for attractive, democratic CM solutions.

5.2 The notion of attractiveness for Canary energy communities

This section creates the narrative of the perceived notion of attractiveness for potential Canary ECs, which, due to the large population, must flexibly consider a variation of interests and needs. The case study revealed that the community i) consists of some individuals that form *active communities and who could become initiators*, but most people need structures and a reduction of barriers to overcome their individualistic nature and take up roles of *active users, prosumers, investors, and members*, and ii) generally *prioritises economic and environmental benefits, with a slight social notion*, and *associates least value to technological benefits*.

The survey consensus analysis of the participants' prioritisation reflects alignment of thinking among the EC members. The results show an overall order of 1) environmental, 2) economic, 3) social, and 4) technological benefits to be positively influencing the EC's decision to participate and engage. That said, the survey participants were a sample of people with high levels of experience and interest (see Appendix B). However, the interviews also highlighted that in the large Canary Island population there are different mindsets and opinions that are difficult to address at the same time (e.g. GC_T_13). Existing initiatives such as Las Palmas Renovables, Energia Bonita (CC16), Adeje Verde (CC17), and communidad energetica Tacoronte (CC18), demonstrate the willingness of some people to engage in an active community. The few people that engage in these initiatives *demonstrate a high sense for the environment* and become initiators (e.g. LP_R_EC_12). LP_EC_7 explains that this is a challenging role which *needs patience*, as citizens would need to put in time and effort to overcome local barriers. To overcome them, it helps to *collaborate* with "other energy communities in Spain that have the same philosophy" (LP_EC_7).

Interviewees have noticed an increasing environmental consciousness among the island community (e.g. GC_LA_EC_9). Hence, overall environmental benefits of CMs are an effective sales point for engagement (GC_R_EC_4). The survey result emphasises this fact, with 44.2 % of the participants perceiving *contribution to overall environmental benefits* and climate change mitigation as the "most important" environmental benefit to drive decision-making. Additionally, the reduction of the islands fossil fuel dependency is slightly more important to the ECs' decision-making (27.9 % "most important") than the reduction of their own fossil fuel dependency (20.9 % "most important"). Interviewees link this perception of attractiveness to the achievable *local energy transition for self-sufficiency and provision of green electricity in the islands* due to the island resources (e.g. GC_EERR_EC_2). However, many people who "hardly have enough money to get to the end of the month won't worry about the planet" (GC_T_EC_3).

All interviewees agree that while environmental benefits are important, they are more a bonus (GC_LA_EC_9) to the prioritised economic benefits which drive the final decisions of most people (e.g. GC_V_EC_5). The survey reveals that the economic independence from existing energy companies (67,4 % "very attractive"; 39,5 % "most important") and then the establishment of monetary savings from energy efficiency (55,8 % "very attractive"; 18,9 % "most important") as key attractive and important drivers for their decision-making. Interviewees explain that the main motivation to participate would be *cheaper electricity and more independence from the existing energy companies* (e.g. LP_R_EC_12). For example, GC_A_EC_8 says "Nowadays people are really worried about energy prices, I think it is very important to the Canarian people to have stable energy prices". Indeed, C_N_14 thinks that through their participation people would expect to save money and not make a financial profit. People are angry with the current system, the energy companies, their pricing, and governance (LP_EC_7). Currently, consumption and pricing are complicated and untransparent for the common energy consumer (CC10). However, given the immense local barriers presented in the baseline scenario, interviewees are aware that full independence is not feasible. Instead, they envision that companies provide new BMs and support for consumers to establish trust (e.g. C_TP_EC_10) so that they "stay with the devil you know" (GC_V_EC_5).

In line with the CMA, in the Canary Islands, there will be a transition from currently passive consumers towards becoming active consumer and prosumers. The interviewees reflect on the differences among the people e.g. regarding income, flexibility, interest, trust, infrastructure, and space (e.g. GC_R_EC_6). There is also still little energy engagement from the islanders. At the same time, however, to inclusively allow everyone to participate who wants to engage, everyone should *take tasks based on their needs and abilities* (e.g. GC_T_EC_3). Given current regulations, interviewees expect individuals to participate first in *collective self-consumption* (e.g. GC_T_EC_3), which "in the future, will lead to a microgrid" (GC_LA_EC_9). In this transition, the EC will locally *trade energy* (GC_V_EC_5) and *sell the surplus* to the main grid (GC_T_13). Only a few prosumers would perhaps be willing to *share their energy* with energy vulnerable households (LP_R_EC_12; GC_R_EC_6). Further ahead, the CM would offer ancillary services due to the large amount of aggregated assets (GC_EERR_EC_2; LP_EC_7). In any case, active consumers *have a co-responsibility for energy conscious behaviour* (savings, management, and sustainability) from the beginning, as otherwise a high demand means higher costs for the installation which would be reflected through a higher energy tariff (GC_EERR_EC_2). Lack of information and interest causes many people to engage in 'wrong' energy behaviour (LP_EC_7; GC_T_13). Consequently, interviewees worry about these people who do not consume responsibly, and suggest *setting rules*, offering flexible time slots, or providing incentives to use energy more actively and appropriately, as important leverage for the

EC individuals to accept sharing energy and revenue within the community (e.g. GC_R_EC_4). Therefore, a fair and attractive design would need flexible price structures which incentivise engagement and consumption to overcome the comfort and information barriers (e.g. GC_T_EC_3). Automation would be attractive to keep the solution simple, make participation easy and reduce efforts (GC_R_EC_4; GC_R_EC_6; GC_T_13). Existing smart meters could already give consumers information to save energy (CC10). Interviewees envision that the users will just make minor decisions (e.g. GC_T_EC_3). Furthermore, active energy management, smart technology, and price signals would support compliance with the active role (GC_R_EC_4; GC_EERR_EC_2; GC_T_EC_3; C_TP_EC_10) and benefitting from existing time-of-use tariffs (GC_LA_EC_9). Drawing the circle, GC_LA_EC_9 underlines that it is “an essential condition” that at the end of the month everyone will have a reduced energy bill. The EC will want to have the financial benefit from their participation to have money for other spendings and *increased quality of life* (GC_R_EC_4; C_TP_EC_10; GC_T_13). As suggested by the CMA, a valuable side socio-economic benefit would be support for the islands’ economic independence through *potential job creation and economic growth* (e.g. LP_EC_7).

The survey findings give further credit to the social notion with overall ‘*facilitation of low energy costs for the energy community'* as the most attractive and important social benefit for the participants. 74.4 % of the participants perceived this benefit as “very attractive”. This benefit is also the only one without perceptions of “unattractiveness” and it is perceived as “most important” 47.9 %. Thus, “the social factor is also important; money isn’t everything” (GC_R_EC_4), but it is not the reason decision-making (GC_R_EC_6). Interviewees know that for small-scale installations some people, but not all, can become investors and create local benefits (e.g. LP_R_EC_12). Despite the individualistic culture, people become EC members, *overcoming distrust* and stopping waiting for subsidies (LP_R_EC_12)**.** They *share costs* between them, for instance, based on consumption level or household size. This reduces the overall investment costs and makes the investments more accessible (GC_EERR_EC_2; GC_R_EC_4; C_N_14). Survey responses highlighted more energy literacy regarding technical aspects than regarding business aspects (see Appendix B). The local authority promotes collective self-consumption to build trust and provide information to the citizens (GC_LA_EC_9; GC_T_EC_3). Interviewees repeat that the *local government should be involved* to inform, support, and decrease perception of risks (e.g. GC_LA_EC_9; CC18). At the same time, it would be the local authorities’ role to help vulnerable households to participate. The local authority could support by supporting their investment in smart devices (LP_R_EC_12), providing shares of renewable energy generation installations (e.g. GC_T_EC_3), or directly developing a public and inclusive CM (C_N_14). Through different approaches the local authority could eventually help tackling fuel poverty (GC_LA_EC_9; GC_EERR_EC_2). Applying the CMA perspective, the interviewees are convinced that investments should come from the community to *develop a sense of ownership*, consequently ensuring long-term success of the solution (e.g. GC_V_EC_5). Cooperative or small community support structures could help to overcome other barriers to participation by, for instance, enhancing knowledge and overcoming bureaucratic hurdles (e.g. LP_EC_7). These visions align with the CMA and survey findings, where *having an 'active role and democratic say'* was perceived the second most important social benefit for decision-making (23.8 %). However, the interview responses reflect that democratic engagement and participation in decision-making and co-design processes will not be attractive for most people and that people would not think about it as a value that influences them to join an EC (e.g. GC_R_EC_6). Instead, people are motivated by the idea of *decreasing the 'power' of large energy companies by gaining independence* and having their own installation and control (C_N_14; GC_A_EC_8; GC_R_EC_4; GC_T_13). This is democratisation for them. GC_EERR_EC_2 explains that the community would want that "*all the benefits are shared more democratically, and not only big corporations, but also the normal citizens can benefit from it"*. In fact, to organise agreement within the EC, interviewees suggest involving *CM managers* who not only manage and aggregate the energy but also support, organise, and mediate within the community due to their social skills (GC_R_EC_6; GC_V_EC_5; GC_T_EC_3; GC_T_13). This is a needed proposal, as future EC scales will vary from few neighbours in their street (e.g. GC_R_EC_4) or in their multi-story building (e.g. GC_T_EC_3) to large virtual 'communities of interest' (e.g. LP_EC_7), making agreement and management increasingly difficult.

<u>Technological benefits</u> are generally less attractive and not as straightforward, according to surveys and interviews. Interviews suggest that this is because (despite interest and perception of knowledge) energy topics are complex, and most concepts and technologies are still unknown to the wider population (GC_A_EC_8). The survey responses underline these findings, as 'provision of local power' (31,0 %), then 'pioneer participation' (26,2 %), and 'ability to electrically connect and disconnect' (21,4 %), were the three most important technology benefits. Few people will value the ability to control of consumption levels as existing tools to reduce energy consumption are also not used (GC_T_13). Interviewees link *technology attractiveness to energy security and independence* of e.g. "not depending on what happens with the mainland" (C_TP_EC_10). This means avoiding variation of future energy prices or possible blackouts on the island (GC_R_EC_6; GC_T_13). However, interviewees are convinced that an attractive CM solution should be solar PV + battery as this is accepted and known technology and fits the all-year-around resources (GC_R_EC_4; GC_LA_EC_9). Everything that would make it more complex would also make it less attractive (GC_R_EC_6). Therefore, interviews envision small, modular, and scalable solutions (LP_EC_7; LP_EC_12). Other solutions would require extensive information and explanation of risks and benefits (CP_TP_EC_10; GC_R_EC_4). The locals want high

certainty (GC_V_EC_5) and "experts behind the proposed solution" (GC_LA_EC_9) before they decide to participate. Therefore, most will wait and decide to participate after they see the solution and its benefits working; here, becoming energy citizens with time (LP_EC_7; CP_TP_EC_10; CC18).

In the end, value-bundles which emphasises economic-environmental models for 'independence' need to be 'sold' to people (GC_T_EC_3; GC_R_EC_4; C_TP_EC_10). C_N_14 suggests first targeting people that are interested and environmentally aware, as those are already more informed but also willing to learn and take slight risks, as "after all, we are all learning about this."

5.3 The notion of attractiveness for Canary CM investors

This section creates the narrative of the perceived notion of attractiveness for possible investors in Canary CM solutions. The local context already presents interest in large-scale PV and wind investments. The case study revealed that investors i) are *forward thinking investors and innovators that can act as educators and supporters* for rolling-out new BMs, and ii) are driven by *economic-environmental priorities* while *recognising CMs' technological and social benefits to them and the island.*

For the islands' energy transition, the government distinguishes between 7 investment programmes among which the most costs are allocated to public self-consumption, community collective self-consumption, and industrial and renewable energy communities (CC19). In line with local goals and the CMA, the interviewees prove alignment of thinking and demonstrate that they are <u>forward thinking investors</u>. Local investors are informed, e.g. 46 % of the survey participants identify as leaders of RE projects, which is reflected in their good energy literacy in technology, business, and island energy system aspects (see Appendix B). While investors previously focused on large scale investments and economies of scale (e.g. CC20), interviewees are aware that they now need to "envisage what is going to happen in the future" (GC_Inv_6) and *algin their business strategy* to the trends in supporting the energy transition (GC_Inv_4; GC_Inv_6). All interviewees *recognise the investment opportunities* for flexibility services (e.g. GC_Inv_7) and community energy (T_Inv_5). The investors know that "generating energy is no longer a differentiating factor. The differentiating factor is what you can do with that energy. Basically, and in a nutshell, adjustment services." (C_Inv_4). Hence, GC_Inv_6 imagines that investment priorities will transition from now renewable generation to community microgrids as happened before from conventional to renewable generation. Since regulations are still unclear, the concepts are somewhat similar and flexible for the interviewees. Therefore, they imagine that, depending on the model, investors will be energy companies, gird operators, or industry (GC_Inv_6), communities (T_Inv_5; GC_Inv_1; C_Inv_4), or existing local investors aiming to enhance their independence (GC_Inv_7) or their WT revenue (C_Inv_4; C_Inv_3). For CMs, the interviewees expect to *lower the investment costs for the community* (GC_Inv_1). The local investors make use of accessible bank loans, subsidies, funds, and guarantees for their projects to increase profit and decrease risk and are convinced that this will similarly help communities (GC_Inv_6; GC_Inv_7). In accordance with the CMA, the investors would *invest in stable long-term returns* as they previously did with wind farms (e.g. C_Inv_4). Having this focus, revenue from a CM with service payments could remove the uncertainty of volatile energy market (C_Inv_4), but there could also be some level of uncertainty in getting the revenue directly from the EC (GC_Inv_7).

Investors perceive economic benefits as the most important to drive their investment decision, as "an investor is not a charity organisation" (GC_Inv_1). The interviewed investors represent small- and large-scale local investors and companies' perspectives, and they all stress that *revenue and profitability* are the driving forces for an investment. Profit gets reinvested in maintenance and possible CM expansion (GC_Inv_7). Already, CM investment would make *economic sense*, given the combination of the local renewable energy resources with the low prices for PV and additional grants and tax relieves (T_Inv_5; GC_Inv_7) and the possibility to not just self-consuming but selling to other consumers (GC_Inv_1). A small community set-up "makes sense in any place" (C_Inv_4) and, by selling energy locally, profit could increase as intermediaries are removed (C_Inv_3). Through using PV, the solution could benefit from economies of scale, and being modular and scalable (GC_Inv_6). Additionally, as PV installations can be placed on rooftops, this solves the issue of space, while also having lower maintenance costs than WTs (GC_Inv7; C_Inv_3). Moreover, all interviewees recognise the need to transform to a smart island energy system (e.g. C_Inv_4). Local expertise exists and knowledge could be transferred (CC21). Although not yet feasible, the interviewed investors foresee the profitability of models such as load shifting, demand response, and ancillary, flexibility services in the future (e.g. GC_Inv_7). Investing in CM solutions early would help to maintain their market shares and be pioneers, as otherwise "somebody else is going to do it" (GC_Inv_6). Therefore, another attractive benefit for the investors is *to explore and be ready for future markets* through investing in CMs. Ultimately, these "financial parameters, that in some way are positive for the investment," (C_Inv_4) are what local investors are interested in and attracted by for creating a positive business case. Unsurprisingly, 'establishing a business case' is perceived as "very attractive" by 45.5 % in the survey alongside two other benefits; the survey revealed 'reduction of infrastructure costs' and 'supporting economic growth of the island' as also "very attractive" for each 45.5 % of the participants. In the survey, *reduction of infrastructure costs* was perceived to be the "most important" benefit by 54,5 %, however, it was only highlighted as a long-term side benefit due to the island context in the interviews (GC_Inv_3; C_Inv_4). As the survey participants perceptions show, s*upporting economic growth* is the second “most important” benefit with 36.4 %. Interviewees explain that jobs will possibly result from. the development (T_Inv_5) and in tourism through the increased ‘sustainable island image’ (C_Inv_4). Local companies already invest for this purpose (CC22; CC23). However, according to the interviews, this is not a driving benefit.

Environmental benefits are a bonus to the investment piece (GC_Inv_7), and always present in the investor’s minds while decision-making (C_Inv_4). The investors see CMs as a potential tool to *support the energy transition and tackle climate change* (e.g. GC_Inv_6). The surveys reveal ‘contribution to overall environmental benefits’ as “most important” to drive decision-making with 40 %. The different interviewees sense the urgency to act and join forces (e.g. C_Inv_3). They present clear thinking that “none is planning to implement a microgrid with a diesel generator” (C_Inv_4). The interviewees hope that through their investments they will help to overcome the islands’ fossil fuel dependency (e.g. GC_Inv_7) and support compliance with local decarbonisation goals (C_Inv_3). In fact, ‘contribution to decarbonisation goals’ was the “most important” driver for 20 % of the participants, along with ‘possible branding and green advertisement opportunities’. C_inv_4 explains that part of the attractiveness of environmental benefits is that, as investors, they can support and *take advantage of a sustainable island image*. While supporting the environment will be good for the island economy and tourism, this will further increase the need to accelerate RES development.

There was generally little consensus in the ‘overall perception of attractiveness’ between the 11 survey participants; still, results highlight that some investors would probably be similarly attracted by the CMs technological benefits. From technological benefits further economic benefits derive for the investors (C_Inv_3). In this category, the survey clearly points out a *decrease in power losses and RES curtailment* as the “most important” (54,5 %) and the “most attractive” (with 36,4 % “very attractive” and 63.6 % ‘attractive’ perceptions) decision-making driver. According to the interviews, reducing RES curtailment is a clear short-term, tangible benefit as with an increase in grid stability, there will be less curtailment, which means less revenue loss and waste of ‘green’ electricity (e.g. C_Inv_4). While the previous benefit is attractive for the island grid, the use and optimisation of local production and consumption are also attractive for the same reasons (GC_Inv_1; C_Inv_3). The bi-directional power flow and the *ability to connect and disconnect from the main grid* allow for revenue and security of supply but also price independence (C_Inv_4; GC_Inv_7). Interviews mention the need for storage and an increase in consumption – being true for a CM and for the islands’ energy grid – e.g. through large-scale hydro-electric power plants, desalination plants, or industrial load (GC_Inv_1; C_Inv_4). Overall, the interaction of assets and the inclusion of CMs into the island grid still need to overcome technical issues (C_Inv_4). Therefore, a long-term benefit will be *to test and learn* *for future operability of smart grids*, strongly linking to the research, development, and innovation (R&D&I) to prepare for future markets. There is the option to learn “how we can combine that smart grid investment with the resource that we need in order to make it commercially viable” and use these learnings also in continental systems (GC_Inv_6).

Consequently, investors also become <u>innovators</u> as they *increase their engagement in R&D&I* to react to the changing market and legislative environment (CC24). Through first development of small scale CMs, then island scale, etc. there is the possibility of learning from increases in scale and grid-connection, operational, management, and balancing aspects at different levels (e.g. C_Inv_4). As interviewees repeat, regarding service models to the EC or grid services “we are experiencing times of uncertainty in these areas and we must experiment” (T_Inv_5). So large energy companies investigate and provide self-consumption services “even though it’s direct competition to their traditional generation supply business” to adapt, but similarly, are innovative technology developers needed to participate and collaborate (GC_Inv_6). The Canary Islands context requires *considering innovative solutions in the future*. To date, innovative technology is still less attractive and riskier for the EC (GC_Inv_6). GC_Inv_3 suggests that in the long-term innovative, local solutions such as solar PV on agricultural green houses in combination with biogas waste plants could be a solution to sustainability and space issues.

Lastly, investors become <u>educators and supporters</u> for the community as part of their service model. First, investors would *support the community in development of CM solution,* in line with the CMA. The interviews suggest community investment to break out of the current energy system structures (C_Inv_4; GC_Inv_1; T_Inv_5) To overcome lack of knowledge and understanding, the EC would receive public and private instructions, information, and support – financially and technically – throughout the different development stages (e.g. GC_Inv_1). People would need a trustworthy ‘guide’ and expert to design and provide the solutions (T_Inv_5). This is a role that existing companies and investors can take over due to their know-how and skills to provide full services (GC_Inv_1; GC_Inv_6). This service would include helping to overcome the individualistic nature of the EC members, which can only happen with previous established trust in the companies (T_Inv_5) overcoming the belief that everyone is “getting rich at the cost of others” (C_Inv_3). By engaging interested people first (GC_Inv_7) and having a ‘middleman’ who gets agreement (C_Inv_4), it will be possible to “unite the community over time” (GC_Inv_1). This act is combined with the need to *demonstrate benefits and provide information to the community through different channels* such as TV and radio (GC_Inv_1). Consultations, meetings, and easy information will further make concepts and technology understandable and accessible for all (T_Inv_5).

Finally, social benefits, are perceived as a parallel side benefit, although not important for decision-making (C_Inv_4). The scattered "attractiveness" perceptions in the survey underline this finding. The "most important" social benefit for decision-making is the contribution to well-being and economic growth (27.3 %). The benefit of CMs for both the investors ESG factors and brand were "most important" to 18.2 % participants. Similarly, 18.2 % of the participants perceived the facilitation of low energy costs as "most important". The three benefits are probably entangled as investors seek to *create social impact and improve image* (C_Inv_3). Interviews highlight the perceived attractiveness of *providing lower energy costs* to the EC in the ideal case (GC_Inv_7; GC_Inv_1; T_Inv_5). Furthermore, although this is not yet critical, investors will be able to provide and support local energy security to the island community (T_Inv_5). T_Inv_5 raises concerns that 'energy democratisation' is misleading advertisement and benefits remain with the rich, highlighting even more the need for investors to be socially just, transparent supporters.

Guided by their economic-environmental priority, the investors recognise the urgency to advocate change while making business from it (e.g. GC_Inv_6). To overcome current barriers and take up roles, investors expect a transition to a stronger energy activist mindset due to greater environmental awareness of community and investors since the pandemic (GC_Inv_1). C_Inv_3 points out the willingness of individuals to lobby for a more environmentally and socially sustainable investment philosophy in their companies. Ultimately, GC_Inv_1 is convinced that "where there are interests, or a profit, the investment will follow. It's not necessary to sell the project to anyone".

5.4 The Canary community microgrid negotiated proposition

This section presents the alignment of the ECs' and investors' perceived attractiveness. Based on the CMA, this section highlights i) the aligned *economic-environmental priorities* for decision-making; ii) the need to overcome the sense of individualism and lack of trust through *diverse expert-led CM solutions*, for taking up roles and responsibilities with time; iii) the *universal, decarbonisation, decentralisation and digitalisation, and democratisation elements* for a negotiated Canary Island solution that would engage EC and investors; and finally iv) the *business model* proposition.

Applying the CMA, this case study revealed alignment in prioritising the sum of economic-environmental benefits for the local notion of attractiveness (e.g. GC_T_13; GC_Inv_1; CC18). The EC is aware that investors want to make a profit, have lower investment costs, and improve their image (e.g. GC_V_EC_5; GC_R_EC_4). Investors know that the EC wants cheap, green energy with increased independence and security of supply (e.g. C_Inv_4; GC_Inv_7). The EC, however, does not directly link this preference with the investors' desire to support the island grid. Nonetheless, ‘independence’ is seen as an aligning factor, creating stability of profit for investors and stable, cheaper energy price for the EC (GC_A_EC_8; C_Inv_4). EC interviewees imagine that creating an island testbed could be attractive for investors (e.g. GC_EERR_EC_2), which is not reflected to this degree by the investors’ interview or survey responses. Similarly, EC participants do not reflect the investors’ expectation that “the feeling of belonging” (GC_Inv_1) or the “feel good feeling” (GC_Inv_7) from setting up an up a community is attractive to people. Given the distinct mindsets in the large population and diverse investors, some assumptions and perceptions are not relevant for all. EC and investors are aware that solutions must “achieve a win-win situation” (C_Inv_4). Sharing and ‘selling’ sets of benefits in bundles based on people’s interest and readiness to participate will support alignment and attractiveness for engagement (e.g. C_N_14; GC_R_EC_6).

Despite being an ‘island community’, the large individualistic population drives the EC and investor notions of attractiveness to support <u>diverse expert-led CM solutions</u>. The case study demonstrates that EC and investors are in the process of mindset change initiated by the introduction of regulatory certainty due to the definition of collective self-consumption. Just a minor proportion of the islanders is ready to take up an ’active’ role (e.g. LP_EC_7). Generally, it requires increase of people’s knowledge and understanding through informing and communicating benefits to transition from their ‘passive’ to ‘active’ role (e.g. GC_Inv_1; GC_T_EC_3). Investors are still highly hesitant due to potential lack of communities` change of energy behaviour and uncertainty of energy market regulations (e.g. GC_Inv_7; GC_T_13). Nonetheless, Canary investors are still forward-thinking and envision aligning and innovating their business strategies to provide services and support the EC (e.g. GC_Inv_6). Furthermore, the local context drives focus on expert solutions for community investment as it decreases uncertainties, helps overcome bureaucratic hurdles, and increases agreement between all parties (e.g. GC_Inv_1; GC_V_EC_5). LP_EC_7 emphasises that community-led models will need experts behind. To initiate participation, trust and transparency will be crucial for the EC to know that they are not taken advantage of (C_TP_EC_10).

A <u>universal</u> aspect for the negotiated Canary Island solution is that it will consist of *plenty of small-scale solutions that add to the main grid* (GC_EERR_EC_2; GC_R_LA_9). EC and investors envision building upon existing infrastructure and regulations with collective self-consumption solution *in a virtual power plant style* (GC_T_13). Deployments evolve by “gradually starting to do more and more things” (GC_Inv_7) and allowing for investment and participation by followers with time (e.g. T_Inv_5; LP_R_EC_12). More individuals and investors will want to join based on mouth-to-mouth recommendations or demonstration of ‘economic’ success (e.g. LP_EC_7; C_Inv_3).

Aligning with local context, decarbonisation will follow the current pathway. *Focus is on established, simple technologies* through initiating with solar PV as innovative, complex solutions will not succeed (e.g. GC_R_EC_6; GC_Inv_6). Considering land limitations, the EC expects roof-top solutions to be attractive to investors as they will ease permission processes (GC_R_EC_4). From the interviews (e.g. GC_T_EC_3; GC_V_EC_5; T_Inv_5) it becomes clear that instead of worries about visual impact there is a sense of pride that arises with awareness and ownership of RES. Integration of flexible technologies such as batteries and EVs will happen with time as prices are still high (e.g. GC_EERR_EC_2).

The decentralisation and digitalisation aspect of being *grid-connected will support the island grid* stability and therefore the network operator (e.g. C_Inv_4). Simple and automated control structures will help the EC not to be "blind" (LP_EC_7), while also minimising efforts and increasing convenience for people (GC_T_13; GC_R_EC_4).

The case study presented the islander's critical view on democratisation. *Tailored, scalable expert-led solutions* will be key while active say is less important. Still, "all options should be possible, and then in each case, each community can choose one mode or another, depending on its circumstances" (T_Inv_5). Hence, EC and investor perspectives align in wanting collective self-consumption service models that allow the selling and sharing of energy. Flexibility business models will only be attractive in the wider future (e.g. GC_Inv_7). Through tailored, flexible price and participation structures and rules as well as different investment options for EC members, such as ESCO or cooperative models, inclusiveness and engagement will be encouraged (e.g. GC_V_EC_5; GC_Inv_6; CC25).

The BM perspective, in line with the CMA, reveals incremental, simple, tailored economic-environmental BM solutions provided by trusted companies. This approach would allow addressing the diverse population of the island, their abilities and needs. PV self-consumption products (e.g. to buy, rent, or own shares) that support independence, cost reduction, and decarbonisation make an attractive *value proposition*. For *value creation*, trusted companies and investors manage partners, resources, and activities and provide scalable, simple, customisable technology solutions. *Value is captured* through product sales and energy savings, sales and security.

In conclusion, the CMA demonstrated that 'attractiveness' is not the same for everyone but that tailored models support aligned attractiveness and transition to willingness to engage and invest. Mindsets strongly align with government guidance. Engagement, however, remains reluctant due to a perceived energy lobby. Therefore, the Canary Island context underlines a top-down approach that requires strong government action to overcome network operator, regulatory and bureaucratic barriers and encourage a notion of trust among stakeholders.

Canary Islands context

- Drivers focus on economic benefits and lack of trust in system with possibility for collective self-consumption.
- Barriers derive from individualistic culture and regulatory constraints.

Notion of attractiveness: from passive to active energy community

Economic benefits at individual level from energy savings and cheaper electricity, where environmental benefits are a 'nice to have'.
Engagement based on regulatory and technological certainty and expert solutions.

Focus on shared economic benefits but 'sell' value bundles based on needs and demonstrate win-win.

Technology

PV self-consumption products that support independence, cost reduction, and decarbonisation. Possible combination with batteries and EVs in the future. Known technologies that add to the island grid.

Microgrid control

Building upon existing infrastructure allows only for Virtual Power Plant control and support island grid stability.

Business Models

Priority on collective self-consumption and increase of savings through local trading to only sell energy surplus. Lack of belief in energy flexibility BM; despite usefulness, only relevant in future. Companies/experts provide products and services for scalable, simple solutions.

Tailor diverse service models to interests, abilities and needs; reduce barriers to participation; and increase trust and transparency.

Notion of attractiveness: forward-thinking investors to align and innovate business strategies and support

Economic benefits are core driver for renewable energy deployment and environmental benefits add to attractiveness.
Risk averse. Incremental expert-led service provision decreases risk.

Figure 6. The Canary Islands business model: an economic-environmental model that highlights incremental, simple, tailored solutions provided by trusted companies.

6 Attractive island community microgrids - Learnings from different island contexts

This chapter contributes to completely answer all research questions by discussing the learnings from the two different contexts – Orkney and Canary Islands – of the case study analysis. The first section reflects on contextual influences through 'place-neutral' and 'place-based' effects on attractive community microgrid (CM) solutions, given the CM key pillars of decarbonisation, decentralisation, digitalisation, and democratisation. The second section discusses key elements regarding the notion of attractiveness and its alignment and negotiation to engage local energy communities (ECs) and investors. The third section reflects on EC and investor engagement based on the development of place-based, tailored CM business models (BMs) along the energy transition pathway. Overall, this chapter demonstrates that the notion of attractiveness supports a) disentanglement of the complexity of CMs and the multiple dimensions that come with this concept, and b) alignment of perspectives and negotiation of potential solutions that solve challenges and create shared value bundles for ECs and investors.

6.1 Place-neutral and place-based effects on CM attractiveness and concept

The case studies presented, the Orkney and Canary Islands, represent "contextual extremes", the Orkney Islands being small-sized, sparsely inhabited, grid-connected islands and the Canary Islands being larger-sized, autonomous and disconnected islands. This section reflects on learnings from both case studies, based on the application to the Community Microgrid Attractiveness Framework (CMA), to showcase *place-neutral and place-based* effects of the local contexts on the CM *decarbonisation, decentralisation, digitalisation, and democratisation* attractiveness.

Both case studies draw attention to the present <u>decarbonisation</u> efforts and the potential usefulness of community microgrids (CMs) to support this decarbonisation. The local aims are to reduce fossil fuel dependency whether for tackling fuel poverty or for increasing self-sufficiency. In any case, the case studies demonstrate that CM solutions, in line with the CMA, should use *100 % renewable energy sources (RES).* The case studies present awareness of the need to use the vast island resources to support the overall island energy transition. Both island contexts showcase that to allow for decarbonisation, *flexible technologies need to be included;* whether at household- or grid-level, technologies such as electric vehicles (EVs) or batteries that support flexibility will be crucial in both island archipelagos. A more place-based aspect is the *local perception of attractiveness of technologies and their innovativeness*. It is true that both case studies reveal that ECs and investors want robust technology designs that are relatively risk-free. Still, the Orkney context presents large interest in innovative technologies linked, however, to its local history, competencies, and industry. In addition, interviewees raised concerns regarding deployment and supply chains because of the islands' remoteness, which was not mentioned that way in the Canary Islands case. In the Canary Islands, a focus on simple, scalable photovoltaic (PV) roof-top solutions is underlined by a combination of trust in technology and government incentives, as otherwise people are not comfortable acting with uncertainty and without expert back-up. *Balancing the limited land with visual impact* also plays a role particularly for EC's perceived attractiveness and acceptance. However, it seems to be a more sensitive issue in small islands where impact of e.g. wind turbines (WTs) is more visible and where fairness therefore requires a large-scale island solution to share both impact and benefits. While there is awareness in the Canary Islands, interviews rather present a notion of pride towards the local visible renewable energy sources (RES) production. If there would be concerns, their focus on roof-top PV limits visual impact and solves the issue of land use. Still, on islands, limited space is an issue for both tenants and owners of the buildings.

Decentralisation is not a new concept in either of the cases, demonstrating the necessary shift to decentralised energy and the overall perception of attractiveness of the CM concept. *Grid constraints, old infrastructure, and limited participation and engagement of the local Distribution System Operators (DSOs)* to act against these issues are place-neutral. In both case studies, ECs have little trust in network operators and energy companies per se, in consequence, ECs are attracted by some prospective independence from them. Similarly, in both case studies, investors complain about the DSOs as obstacles to investment in more RES, due to either lack of transparency or connection costs. While the islands face severe grid congestion with resulting high levels of unpleasant RES curtailment, the islands' geography and energy system present different narratives for causing and resolving it. The Orkney Islands stress the need for a larger grid-connection cable with the mainland, which would easily allow the end of curtailment and the implementation of even more RES. The Canary Islands, as an isolated system, focus on solutions that help to ensure grid-stability of the main island energy grid while this is transforming towards net zero. In line with these issues, the island size and population influence perceptions of the scale of the CM model. The case studies demonstrate different models and a fine line between discussing local neighbourhood CM solutions and transition of the whole islands to becoming an island-scale CM or smart local energy system. The cases also present different regulations for curtailment or local flexibility markets. Regulatory changes are needed to attract EC and investors; however, the *lobbying for specific regulatory changes* will support a perspective for place-based policy design.

Complementary to decentralisation for the CM concept, as highlighted in the CMA, digitalisation is key to enable automation and control which stands at the centre of and for CMs. The case studies imply that *scalability and controllability of the systems* are place-based considerations. The Orkney model is more visionary and aligned to the CM concept. The model describes attractiveness of a smart local energy system with central control in line with household automation, allowing for different levels of participation, resilience, and a potential local energy market. Thoughts may derive from experiences with the existing projects and the Advanced Network Management (ANM) in the Orkneys. The proposed Orkney solution would be smarter and more inclusive. In the Canary Islands, small-scale collective self-consumption ECs would have a more straight-forward control and automation based on rules and shares. Although solutions would be possible to upscale, the vision is to add them to the main grid so they become assets that the DSO's network control organises. With conversations circling around smart grids and technologies and being in the 21st century, it is perplexing that in the Orkney Island digital exclusion is such a huge issue, which is not the case in the Canary Islands. Inclusive participation first means providing access and bringing all to one standard, whether that be through hard or soft infrastructure, to *tackle existing digitalisation issues*. Interviewees in both cases are not bewildered by smart technology. They can imagine participating if the provided *solutions are accessible, kept simple and not complicated* although the Canary Islands case emphasises the need to first overcome the 'love of comfort'. Both cases suggest local assistance e.g. younger people helping older ones to ease participation. Overall, however, both cases reveal that adoption of smart, active energy behaviour is a 'future' not a 'current' step.

The island contexts present opposing opinions towards democratisation through CMs. While the Orkney Island case shows the importance of democratisation aspects, the Canary Islands case reflects on it as marketing strategy with little possibility for change. These views result from the local context and culture, which affects the *local perception of attractiveness of benefits, other drivers,* and the CMA overall. The Orkney Island case demonstrates a significant 'social prominence' due to the community and volunteering history and strong sense of cohesion stemming from being a small, isolated community with severe local challenges, perceived injustice, and large needs for change. The Orkney case exemplifies a social, economic benefits for "all" mindset, which is illustrated by the desire for cheaper electricity prices to tackle fuel poverty as the balance between need for heating and price increases create a situation where people fight for survival. The local price structures, with the islands paying more for the locally produced RES than the mainland, are perceived as incredibly unfair. The local difficulties and culture drive intrinsic motivations and willingness for active participation, initiation, and change through a bottom-up community-led initiative despite uncertainties. In contrast, the Canary Island case reflects the prominent Spanish individualistic culture and the suspicion that people would abuse social structures. Hence, local focus is put on economic benefit for "one" and environmental benefits. The local Canary community also complains about high energy prices, but this could be seen as an expression of dissatisfaction as prices are already subsidised. Interviews point out that lower prices would allow an increase in comfort and quality of life through, for example, opening up the possibility of using an air conditioning system. In the Canaries, it is true that the energy price driver is linked to increased independence and self-sufficiency but needs for CMs are still low and more linked to environmental consciousness. At the same time, however, the Canary case study reveals that most people will be attracted by top-down models where experts "sell" solutions and overcome bureaucracy. Looking at the Orkney context demonstrates that where the need is greater, ECs and investors are more aware and ready regarding their mindsets for taking up and aligning their roles and responsibilities. This situation goes hand in hand with the fact that in Orkney people are considered to be relatively energy educated and engaged, while in the Canaries, interviewees perceive a lack of knowledge and need for education and information. Still, survey results show a similar energy literacy among all participants and case studies, highlighting more confidence in knowledge regarding technology aspects and lesser towards business aspects. Furthermore, the large-scale vision in the Orkney's requires large investments and therefore needs and wants third-party investors and cooperation. In the Canaries, small-scale solutions and incentives allow for more direct EC investment and affordability with time for all actors to get comfortable with the new roles. Still, independent of the place, both case studies emphasise the *different levels of interest in and abilities to participating and engaging* in an EC. It is true that population size differs in the islands, but both cases stress the existence of more active community members and people that want to be left alone. At the same time, the consciousness in each case study points towards models that take individual needs and abilities into account as people can be energy vulnerable, have less flexibility, or less access. Generally, the aspects of energy BMs are still being learned and explored, but the case studies focus on providing and trading local energy first and supplying energy flexibility in the future once regulatory framework is available. Consequently, there is the place-neutral perspective of *evolving these BMs and simultaneously establishing fair, transparent, and flexible price and participation structures.*

Some perceptions apply <u>universally</u> to the proposed CM solutions. That is, the need to *build upon existing infrastructure and evolve over time* is place-neutral. There is an awareness in both cases that a) investment costs would be too high to build an individual grid, it would be a waste of existing infrastructure and resources, and possibly would leave the EC worse off; and b) all aspects put together, it is a transition of multiple dimensions, so change will evolve over time. The local 'island' context will not necessarily ease this transition as e.g. the smaller scale or "lighthouse" idea could suggest. The cases showcase that 'remoteness' of islands has different effects and meanings. Comparing economic context and local drivers of the autonomous, large Canary Islands with the connected, small Orkney Islands, the Orkney Islands suffer more from its remoteness, even though the Canary Islands are geographically more remote. The results suggest 'local island senses', with people's nature being socially engaged and environmental conscious, do not form just because of living on an island but because of local needs. Additionally, culture influences priorities of, for instance, community benefit or willingness for participation. Another influence is the perception of bureaucracy, which seems to be a national and not solely an island issue. *Overcoming levels of bureaucracy* will require place-based changes and increased support for ECs. And yet, both island cases reveal a *sense of 'islandness'* with general needs and issues different to the mainland, which should be reflected in future CM solutions and regulatory designs.

In conclusion, by using two distinct contexts, this case study approach, revealed place-neutral and place-based effects on CM attractiveness, which when addressed will increase attractiveness of the solution (Table 7). The case studies empirically present that place-based CM models follow existing pathways and structures of the local context. Gird and regulatory barriers or local mindsets set boundaries to the design of CM solutions and do not support the transformative change that is suggested by global energy transition visions. Altogether, contexts affect attractiveness and lead to distinct solutions. Still, rather than considering this a matter of path-dependency, the CMA perspective allows for path evolvement and development as CM solutions and their scale increase with time, which is time to learn, collaborate, change, and join.

Table 7. Key place-neutral and place-based effects on and directions for community microgrid attractiveness.

CM pillars	Place-neutral	Place-based
Universal	- Build upon existing infrastructure - Evolve over time	- Build and reflect upon island senses - Overcome level of bureaucracy
Decarbonisation	- Develop towards 100% RES - Include flexible technologies	- Consider local perception of attractiveness of technologies and innovativeness - Adapt balancing land and visual impact
Decentralisation	- Mind and overcome grid constraints and the DSOs' lack of participation	- Lobby for specific regulatory changes needed (DSO, curtailment, local flexibility markets)
Digitalisation	- Provide simple and not complicated solutions	- Tackle existing digitalisation issues - Evaluate and design for scalability and controllability of systems
Democratisation	- Consider different levels of interest and abilities among people - Evolve BMs and establish flexible prices and participation structures	- Consider local perceptions of attractiveness of benefits, roles, and other drivers

6.2 The notion of attractiveness and negotiated solutions to engage community and investors

Following on from the previous section, this section holistically discusses learnings from both cases studies on the notion of attractiveness, that is, i) *attractiveness of CM benefits*; ii) *roles and responsibilities*; and iii) their *alignment and negotiation* towards tailored solutions, based on the application of the CMA to the case studies and for using the CMA as a tool to support decision-making. Thus, this section contributes to a better understanding on how to engage communities and investors to participate and invest in concepts such as CMs.

First, the case studies clearly demonstrate the importance of *understanding the perceptions of attractiveness of economic, environmental, social, technological benefits* as not all have the same level of attractiveness or importance. That is true for the multitude of potential EC individuals and investors. The survey answers, in both cases, reveal and confirm that people have not only diverse but possibly several motivations to decide to participate. The survey results show reflected answers, where not all possible CM benefits are equally attractive. This is true in both case studies. No EC or investor participant consistently answered "very attractive" to all benefits. In fact, the survey answers and the interviews give the impression that EC and investors are rather critical and need to be convinced by the “right” benefits. All in all, the aligned notion of attractiveness in each case study showcases that there is a hierarchy of benefits for both EC and investors. This hierarchy is important to understand and see, as all CM benefits are advertised, discussed, and promoted almost equally. At the same time, it is important to recognise that people can associate different meanings to benefits, for example, ‘independence’ can mean total or partial economic or technological independence from traditional energy companies, or from mainland energy prices. The same example can be used to highlight that people’s priority can change over time. The case studies suggest that energy independence becomes more important with time, generally, entering the discussion of energy autarky and autonomy. In both case studies perception of attractiveness of economic, environmental, social, and technological benefits and salient, detailed meaning closely connects to local challenges and needs. Therefore, the place-based, tailored notion for attractiveness alignment from the different benefit perspectives remains important. Benefits become important for ECs and investors if they eliminate perceived risks, whether economic, environmental, social, technological risk and effecting personal, community, or wider levels. Additionally, the lack of regulations and regulatory certainty (e.g. for flexibility markets, RES curtailment, or fair and transparent energy prices) not only increases perception of risk, but also challenges maximisation of attractiveness and the move from vision to implementation. Overall, the local context and culture present tendencies and priorities of ECs’ and investors’ perceived attractiveness that contribute to their alignment.

The negotiated case models showcase that it is the shared ‘bundle’ of values and their synergy that would drive decision-making. In both contexts investigated, this research found that the two key benefit dimensions shape the local aligned notion of attractiveness and solution. The negotiated models of each case study highlight both the EC’s and the investor’s awareness of each other’s priorities, easing alignment and creation of shared value. ECs and investors want to decrease risks and therefore seek win-win situations. All know that the attractiveness of long-term stability and security of cost, revenue, and energy is based on reciprocity. Additionally, the EC perspective in both case studies reveals that the islanders – in their role as citizens or energy customers – have been and feel “overlooked”. Therefore, future attractive CM solutions should highlight the community benefit share. Additionally, a model that allows to tailor the benefits and attractiveness to the individual would further align attractiveness and drive positive decision-making. Consequently, this research urges the *development of place-based, tailored value propositions and shared value bundles* to maximise value for ECs and investors, based on the following:

- In both cases, economic benefits remain the core driver for decision-making, although, meanings differ between ECs and investors from creating savings or revenue to creating profit. CM concepts make more and more economic sense for investors. The case studies also show that economic value can have a strong social or individualistic notion. For the ECs, clear emphasis is put on reducing their energy bills, reinforced by the energy crises, local fuel poverty, and not benefiting from the (abundant) local RES production. Investors need revenues and profits from energy sales to justify their investment and pay for future, for instance, CM BM expansions or maintenance. For both ECs and investors limiting RES curtailment is attractive as it directly or indirectly affects economic benefits. Moreover, ECs and investors align in wanting to contribute to job and capacity creation and overall economic growth, as local jobs could even decrease risks. Locals who are skilled for maintenance and repair would assure smooth operation of the microgrid and provide help to the EC individuals.
- Environmental benefits were perceived as highly attractive in the survey, but the interviews revealed contrasting opinions. It is likely that survey participants gave it a high score, as primarily wanting environmental benefits is part of ‘today’s good tone’. Interview participants reflected more honestly on its importance during the discussions. Tackling climate change is most likely only the primary driver for people who face no other challenges. For most of the people, environmental benefits are only an attractive ‘bonus’. Still, this bonus needs to be properly communicated and sold by, for example, linking the specific benefits to the island challenges.

- Social benefits are a key driver in the case of the Orkney Islands but of much lesser importance in the Canary Islands. This is due to both Orkney's mindset of wanting community benefit first and Orkney's culture of cooperation and social compassion. The Orkney case study demonstrates that the 'social notion' is important and exemplifies its monetisation. Nonetheless, in both case studies, social benefits are not as directly reflected on as economic and environmental benefits, showing that it would be beneficial to highlight, frame, and incentivise social benefits for ECs and investors more clearly and directly.
- Technological benefits are of least importance and of least interest for ECs and investors in both case studies. The surveys show that these benefits are of lesser attractiveness than the other CM benefits. The interviews demonstrate that this is because these benefits are more difficult to grasp for the participants and rather linked to their other priorities. In addition, it comes down to minimising risk, as technology benefits are associated with innovation and ECs do not want to be worse off due to 'fancy' technology that fails just as investors do not want to lose revenue. Furthermore, there is confidence that technology is available, although with varying tendencies of attractiveness towards innovative technologies.

The case studies demonstrate the entanglement of CM benefits and roles and responsibilities by describing the ECs' and the investors' perceived notion of attractiveness. It is part of the CM attractiveness that benefits are aligned with current and new roles to stimulate uptake and mindset change. To maximise attractiveness for all and engage citizens and investors without leaving anyone behind, the case studies suggest *aligning roles and responsibilities* within and among the community and the investors to establish an ecosystem of like-minded actors. The CMA captures the various roles and responsibilities for ECs and investors in a broad way. The case studies underline the applicability of the CMA and even the need to reflect and apply all roles to a local context. Case study findings suggest that all roles and responsibilities complement each other and help to maximise benefits and decrease risks. As a representative sample of the multitude of individuals, the interviewees in this research represented a variety of actors with different levels of energy literacy and existing roles and connections in the local community. Their reflections demonstrated that the variety of mindsets, priorities, and readiness levels for ECs and investors to take over roles and responsibilities needs to be aligned in the CM proposition. Contributing to the 'inclusiveness' perspective of innovation (Smith et al. 2023), it becomes obvious that all roles in this transition are important and not everyone "can" or "wants" to take up all roles (such as active consumers, prosumers, investors, members, initiators or managers for EC individuals; or forward-thinkers, business strategists, innovators, supporters and educators for investors) and salient responsibilities. The case studies showcase that existing roles, expertise, and culture strongly influence perceptions of attractiveness and willingness of uptake (see community-led against expert-led model), which therefore should be considered and built upon.

A tailored solution will allow alignment with the variety of roles and responsibilities, multitude of opinions, while reducing barriers to participation and decreasing the risk of people opting out. For ECs, case study results stress the importance of tailoring models around local and individual people's needs, abilities, and interests. At the same time, enabling adoption and change over time will be necessary since, for example, level of consumption or flexibility can alter due to changes in household composition or of jobs, or people want to join with investments over time. For investors, the case studies highlight the need for more proactively taking over their roles, learning and growing through collaboration and supporting communities directly or indirectly. Provision of diverse models – choice – mutually supports alignment and inclusiveness. Ultimately, these approaches help to bring ECs and investors closer together as it maximises attractiveness for both. Consequently, this research urges the *tailoring of roles and responsibilities for inclusive and proactive value generation* and creation to places, context, and community of implementation, based on the following perceptions and implications from the case studies:

For energy community roles and responsibilities:

- ECs and investors envision that citizens, that is traditional energy consumers, predominantly take the role of <u>active consumers, users, and prosumers</u> in a CM concept. Reading between the lines of the proposed models, the minority will become prosumers as the majority will lack financial resources, space, power, and even confidence to buy RES. An option for inclusiveness could be the possibility of a more 'passive' prosumer role, where first costs for the renewable energy generation technology shared and then also the produced energy is automatically shared. Active consumers and users, nonetheless, has a co-responsibility for behavioural change and efficient energy use. There seems to be a slightly different notion between the roles of 'consumers' and 'users', as in the Canary Islands the role of consumers is highlighted, whereas in the Orkney Islands it is users. It is possible that the narratives relate to the proposed models of being part of active self-consumption or a user of a smart local energy system. In the Orkney Islands people would make use of the local energy, while in the Canary Islands people consume based on rules. In any case, the focus is on establishing conscious energy saving behaviour to save money in order to have more money whether for heating or air conditioning, needs that will be enforced by climate change. Nonetheless, the diverse island focuses underline the different readiness levels and mindsets within our society. While in the Orkney Islands people seem eager to engage and get active, in the Canary Islands, people can imagine participating but would need to see more regulations, rules, structures, or other people's participation first. Ultimately, incentivising behavioural change to establish cost savings as a motivation to take up active energy behaviour will also be key.

- The concept of energy democratisation suggests the preference for people to become initiators. The island contexts, where local norms and values should supposedly unite people and ECs, shows that reality is different. Only a few people will be willing to put in time and effort and spend money to confront big players or work through bureaucracy and permits. It is a difficult role that certainly some will take up but cannot be expected to be the default. Moreover, what helps the Orkney initiators, is indeed the context of its small size, large expertise, community history, and feeling of being let down by anyone except themselves. This situation is, however, something that for a just energy transition no community should experience. Before communities even end up in the situation 'of fighting for survival' by initiating a CM, challenges should be tackled by policy and investors. At the same time, EC initiators who drive for independence and environmental benefits, as in the Canary Islands study, should be supported.
- In both cases EC and investor representatives prefer that the community members should become investors; however, they also pointed out that not everyone will have the financial resources to make an investment, which supports the importance of this thesis's focus on engaging both ECs and investors for a just energy transition. Different models require different investment structures, and the case studies demonstrate that affordability and subsidies alone will not fully facilitate investments but certainly help. The case studies suggest community investment helps the individuals to develop 'a relationship' with the technology and to gain ownership and more independence. Investors favour community investment models, as all these aspects will ensure long-term participation, maximisation of benefits and decrease of risks. Hybrid investment structures will be most attractive as not all have the same financial resources or credibility. Models therefore need to provide options to invest, to share costs and increase accessibility and affordability, but also to not invest.
- These structures closely relate to governance structures where EC individuals can become both managers and members. The Orkney Islands case serves as an example of the attractiveness of community governance, where the EC would have CM managers. There, both the EC and the investors are aware of the strong will of the local community to participate and contribute to decision-making processes. This would be solved through community representatives, while most of the islanders will be members of the set-up organisation where some engage more than others. In the Canary Islands case, the culture emphasises a concept where the EC consists of members that have their vote, but the main decisions remain with the service company or an external manager who organises assets

and people. The different concepts reveal the large lack of trust, first, towards energy companies, and second, towards other community individuals. As the cases suggest, to improve trust and agreement, local authorities can assist, participate, or support.

For investor's roles and responsibilities:

- The case studies shows that current investors can be best described as forward-thinking investors. Indeed, they are ready to cover upfront costs or help the community get attractive bank loans. In line with the CMA, these investors 'think and talk' long-term returns and, as both surveys and interviews showcase, have a sustainable value mindset. The Orkney Islands case study presents great awareness among the investors regarding the social value of local investments. The Canary Islands case exemplifies the strong business strategy mindset presented in the CMA. Both cases demonstrate that investors recognise the changing market environment and needs, leaving them with either adapting and acting or losing their market share. Still, the investors seem 'on hold' as innovative financing solutions are not enough if regulations and network connections pose not only risk but open-ended uncertainty. To drive positive decision-making even of the most forward-looking investors needs calculated economic value and profits.
- It is true that big investors, institutions, and existing energy companies could strengthen their innovator role using either their existing revenue streams, as the Canary Islands case suggests, or collaborations and government grants, as in the ReFLEX project in Orkney. Starting pilots with sustainably driven innovators could be important as many regulations are still not in place for all CM benefits to unfold. The case studies present a focus that will be less on technology innovation and more on business and conceptual innovation to work around and within regulatory boundaries. A challenge-oriented mindset supports developing business opportunities out of local challenges which accelerates investors' proactiveness to lobby to have business-ready concepts for the energy transition pathway, and to tackle regional inequalities. The island context highlights the possible innovative playgrounds for ECs and investors to develop and test new BMs, collaborations, and evolve in 'open mindedness' rather than 'self-interest', while implementing place-based, tailored solutions and translating them to other contexts (see also Enlit 2023).
- Moreover, investors take the educators and supporters role. This role is independent of the type of investor and the project stage, as '*we* are in *this* together'. This means there is a need for shared dialogue between investors, EC, government, and technology developers, which will help alignment of priorities but also of information and processes. The dialogue will support development, decrease risks, and accelerate uptake. For instance, as the case studies suggest, working with communities or technology developers (start-ups) from the beginning, helps to set up risk free conditions, rules, and contracts

which ensure that financing can be done, and people regain trust. At the same time, the case study narratives stress that people have strong opinions and expertise about their place. Considering that initiatives should start with the already active community, there is a fine line for ECs' acceptance between being educated or provided with training and information, underlining the focus on supporters rather than educators. Finally, sharing information and upskilling local competencies holds true for the whole system and between investor collaborations and not just ECs.

Negotiation and alignment of the notion of attractiveness is feasible as the case studies and the CMA demonstrate. The CMA serves as a tool to give directions and open mindsets for aligning and negotiating priorities for mutual attractiveness, thus, drives positive decision-making for participation and investment. It is crucial to balance powers by mutually recognising value, interests, and priorities, and value in the other actors' roles and expertise. The alignment of the notion of attractiveness brings all points of the CMA together, making the puzzle complete. Still, *to fully align the notion of attractiveness and create CM value generation for democratisation, the following enablers are needed*:

- The case studies, despite their contextual differences, reveal the necessity to build trust, as it is an immense issue, relevant for all CMA aspects. The case studies suggest that trust a) depends on local culture and system and is therefore place-dependent and b) is something that must be built again. Active ECs act because they do not trust the system to make change; other members of the community do not engage because they trust neither the government, nor businesses, nor even their neighbours. Investors do not trust in governments to establish regulatory certainty and are sceptical towards EC participation in CMs. Also, the case studies show that trust in technology can influence preferences and decisions. According to Derkenbaeva et al. (2022a), the culture can influence whether these aspects make people want to act bottom-up (the Orkney Islands) or wait for top-down certainty (the Canary Islands). In any case, the proposed co-creation and aligned attractiveness perspective of the CMA will support this process. Therefore, trust is a central pillar for any attractive CM and for local energy transitions.
- Part of this task is to improve transparency. An attractive CM must be transparent regarding outcome benefits and responsibilities. The case studies raise awareness to create realistic expectations, decrease disruption of change, ensure transparency of policy, business, and technology design. Transparency for the EC begins with changing existing business and market structures to disentangle the complexity of the current energy bills, moving towards providing real choice and empowerment for change through transparent CM models with simple pricing structures. The Orkney case stresses that ECs are not against innovation but wish for transparency from the beginning. By including the

EC in dialogue, and being transparent about possible technological disruptions or changes, acceptance will increase rather than decrease as trust is built. It is important for the EC to know that signing up for innovations they are not worse off or left alone if something does not work, but transparency and support is given. Improving transparency also means that bureaucracy decreases, communication of investment strategies and DSO network improvement plans increases, and overall clear energy transition strategies are being provided.

- Surveys and interviews reveal the need to <u>increase energy literacy regarding energy BMs</u>. The survey was designed and distributed to reach the more 'active' community and investors but has not been exclusive. For instance, the community survey sought a variety of perspectives from the local authority to volunteer or social group representatives to residents with little to no expert knowledge Interestingly, EC and investor survey results in both case studies present a similar perceived energy literacy among participants with slightly more confidence in knowledge regarding renewable energy technologies and the island energy system than regarding energy BMs. It is not surprising that people know less about business concepts as these are still emerging, while technologies have matured and knowledge has increased over the years. This is why this research is being carried out. However, it is surprising that survey results of both case studies are so similar even though the interviews stressed very high energy literacy in Orkney and very low energy literacy in the Canaries. In fact, the case studies demonstrate that discussing technologies, attractiveness, and roles and responsibilities was tangible for interviewees, while the CMA enables the creation of a BM out of this information. Nonetheless, findings imply that ECs and investors need more information on energy BMs and people's knowledge should not be underestimated. This fact highlights again the fine line between education and providing information.
- In line with all the above aspects, <u>fairness has to be an underlying design concept</u> and significant element for aligning the notion of attractiveness. The cases exemplify regional inequalities, although distinct and to different extents, and the immense feeling of injustice of the current role of the 'energy consumers' and what is put on them or expected of them in the energy transition. Vulnerable households affected by high prices are already reducing their energy consumption at the expense of their comfort. Roles, responsibilities and benefits need to reflect fairness. The energy crisis affected all and drives the desire for solutions that provide cheaper energy bills. Societal challenges increase, costs increase, and disparity between energy rich and energy poor will increase if solutions do not take a fairness perspective. This means providing CM solutions that represent the cheap RES production, share benefits openly and fairly between EC members and investors, allow for inclusive participation, and provide local benefits first.

Democratisation emphasises the need to provide legal structures and provide financial solutions to allow vulnerable households to participate. To facilitate these structures and solutions the case studies stress the role of local governments. Fairness will support win-win solutions and acceptance e.g. of visual impact or behavioural change.

In conclusion, this section highlights the needed mindset changes among all actors, not only ECs and investors, away from self-interest to aligned attractiveness. The notion of attractiveness serves to sell solutions, which solve challenges and create shared value bundles, instead of technology configurations. This section provided an understanding of existing, emerging, and new roles and relationships of and between communities and investors in the energy value chain. Finally, the findings of this research suggest that a focus on attractiveness supports tailoring value dimensions for attractive CM BMs. Supporting this, Table 8 captures key elements and suggestions for aligning and negotiating the notion of attractiveness.

Table 8. Key elements and suggestions for aligning and negotiating the notion of attractiveness.

<table>
<tr><th rowspan="2">Notion of attractiveness</th><th rowspan="2">CMA suggestions</th><th colspan="5">Key aspects for aligning and negotiating</th></tr>
<tr><th colspan="3">Energy community perspective</th><th colspan="2">Investor perspective</th></tr>
<tr><td rowspan="2">Attractiveness of CM benefits</td><td>Aligning perceptions of attractiveness of benefits</td><td colspan="5">- Consider local culture, perceptions, and priorities
- Address (local) challenges and decrease risks
- Understand different meanings
- Understand hierarchy of attractiveness of CM benefits
- Recognise priority changes over time</td></tr>
<tr><td>Tailoring place-based value propositions and shared value bundles</td><td colspan="5">Economic (profit, revenue, savings)
Social (community benefit)
Environmental (tackling climate change)
Technological (risk-free innovation)</td></tr>
<tr><td rowspan="4">Roles and responsibilities</td><td rowspan="2">Aligning variety of roles and responsibilities</td><td colspan="5">- Establish ecosystem of like-minded actors
- Consider local entanglements of benefits and roles and responsibilities.
- Recognise variety of mindsets, priorities, and readiness levels
- Build upon existing roles and expertise</td></tr>
<tr><td colspan="3">- Recognise variety of individuals with diverse needs, abilities, and interests
- Enable adoption and evolving over time</td><td colspan="2">- Encourage proactive take-over of roles</td></tr>
<tr><td rowspan="2">Tailoring place-based roles and responsibilities for value generation</td><td colspan="3">Prosumers and active users (adopt conscious energy saving behaviour based on rules)</td><td colspan="2">Forward-thinking investors (have strategic, sustainable mindset but need more certainty)</td></tr>
<tr><td>Initiators (need support)</td><td>Investors (require enabling and hybrid investment options)</td><td>Managers & members (depend on governance structure)</td><td>Innovators (focus on business and conceptual innovation through collaborations)</td><td>Educators & supporters (foster dialogue, and emphasis on supporting role)</td></tr>
<tr><td>Proposition framework</td><td>Enable alignment and democratisation</td><td colspan="5">- Build trust among actors and in system
- Improve transparency and decrease complexity
- Increase energy literacy on energy business models
- Ensure “fairness” as underlying design concept</td></tr>
</table>

6.3 Propositions for and from place-based tailored CM solutions for engagement with time

It remains that there is no one-size-fits-all for CMs. Building upon the learnings of the previous sections, using the CMA as a tool for creating attractive CM business model solutions for engagement of EC and investors require a ‘pathway’ perspective of deployment, change, and adoption (Figure 7). *Different contexts and cultures* require place-based, tailored CM solutions that translate into *first attractive BMs and strategies* for engagement and positive decision-making. *Regulatory changes* will allow for *evolvement of BMs and application of change* for increased attractiveness and full adoption and engagement by EC and investors to *reach overall transition targets* and CM scales. The section concludes with learnings on how CMA supports the development of attractive CM solutions, the engagement of ECs and investors, and the adoption of a place-based perspective.

The case studies demonstrate distinct but related *contextual and baseline conditions* for CM attractiveness influencing decarbonisation, decentralisation, digitalisation, and democratisation and consequent engagement. The case study findings underline the islands’ vulnerability given the immense economic, social, infrastructural, and climate change challenges, supporting the discussions of Del Gatto and Mastinu (2018) and Haase and Maier (2021). These challenges translate into key drivers for CM attractiveness such as tackling high energy prices and perceived injustice, increasing energy independence, limiting RES curtailment, and overcoming grid constraints. However, some grid limitations and regulatory environment remain barriers to CM implementation. Building upon some existing infrastructure and seeing challenges as opportunities drives innovative CM solutions. Overall, local drivers and barriers influence the design of CMs, driving place-based CM models and salient adoption pathways.

The case studies suggest that *local culture* influences CM designs and the engagement of the EC and the investors. According to Derkenbaeva et al. (2022a), the Spanish culture is in-between the “pyramid” and “machine” culture types. That means people are not happy to act with uncertain consequences and do not feel empowered; therefore, they need clear regulatory directions and reliable, transparent procedures based on expert knowledge. Hence, Derkenbaeva et al. (2022a) suggest top-down evidence-based guidance and mandatory regulations for these culture types. UK culture is situated in the “market” culture, where citizens take action despite uncertainty, feel a strong sense of inequality between themselves and people with power, and challenge those with power. Derkenbaeva et al. (2022a) add that in market-type cultures, citizens will take a more initiating role in the energy transition, and will be attracted by bottom-up BMs, where they have decision-making power and are supported financially and structurally by, for example, the government.

Given the contextual and cultural differences, the case studies present distinct CM solutions.

The Orkney Islands case demonstrates alignment of attractiveness through a *community-led, bottom-up* model. The Orkney Islands context demonstrates that although CMs and ECs are less legally defined, there has been immense progress and cooperative, community movements that would drive attractiveness of a CM. The Orkney model demonstrates the strong sense among the community to become initiators and investors to tackle injustice while wanting to allow inclusive participation and sharing of benefits. Therefore, the model envisions a stable technological platform *covering the islands' whole energy system* and providing the opportunity to *gradually build new solutions* (modularity) for the community. This model, however, still requires *hybrid investments with strong support* for developing the solution. Investments are needed to improve the capacity of the interconnected grid and support digitalisation. The investors support this model and mindset as they are aware of local context, challenges, and culture. EC and investor perceptions of attractiveness align by highlighting *economic and social benefits and decreasing risks* by tackling local challenges such as fuel poverty, that derive from high energy prices, and adopting to local culture. The model's success requires a *governance structure that ensures transparency of roles, decision-making, benefits sharing and inclusiveness*. Initial focus needs to be on energy resilience and local energy use. With time, the Orkney Islands case, as a representative case for grid-connected islands, shows how energy flexible solutions can improve local grid structure, but also that it could support the wider UK grid and create revenue through disconnecting and connecting once the complete island CM, with batteries, has been achieved.

The Canary Islands case emphasises the *virtual connection between different small-scale expert-led models*. The focus is on improving grid stability and increasing renewable energy production for self-sufficiency. Therefore, models for providing flexibility in the future are highly attractive in this context. The Canary Islands context presents a legal framework for ECs, not for microgrids, but ends up with slow uptake due to an overwhelming level of bureaucracy and an individualistic culture. The culture of people explains the scepticism of both EC and investors towards regulatory change, resistance to act without the change, and the need for clear energy behaviour rules. The model accommodates diverse mindsets and readiness levels as *expert companies will offer solution options* accordingly, e.g.

- For individualists with financial possibilities, fixed-price, individual or collective self-consumption PV installations.

- For interested people that cannot or do not want to make the investment, ESCO service-models where the company pays for the installation and the users pay a tariff based on their use.
- For people from outside the CM and communities of interest to invest or benefit, the company invests in large-scale capacity and, given the Spanish “EC regulation”, sell shares for infrastructure and its revenue or for renewable energy use.
- For communities of place with a willingness to initiate, models that focus on assisting community-led self-consumption projects by providing established technology and governance structure solutions and support during bureaucracy and communication processes.

The Canary EC and investors emphasise the aligning of attractiveness in *economic and environmental benefits and the decrease in economic risk* due to curtailment or energy price fluctuations that increase energy bills. The model allows for *individuals' and businesses' private investments* that help move towards an improved and high-RES islandic grid. The model’s success requires a *consistent and transparent subsidy model and clear communication from the regional and national government*. With time and success, as the CM solutions scale and merge, people will follow and investors will benefit from increased revenues and new market-proofed BMs.

The proposed models can be translated to a BM perspective, to create attractive CM solutions that drive positive decision-making for participation and investment, but also to provide strategic guidance on how to achieve implementation and adoption. Proactive investor roles merge as they innovate and support to create place-based tailored BMs and adopt long-term perspectives for creating virtual connections of diverse small-scale and CM solutions. By first targeting the already more active part of the community, supports buy-in of more people as they will be able to compare alternatives from the set of options and the proofed attractive solutions. All solutions provide *value propositions* of aligned attractiveness, are transparent, tackle local challenges, and provide lower energy prices than traditional solutions. Still, as the case studies show, final shared-value bundles will be place-based and tailored to the individual or group. Then, whether investors provide solutions or help the community develop them, there is a strong need for collaboration for *value creation and delivery*. Collaboration will be needed between public and private sector and with the EC, to ensure maximisation and inclusiveness of benefits and decrease of risks and uncertainties. Moreover, collaboration with and of local DSOs will be necessary as CM solutions build upon existing infrastructure and dependent on the public grid. The tailored solutions accommodate for the multitude of EC users, consumers, and prosumers and their different energy consumption, production, and flexibility levels. At this stage, putting them all together first matches local energy for resilience and efficiency and then sells the surplus to the wider energy grid. CM control with automation and set rules will ensure simplicity for the EC and security for investors. People will still be able to make minor decisions at the control level to ensure fairness and comfort. As the case studies suggest simple solutions with tools such as apps, where participation creates a “feel good feeling” and make energy consumption and energy bills understandable and transparent, could increase attractiveness and participation. By providing incentives and benefits, and with increasing trust, EC individuals will change their behaviour ever so slightly and increasingly to improve the process of matching local energy demand and production. *Value is captured* depending on individuals’, communities’, or businesses’ investments or shares through revenue and energy cost savings, overall environmental benefits, and promotable economic success.

For the full attractiveness of CMs to unfold, *regulations must change,* or new regulations need to arise. National regulations should not only present transition targets but also provide clear strategies on how to achieve them, for instance, through CMs. Thus, regulations have to provide increasing certainty and clarity for ECs and investors. It is crucial to understand that CM BMs, including energy service BM and roles and responsibilities of EC and investors, are not yet mature enough to fit within regulatory boundaries but equally these boundaries should not be restrictive. The case studies suggest that while there is lack of regulatory certainty, it is necessary to find attractive workarounds instead. New regulations will then allow, for example, the introduction of inclusive governance structures, new revenue streams or subsidies, and the combining of flexibility, transparency, and certainty. In addition, as Sachs et al. (2019) have already highlighted, regulations across countries need to align regarding, for instance, local energy and flexibility market structures, so that investors can translate their business case to other contexts.

Evolvement and adoption of change follows with increasing regulatory certainty, trust, acceptance, and understanding. Thus, the wider community and hesitant investors will follow as they see the concepts working and benefits unfolding. Hence, the case studies stress the need to continuously communicate a) benefits for the individuals, community, and island (such as for image or environmental benefits) and b) success stories, while increasing c) energy literacy, framing communications in an understandable, relatable way which will support both uptake of roles and acceptance. The BMs evolve accordingly as v*alue propositions* evolve – if needed – to changing priorities and the changing environment. *Value creation and delivery* processes benefit from regulatory changes and experience. Increased uptake results in aggregated capacity of diverse consumer and prosumer energy profiles which will support CM efficiency and enable new revenue streams. With increasing scale, the CM’s complexity will also increase and require a CM aggregator or manager who schedules and adopts local energy and flexibility just like the Tetris game. It will be important to set and plan the demand and production profiles together to have as few gaps as possible. Unlike the Tetris game, active energy behaviour and demand response will help to adjust the ‘blocks’. Adding to the already adopted energy BMs and improved local efficiency, future CMs will manage, sell, and provide flexibility services. The case study findings underline the importance of household and community energy storage such as batteries to absorb flexibility both ways which can also be integrated with time as prices decline. Through the revenue increase of value stacking of energy BMs, the decrease in costs from economies of scale, or favourable subsidies, *value is captured*. Increased capacity, efficiency, and services will not only increase investor revenues but also support their market-share. Communities further capture value through decreasing inequalities and the overall environmental benefits.

The CMA *supports* the development of attractive CM solutions that drive positive decision-making. The CMA presents a notion to first identify the local baseline and island issues, with drivers and barriers, then identify motivations and priorities, and finally develop BM innovations that evolve along the local energy transition pathways, mindsets, and regulatory changes. The CMA suggests that risk-averse investors invest in CM concepts and take over more proactive roles, and traditional energy customers take an active role in an EC with time and increasing attractiveness. Adopting the CMA perspective suggests place-based, tailored propositions for attractiveness that engages ECs and investors, helping to reach a complete vision of the solutions and contributing to the EU’s 4 D strategy or the full decarbonisation of islands.

The place-based, tailored CM solutions propose that *investors* who are forward-thinking realise that money is not in technology alone but in flexible provision of services, as times of uncertainty and societal challenges continue and people’s needs change. ‘Flexibility’ becomes three-fold as investors need to flexibly adapt their model to e.g. regulatory, environmental, and societal changes; provide flexible CM service- or support-models to EC and individuals; and trade the EC’s energy flexibility for revenue and energy efficiency. The CMA helps investors to gain confidence and develop attractive business ideas – different options that can be scaled, combined, and merged with time. A key opportunity for investors remains the ability to become forerunners in trading community energy flexibility or developing whole system service and support solutions. The capacity of most CM models will not be big enough to trade under the current energy market regulations which, however, should not stop the initiative as capacities will add up and be aggregated with time. Consequently, findings of this research suggest that investors should see the low-hanging fruits and by using a CM attractiveness perspective overcome their perceptions of risk.

The case studies showcased that with place-based, tailored CM solutions, *communities* are in principle willing to engage. However, as OK_Inv_1 has already suggested, “we have to be realistic” regarding the ECs roles, responsibilities, and their uptake. The pathway perspective highlighted the importance of starting and targeting already active communities and allow participation with time. There are still too many barriers to the participation and uptake of people's more active role in an EC, whether these be of a technological, infrastructural, financial, regulatory, or social nature. It is important to decrease complexity and address attractiveness for a) the decision-making in participation in the first place and b) the long-term participation and behavioural change. From the case studies, it becomes clear that it is not the consumers non-uptake and non-participation but not having a simple, inclusive, and transparent alternative that slows down the energy transition. As the case studies stress, the increasing lack of trust of ECs towards energy companies and government over the last decades needs immense counteraction work through increased transparency and shared dialogue before slow uptake can be criticised. Using the CMA perspective and establishing place-based tailored solutions along with flexible, supportive regulations and incentives will encourage EC engagement and participation.

Ultimately, the *place-based perspective* is critical for investors to establish an attractive business case in line with the EC's perceived notion of attractiveness. This research proposes tailoring models for attractiveness as we must remind ourselves when wearing our research, policymaker, or business developer 'hats' that we are not only talking about users, consumers, or customers that need to take up their roles, but that *we* are users, consumers, and customers ourselves, and reflect on the attractiveness of decisions and CM BM designs with this 'thinking hat' accordingly. The same is true for investors; recognising the variety of investors and investments is important to understand their needs and the investment boundaries for where third-party investment begins and community investment ends. These reflections will be necessary to fully understand power dynamics within CM governance and EC independence, and consequently provide fairness, trust, and transparency to simulate uptake of roles for the energy transition (Avelino and Wittmayer 2016). The CMA supports taking this perspective in order to foster collaboration and to align decisions and visions.

In conclusion, implications for the engagement of ECs and investors could be made from learning of the proposed place-based models and their evolvement along the energy transition pathways. The EC and investor perspectives suggest that there is general willingness to participate if place-based, tailored models become feasible and economically viable through regulatory changes. For a just energy transition, there is pressure for investors to become proactive and provide a number of new, transparent models to the EC. To not cause a wider divide between energy rich and energy poor, EC participation has to be incentivised and encouraged over time, which allows the alignment of models with cultural mindsets and increasing energy literacy.

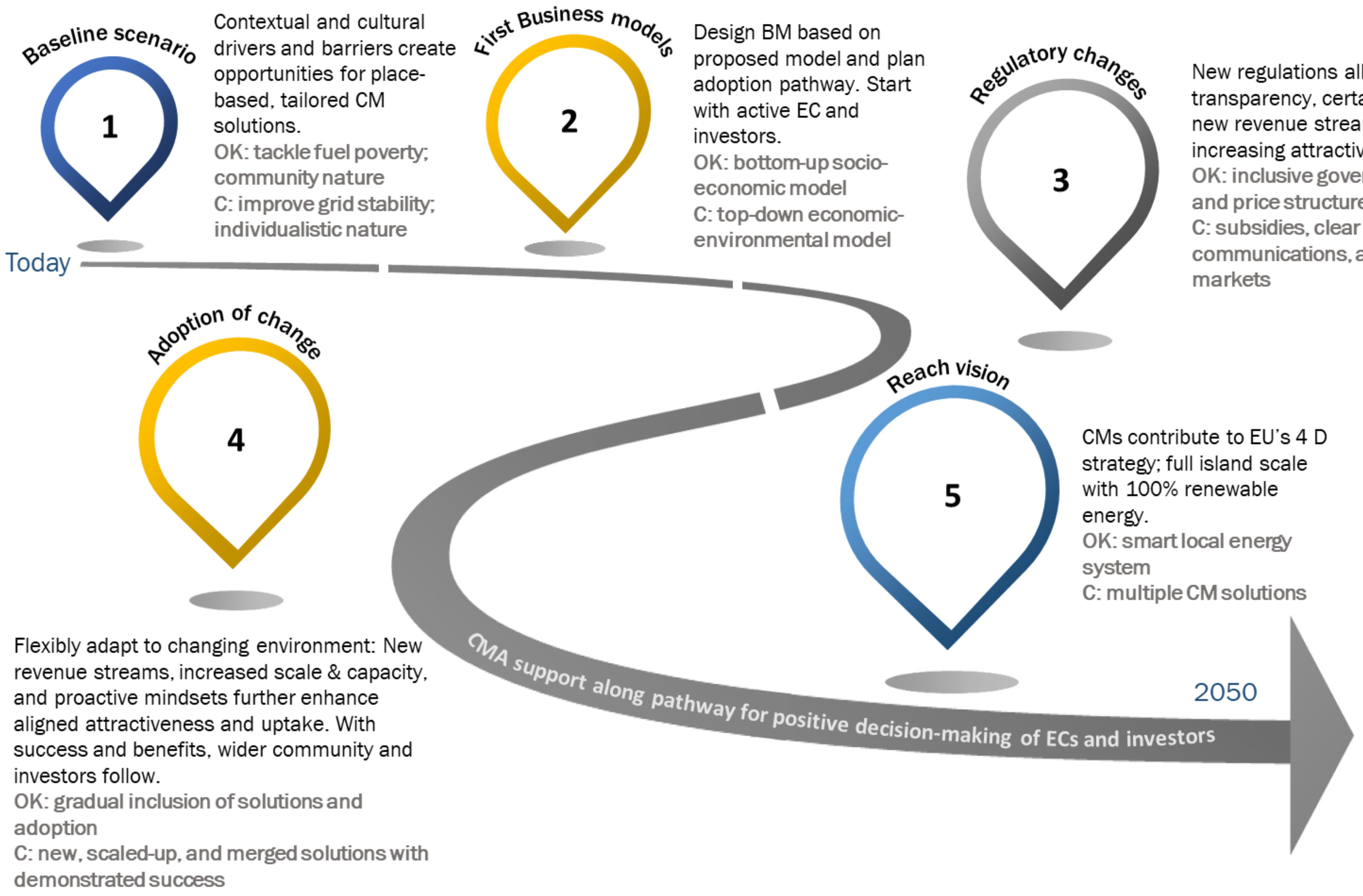


Figure 7. Pathways for place-based, tailored CM solutions, attractiveness, and consequent EC and investor engagement based on CMA learnings (OK- Orkney Islands; C- Canary Islands).

6.4 Policy recommendations

This research provides empirical evidence leading to policy recommendations for change. The case study approach revealed that regulations (or lack of them) at international, national, and local level remain the main barrier to CM attractiveness and EC and investor engagement. Findings support policy discussions of e.g. Behrendt (2023); Hoicka et al. (2021); Marczinkowski et al. (2022); Mauger (2022). This research stresses the role of international, national, regional, and local governments as catalysts for the energy transition. These government levels are encouraged to align and collaborate to drive transitions and not use lack of investments as an excuse for not achieving targets. They need to change their mindsets just as importantly as ECs and investors, and accelerate their policy-making processes and decisions.

To foster EC and investor engagement, policies and regulatory frameworks should decrease complexity of concepts, while still allowing place-based solutions and shared-value bundles for ECs' and investors' increased attractiveness. As a result of this research and the perspective presented, *policy recommendations* follow:

Initiating, urgent short-term actions

- An underlying learning of this research for policy makers should be the need for balancing regulatory flexibility and certainty. On the one hand, regulations need to be more flexible, agile, and proactive to align with the quick changes in the industry and in the needs of people and contexts (e.g. also Soutar 2021). It is an obvious struggle, as on the other hand, regulations must present certainty to both ECs and investors to create trust. Still, the island context shows that this could be achieved through clearer energy transition strategies from local governments and increased local governments power to act for achieving the targets.
- Clarifying roles and responsibilities will be useful but should not be restrictive. Therefore, in line with Lowitzsch et al. (2020), this research suggests that it either requires regulatory sandboxes from which regulations can build with time, or policy structures that encourage innovation – technological, but even more conceptual, BM innovation – especially regarding energy flexibility and salient value creation.
- The case studies also demonstrate that policy needs to balance incentives and lack of incentives. The case study narratives repeat a notion of being unsatisfied with government actions and having economic benefits as main drivers. The Canary Islands case highlights perceptions that the subsidised energy price slows down PV uptake, while subsidies for PV installations are generally attractive. Overall, for an inclusive energy transition, it cannot be recommended to create more costs for citizens but rather incentivise uptake and installations, energy conscious behaviour, or other active roles and responsibilities.

- In addition, legal structures should be in place to allow vulnerable households to participate, or at least structures that ease and attract their inclusion for investors through, for example, incentivising social bonuses and tariffs or direct shares. Structures could also support, as the case studies suggest, local authority participation in CM developments to some extent to encourage trust, either as consumer, prosumer, supporter, or investor. That said, the case studies reveal the attractiveness of social and environmental benefits for the EC and the investors as well. Incentives for monetarisation of social and environmental benefits would further support attractiveness.
- Furthermore, EC initiatives and investments require special support schemes which include e.g. dedicated funding streams and subsidies. Additionally, national governments need to provide enabling regulatory frameworks for hybrid investment structures or support these investments and EC-investor collaborations by taking the project risk. Actions along these lines will be crucial to give citizens the tools for 'energy democratisation' and to take up and accept the roles that are expected of them.

Medium-term actions

- The EU provides guiding regulatory frameworks for e.g. 'energy communities'. However, this research showcases that regulations need to go beyond these structures and, again, balance i) simplicity and flexibility so that regulations align with place-based, tailored CM solutions based on, for instance, island needs (e.g. also Hoicka et al. 2021); and ii) alignment and comparability over international borders. The case studies showcase the influence of their national regulations on the final CM solution. The resulting different solutions and regulatory complexities hinder cross-national learnings, BM translations, investments, and cooperation between investors. Therefore, alignment of national regulatory frameworks and energy market structures would accelerate CM solution building and development.
- To fulfil decarbonisation goals and foster attractiveness, regulatory changes are needed to stop curtailment of RES. RES curtailment not only means revenue loss for investors, but also sends the wrong message to citizens, as they wish to see the abundance of RES reflected in their energy bills. DSOs are still incentivised for profitability and not for long-term investments (Enlit 2023); therefore, as both cases highlight, they do not engage in grid-improvements. As the case studies highlight, legislation needs to change to, for example, fines for DSOs for RES curtailment, to incentivise them to invest in modern grid infrastructure or at least give permission for battery solutions, increase transparency for grid-connection points and support value from energy flexibility. Overall, it needs more interaction and collaboration with and from the DSO and across the energy value chain.

Structural, long-term actions

- The island cases are a great example of local grid congestion due to increasing implementation of RES. Although least attractive, technological benefits and supporting the island grid through energy flexibility has been pointed out as an important issue which will increase in importance over the next years. CMs build upon prospective future participation in flexibility services and resulting revenue streams. Lack of legal frameworks for local flexibility markets hinder CM implementation and revenue streams, and consequently attractiveness per se. Therefore, regulations must i) facilitate and <u>decrease uncertainty of these investments and allow innovations</u> while the regulatory framework is not mature; and ii) eagerly establish a <u>flexible framework that enables flexibility services, encourages investment, and rewards ECs flexibility</u> capital and participation.
- At the same time, islands contexts stress the need for <u>local island wholesale markets and local energy use to represent transparent, local energy prices</u>. This research shows that community engagement is driven by lower, transparent energy prices. Currently, the complexity of the many energy tariffs and the untransparent options of energy marketers confuse citizens. Moreover, the local energy prices should clearly represent the abundance of renewable energy production. This could be achieved, for example, if the prices were not dictated by either fossil fuels or renewables but separated. Increased transparency and prices would encourage investors to invest in RES and consumers to buy renewable energy. These changes will require more in-depth structural actions with conversation and alignment between national and international governments and the tackling of energy lobbies.

6.5 Contribution of notion of attractiveness

The section presents the notion of attractiveness as the key concept that contributes to knowledge due to its simple but though provoking nature and its centrality in and for the 'Community Microgrid Attractiveness' framework (CMA). First, the section presents the conceptual framework, the CMA (research question 1). Additionally, the value of the notion of attractiveness is highlighted for negotiation and alignment. Second, it is emphasised how the local perspectives (context and culture) supports attractiveness (research question 2). Third, a paragraph explains the contribution of the notion of attractiveness for BM designs, marketing, and innovation (research question 3). Finally, the section concludes with the overall contribution of the notion of attractiveness as a concept and what it means for researchers.

This research contributes to knowledge through the conceptual framework and concept of the notion of attractiveness. The conceptual framework was first built based on literature and then clarified through the case study analysis. The research's conceptualisation draws upon a wide set of studies, and therefore, contributes to diverse technology, business, innovation, social, political, and regional perspectives and academic discourses (Köhler et al. 2019). In line with Creamer et al. (2018), the final CMA disentangles the complexity of CMs into several elements and demonstrates the interrelationships through the notion of attractiveness to answer research question 1. That means, the notion of attractiveness is the central element of the framework. The 'attractiveness' perspective channelled research ideas and values at all stages, for example, influencing chosen literature and thematic analysis. At the same time, the notion of attractiveness emphasises the connections and the big picture of the CMA that requires to see all elements together. This conceptual framework essentially contributes to Creamer et al. (2018) by presenting intersections and understandings of participation levels and energy community concepts and to Köhler et al. (2019) by addressing the diverse dimensions of transition studies.

The CMA disentangles the CM configuration into *microgrid technology for decarbonisation, microgrid control for decentralisation and digitalisation, and microgrids for value generation for democratisation*. The attractiveness perspective highlights broad configuration possibilities and options based on local contexts and purposes, leaving space for a negotiating a design. For that reason, the CMA focuses on the *EC and investor notion of attractiveness* defined by perception of environmental, social, technological, and economic benefits and roles and responsibilities (e.g. active consumers, prosumers, investors, members, initiators, or managers for EC individuals; or forward-thinkers, business strategists, innovators, supporters and educators for investors). Findings show that different priorities and readiness to take up roles shape CM propositions. The CMA captures the CMs' complex values (Hall and Roelich 2016) and promotes the creation of tailored, place-based (context-dependent), and inclusive solutions that maximise benefits and decrease risks. The notion of attractiveness suggests to first identify the local baseline and island issues, with drivers and barriers, then identify motivations and priorities, and take advantage of local path dependencies, evolve and change local mindsets and designs of CM BMs with time.

Negotiation and alignment of community and investor priorities and perceptions are crucial to assure the engagement of local EC and investors. This alignment process is underpinned by the notion of attractiveness. The notion of attractiveness supports a 'simple lens' to understand and match outcome expectations, and as such, helps to encourage communities to participate and investors to invest, helping overcome financial gaps and overcoming perceptions of risks. This research thereby directly contributes to calls for research for deeper insights on drivers and motivators for engagement of communities and investors (Hackbarth and Löbbe 2020; Hafner et al. 2020; Löbbe et al. 2020; Nykvist and Maltais 2022). A focal point of attractiveness is inclusiveness, fairness, trust, and transparency throughout all dimensions. Thus, 'attractiveness' adds to fairness, flexibility capital, and energy justice discussions (Powells and Fell 2019; Heiskanen et al. 2021). Similarly, the notion of attractiveness highlighted that improved regulatory certainty, clarity, and alignment are needed to enable CM attractiveness and alignment of perceptions, contributing to discussions of e.g. Hoicka et al. (2021).

The investigation to answer research question 2, the influence of different local contexts on attractiveness and the final CM solutions, contributes to knowledge in several ways. First and foremost, this research found that the process and outcome are underpinned by the local contextual conditions and culture, here, the *island context*. This research empirically demonstrates that tackling local challenges, addressing needs, and making use of local opportunities aligns and maximises the notion of attractiveness. Thus, this research's attractiveness lens aligns with the proposed challenge-oriented model of Isaksen et al. (2022) for regional innovation systems. At the same time, this research supports findings of Arvanitopoulos et al. (2022) and Derkenbaeva et al. (2022a), highlighting the local perspective and the need for place-based CM solutions due to different baseline conditions, contexts, cultures, and local expertise. Finally, the findings present, on the one hand, how communities can be engaged at different locations and, on the other hand, how attractive the testbed learnings are for investors, directly contributing to open questions of Piterou and Coles (2021).

Answering research question 3, the research demonstrates how insights from the CMA perspective can be translated to tailor BMs for shared value and purpose (Schaltegger, Hörisch and Freeman 2019; Hiteva and Foxon 2021). This research thereby contributes to BM innovation discussions, helping to prepare businesses for full sets of services while accelerating value-based selling and addressing user concerns (e.g. Baldassarre et al. 2017). On the one hand, this research builds on Williams et al. (2015) with qualitative evidence of investors decision-making and preferences to drive investments. On the other hand, the EC perspective and findings give existing energy companies that are innovating their BMs for new products and services (to not lose their market share) directions for change and marketing (e.g. Bryant et al. 2018; Morgado 2021).

Overall, the notion of attractiveness as a concept is an original contribution to knowledge as it suggests taking the perspective of first asking then designing. It is this perspective which underlines that attractiveness is not the same for everyone and perceptions can evolve over time. Thus, it must be repeated that the CMA is a tool that can be used by researchers of diverse fields or in practice by diverse stakeholders; it is not restricted to the use by ECs and investors. The notion of attractiveness is an ideal concept to bring the perspectives of these two stakeholder groups together. These insights are of immense relevance to keep in mind or further investigate by any energy transition researcher.

In conclusion, the CMA with the notion of attractiveness at its heart is interdisciplinary-based theory that thrives to disentangle, explain, and explore needs and expectations for designing attractive CM solutions that intrinsically engage and attract ECs and investors to participate and invest in CMs or CM-like concepts. This research therefore contributes to knowledge by providing a framework that not only guided this research but also helps future researchers situate themselves and navigate in the presented complex interactions.

7 Conclusion

The transformation of global and local energy systems is driven by the European Union's decarbonisation, decentralisation, digitalisation, and democratisation (4 Ds) strategy for a just energy transition. Community microgrids (CMs) underline the notion of a 4 D local energy transition by integrating diverse technologies and applying innovative energy business models (BMs). While the CM concept attracts increasing interest due to its synergetic abilities, the resulting complexities and lack of standardisation limit the engagement of energy communities (ECs) and investors. Hence, the aim of this research was to disentangle the complexity of CMs through both the communities' and investors' perceived 'notion of attractiveness' in order to develop solutions that encourage their participation and investment in CMs.

This research successfully answered its research questions (RQs) through a 3-stage research design, following a case study approach. This research identified islands as a valuable context in which to apply the CMA framework and to investigate contextual influences on 'community microgrid attractiveness' due to their natural boundaries. By investigating the Orkney Islands (UK) and the Canary Islands (Spain), this research was able to learn from distinct but related geographical and social contexts. This research achieved its objective by developing and detailing the 'Community Microgrid Attractiveness' Framework (CMA) which supports alignment of perceptions for creating an attractive CM solution for ECs and investors. Figure 8 gives an overview of the CMA, presenting the elements that define an attractive CM and their interrelation and summarising the key findings of this research`s questions.

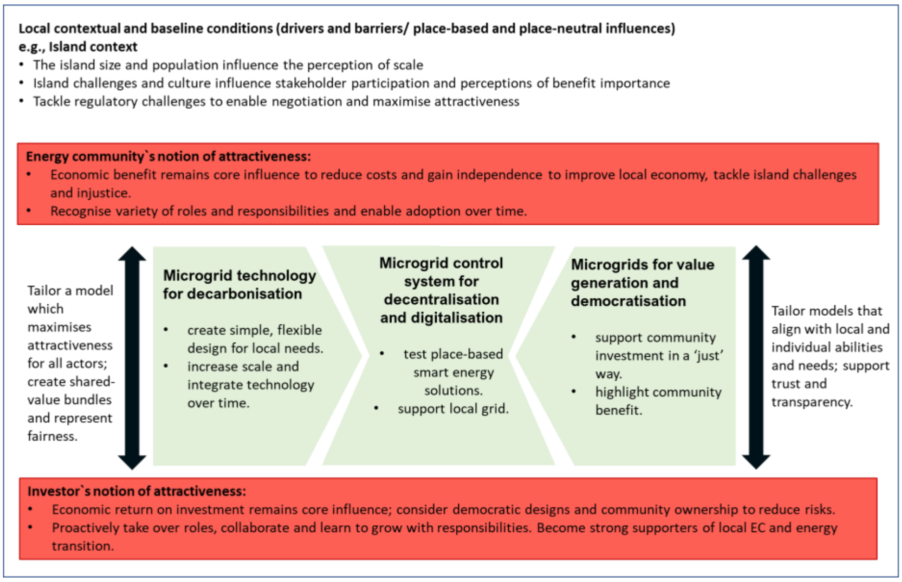


Figure 8. Key findings for the CMA *and alignment of EC and investor perspectives.*

The CMA shows the elements that compose an attractive CM for ECs and investors (RQ1); highlighting main contextual influences on attractiveness and CM design (RQ2); and detailing aspects for aligning and negotiating attractive, place-based, tailored CM solutions and overall BMs that engage both EC and investors (RQ3). In addition, this research empirically demonstrates that tackling local challenges, addressing needs, and making use of local opportunities aligns and maximises the notion of attractiveness. Thereby, the CMA disentangles the complexity of CMs into several elements and demonstrates the interrelationships through the notion of attractiveness to answer research question 1.

This research fully answers research question 2 by investigating two different island contexts based on a case study approach to identify place-neutral and place-based differences and similarities that influence CM attractiveness. Additionally, the research presents drivers and barriers which all influence CM attractiveness and local energy system transformation. The place-based lens of the results highlights the synergy of social, political, and local notions for underpinning technology and business innovations of CMs. This research shows that local baseline conditions – context and culture – are an omnipresent influence on CM attractiveness and salient designs, leading to e.g. more community- or expert-led solutions.

In relation to research question 3, the CMA application to the cases reveals that place-based, tailored solutions that recognise and align community and investor preferences from an ‘attractiveness’ point of view will encourage EC and investor engagement. Thus, the CMA supports the design of attractive CM BMs that would drive positive decision-making. For fully positive decision-making by ECs and investors, this research stresses the need for a) inclusiveness, fairness, trust, and transparency throughout all dimensions; b) improved regulatory certainty, clarity, and alignment to enable CM attractiveness; and c) models that allow engagement of ECs and with investors early on and over time.

The discussion of attractive island community microgrids – learnings from different island contexts present this research’s insights and contribution to practice, policy, and theory. The research demonstrates that the proposed CMA framework is generic enough to be adopted and replicated in various contexts and specific enough to serve as a tool to help and give food for thought for conversations between local communities, policy makers, and potential investors or for research directions. This research and the proposed framework support the shared dialogue and tailoring of place-based and -led technological and BM innovation for local CMs. The CMA is a tool to accelerate stakeholder engagement, tackle local challenges and regional inequalities, and make use of local opportunities while helping to shape local solutions and policies. Based on these findings, this research proposed recommendations for policy change. Finally, this research contributes to knowledge by pulling together strings of sets of research fields and perspectives together through the notion of attractiveness into an original conceptual framework.

Overall, the nature of this research and time constraints set limitations to this research. According to Yin (2018) it is difficult to draw generalisations from case study research. This could be overcome with further research. This research focused on places with strong contextual and cultural differences (e.g. community-driven against individualistic EC nature), shedding light on aspects that cannot be seen if one compares similar islands and contexts. The application of the CMA to more ‘in-between’ island or urban cases could help to showcase elements that are more difficult to investigate or negotiate in those mixed communities.

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9 Appendices

Appendix A – Data collection material

A1. Survey questions community perspective

INTRODUCTION

This section will allow you to share some details about you/ your organisation. This will allow me to understand your possible role in an energy community of a community microgrid in the Orkney Islands.

1. Describe your participation and engagement in renewable energy initiatives/projects. Please select the one that applies most.

- I am interested but am not currently participating.
- I participate in a renewable energy project but do not make decisions/have a leadership position.
- I participate in a renewable energy project and am engaged in the decision-making process.
- I participate in and lead a renewable energy project.
- I am not currently participating and I am not planning to participate.

2. How would you evaluate your own **energy literacy from a community perspective** regarding...? Please select from 'no knowledge (0)' to 'very good knowledge (5)'

Please don't select more than 1 answer(s) per row.

	Not sure	No knowledge (0)	Very little knowledge (1)	Little knowledge (2)	Knowledge (3)	Good knowledge (4)	Very good knowledge (5)
...technical aspects (e.g., renewable energy technologies and their role in the island energy system)	☐	☐	☐	☐	☐	☐	☐
...business aspects (e.g., community energy business models that can support the energy transition such as energy flexibility services)	☐	☐	☐	☐	☐	☐	☐
...the island energy system (e.g., opportunities and challenges)	☐	☐	☐	☐	☐	☐	☐

PERCEIVED ATTRACTIVENESS VALUES OF COMMUNITY MICROGRIDS
Community microgrids provide direct and indirect benefits that can be of environmental, social, technological, and economic nature. These 'microgrid benefits' depend on the technological and business model configuration of the microgrids. A combination of these benefits forms the overall perceived attractiveness value of community microgrids.
This survey aims at providing an understanding of the **perceived attractiveness and salient importance of these microgrid benefits** from the point of view of the **people (the energy community)** that would live, participate, engage, and interact in a community microgrid in the **Orkney Islands**.

ENVIRONMENTAL BENEFITS
Community microgrids provide environmental benefits. On the one hand, due to the integration of local renewable energy technologies. On the other hand, through eventually helping the main power grid with balancing issues wherefore the main power grid can integrate more renewables.

3. To what extent are the following **environmental 'microgrid benefits' unattractive or attractive** drivers for participation and engagement for you/ individuals of the energy community?

Please don't select more than 1 answer(s) per row.

	Not sure (0)	Very unattractive (1)	Unattractive (2)	Neither attractive nor unattractive (3)	Attractive (4)	Very attractive (5)
Contribution to overall environmental benefits, clean air, and climate change mitigation for island	☐	☐	☐	☐	☐	☐
Supporting compliance with island decarbonisation goals	☐	☐	☐	☐	☐	☐
Reduction of islands' fossil fuel dependency	☐	☐	☐	☐	☐	☐
Reduction of my own fossil fuel dependency	☐	☐	☐	☐	☐	☐

3.a. Among the previously evaluated **environmental microgrid benefits**, which one is the **most important driver** to influence you/ individuals of the energy community towards a positive participation decision?

3.a.i. If you selected Other, please specify:

3.b. If you would like to include any evidence to support your responses, and/or would like to add any further direct and indirect **environmental benefits**, please include this in the box below.

SOCIAL BENEFITS
Community microgrids provide social benefits through effective configuration of technologies and business models. The concept further supports the formation of a local community, aiming to decrease energy vulnerability and increase energy democracy.

4. To what extent are the following **social 'microgrid benefits' unattractive or attractive** drivers for participation and engagement for you/ individuals of the energy community? Please don't select more than 1 answer(s) per row.

	Not sure (0)	Very unattractive (1)	Unattractive (2)	Neither attractive nor unattractive (3)	Attractive (4)	Very attractive (5)
Provision of power quality and reliability to energy community/island	☐	☐	☐	☐	☐	☐
Enabling an active role and democratic say in (local) energy system for me and other individuals of community	☐	☐	☐	☐	☐	☐
Facilitation of low energy costs for others as part of the energy community	☐	☐	☐	☐	☐	☐
Contribution to related island fuel poverty strategies through the inclusion of vulnerable households	☐	☐	☐	☐	☐	☐
Contribution to well- being and strengthening of community through capacity building, economic growth, jobs, awareness, and engagement	☐	☐	☐	☐	☐	☐
Forming part of an 'active' community	☐	☐	☐	☐	☐	☐

4.a. Among the previously evaluated **social microgrid benefits**, which one is the **most important driver** to influence you/ individuals of the energy community towards a positive participation decision?

4.a.i. If you selected Other, please specify:

4.b. If you would like to include any evidence to support your responses, and/or would like to add any further direct and indirect **social benefits**, please include this in the box below.

TECHNOLOGICAL BENEFITS

Community microgrids provide technological benefits as they serve as a technology integration platform, to produce, consume, store, distribute, and control energy locally. Often the focus is to integrate high shares of renewable energy and smart technologies into microgrids. Technology solutions can either be established or innovative in nature, however, always contribute to the microgrid's overall energy resilience, efficiency, and flexibility.

5. To what extent are the following **technological 'microgrid benefits' unattractive or attractive** drivers for participation and engagement for you/ individuals of the energy community?

Please don't select more than 1 answer(s) per row.

	Not sure (0)	Very unattractive (1)	Unattractive (2)	Neither attractive nor unattractive (3)	Attractive (4)	Very attractive (5)
Provision of local power production, consumption, and control	☐	☐	☐	☐	☐	☐
Support decrease of power losses and renewable energy curtailments	☐	☐	☐	☐	☐	☐
Support the promotion, demonstration, and testing of technologies while maintaining/increasing quality of life	☐	☐	☐	☐	☐	☐
Pioneer participation in and access to integration of low carbon, renewable energies, and energy efficiency at low cost and risk	☐	☐	☐	☐	☐	☐
Use of smart technologies for home devices control	☐	☐	☐	☐	☐	☐
Ability to electrically connect and disconnect from the main power grid (for self-sufficiency and business models)	☐	☐	☐	☐	☐	☐

5.a. Among the previously evaluated **technological microgrid benefits**, which one is the **most important driver** to influence you/ individuals of the energy community towards a positive investment decision?

5.a.i. If you selected Other, please specify:

5.b. If you would like to include any evidence to support your responses, and/or would like to add any further direct and indirect **technological benefits**, please include this in the box below.

ECONOMIC BENEFITS

Community microgrids provide direct and indirect economic benefits to the different microgrid stakeholders and to the island through various value streams that depend on the configuration of technologies and business models.

6. To what extent are the following **economic 'microgrid benefits' unattractive or attractive** drivers for participation and engagement for you/ Individuals of the energy community?

Please don't select more than 1 answer(s) per row.

	Not sure (0)	Very unattractive (1)	Unattractive (2)	Neither attractive nor unattractive (3)	Attractive (4)	Very attractive (5)
Exploration of (local) energy markets	☐	☐	☐	☐	☐	☐
(Economic) independence from existing energy companies	☐	☐	☐	☐	☐	☐
Establishment of monetary savings from energy efficiency	☐	☐	☐	☐	☐	☐
Establishment of monetary savings and revenue from business models (prosumer, demand response, auxiliary services)	☐	☐	☐	☐	☐	☐
Establishment of monetary savings and revenue from local energy trading	☐	☐	☐	☐	☐	☐
Improvement of energy cost predictions	☐	☐	☐	☐	☐	☐
Contribution to local economic growth through capacity building and jobs	☐	☐	☐	☐	☐	☐

6.a. Among the previously evaluated **economic microgrid benefits**, which one is the **most important driver** to influence you/ individuals of the energy community towards a positive participation decision?

6.a.i. If you selected Other, please specify:

6.b. If you would like to include any evidence to support your responses, and/or would like to add any further direct and indirect **economic benefits**, please include this in the box below.

PRIORITY

7. How would you **rank the importance of environmental, social, technological and economic benefits** as drivers to influence you/ individuals of the energy community towards a positive participation decision? Please select from 1. (most important) to 4. (least important) Please don't select more than 1 answer(s) per row. Please select at least 4 answer(s). Please don't select more than 1 answer(s) in any single column.

	1.	2.	3.	4.
Environmental benefits	☐	☐	☐	☐
Social benefits	☐	☐	☐	☐
Technological benefits	☐	☐	☐	☐
Economic benefits	☐	☐	☐	☐

THANK YOU

Thank you very much for your participation. This survey has come to an end. Before you leave, I would like to know:

8. **Are you happy for me to get in touch with you** to follow-up on your response to this consultation? The reason for this would be to obtain more detail on your views and discuss possible attractive microgrid technologies and business models through an **interview**.

Yes/No

If yes, please provide:

9. Your name:

10. Email address:

11. (If applicable) Organisation & position:

12. If you have some more time, please provide some details on your position, role, and experience (e.g., regarding participation in renewable energy or community projects, representation of citizen groups, role in the local energy system and experience with different technologies, and your organisation and interests).

Key for selection options

3.a - Among the previously evaluated environmental microgrid benefits, which one is the most important driver to influence you/ individuals of the energy community towards a positive participation decision?
Contribution to overall environmental benefits, clean air, and climate change mitigation for island
Supporting compliance with island decarbonisation goals
Reduction of islands' fossil fuel dependency Reduction of my own fossil fuel dependency
Other

4.a - Among the previously evaluated social microgrid benefits, which one is the most important driver to influence you/ individuals of the energy community towards a positive participation decision?

Provision of power quality and reliability to energy community/island
Enabling an active role and democratic say in (local) energy system for me and other individuals of community
Facilitation of low energy costs for others as part of the energy community
Contribution to related island fuel poverty strategies through the inclusion of vulnerable households
Contribution to well-being and strengthening of community through capacity building, economic growth, jobs, awareness, and engagement
Forming part of an 'active' community
Other

5.a - Among the previously evaluated technological microgrid benefits, which one is the most important driver to influence you/ individuals of the energy community towards a positive investment decision?

Provision of local power production, consumption, and control Support decrease of power losses and renewable energy curtailments
Support the promotion, demonstration, and testing of technologies while maintaining/increasing quality of life
Pioneer participation in and access to integration of low carbon, renewable energies, and energy efficiency at low cost and risk
Use of smart technologies for home devices control
Ability to electrically connect and disconnect from the main power grid (for self-sufficiency and business models)
Other

6.a - Among the previously evaluated economic microgrid benefits, which one is the most important driver to influence you/ individuals of the energy community towards a positive participation decision?

Exploration of (local) energy markets
(Economic) independence from existing energy companies Establishment of monetary savings from energy efficiency
Establishment of monetary savings and revenue from business models (prosumer, demand response, auxiliary services)
Establishment of monetary savings and revenue from local energy trading Improvement of energy cost predictions
Contribution to local economic growth through capacity building and jobs
Other

A2. Survey questions investor perspective

INTRODUCTION
This section will allow you to share some details about you/ your organisation. This will allow me to understand your possible role as an investor in community microgrids in the Orkney Islands.

1. Please describe your **experience and engagement in investments into renewable energy initiatives/projects**. Please select the one that applies most.

- I am interested but am not currently investing.
- I invest in a renewable energy project but do not make decisions/have a leadership position.
- I invest in a renewable energy project and am engaged in the decision-making process.
- I invest in and lead investments in a renewable energy project.
- I am not currently investing and I am not planning to invest.

2. How would you evaluate your own **energy literacy from an investor perspective** regarding...?
Please select from 'no knowledge (0)' to 'very good knowledge (5)'

Please don't select more than 1 answer(s) per row.

	Not sure	No knowledge (0)	Very little knowledge (1)	Little knowledge (2)	Knowledge (3)	Good knowledge (4)	Very good knowledge (5)
...technical aspects (e.g., renewable energy technologies and their role in the island energy system)	☐	☐	☐	☐	☐	☐	☐
...business aspects (e.g., business models that can support the energy transition such as energy flexibility services)	☐	☐	☐	☐	☐	☐	☐
...the island energy system (e.g., opportunities and challenges)	☐	☐	☐	☐	☐	☐	☐

PERCEIVED ATTRACTIVENESS VALUES OF COMMUNITY MICROGRIDS

Community microgrids provide direct and indirect benefits that can be of environmental, social, technological, and economic nature. These ‘microgrid benefits’ depend on the technological and business model configuration of the microgrids. A combination of these benefits forms the overall perceived attractiveness value of community microgrids.

This survey aims at providing an understanding of **the perceived attractiveness and salient importance of these microgrid benefits** from the point of view of **investors**, that would eventually invest into community microgrids **in the Orkney Islands.**

ENVIRONMENTAL MICROGRID BENEFITS

Community microgrids provide environmental benefits. On the one hand, due to the integration of local renewable energy technologies. On the other hand, through eventually helping the main power grid with balancing issues wherefore the main power grid can integrate more renewables.

3. To what extent are the following **environmental ‘microgrid benefits’ unattractive or attractive** drivers for you/ investors to invest?

Please don't select more than 1 answer(s) per row.

	Not sure (0)	Very unattractive (1)	Unattractive (2)	Neither attractive nor unattractive (3)	Attractive (4)	Very attractive (5)
Contribution to overall environmental benefits, clean air, and climate change mitigation for island	☐	☐	☐	☐	☐	☐
Supporting compliance with island decarbonisation goals	☐	☐	☐	☐	☐	☐
Reduction of islands’ fossil fuel dependency	☐	☐	☐	☐	☐	☐
Impact on and contribution to environmental (ESG) responsibilities	☐	☐	☐	☐	☐	☐
Possible branding and green advertisement opportunities	☐	☐	☐	☐	☐	☐

3.a. Among the previously evaluated **environmental microgrid benefits**, which one is the **most important driver** to influence you/ investors towards a positive investment decision?

3.a.i. If you selected Other, please specify:

3.b. If you would like to include any evidence to support your responses, and/or would like to add any further direct and indirect **environmental benefits**, please include this in the box below.

SOCIAL MICROGRID BENEFITS
Community microgrids provide social benefits through effective configuration of technologies and business models. The concept further supports the formation of a local community, aiming to decrease energy vulnerability and increase energy democracy.

4. To what extent are the following **social 'microgrid benefits' unattractive or attractive** drivers for you/ investors to invest?

Please don't select more than 1 answer(s) per row.

	Not sure (0)	Very unattractive (1)	Unattractive (2)	Neither attractive nor unattractive (3)	Attractive (4)	Very attractive (5)
Provision of power quality and reliability to energy community/island	☐	☐	☐	☐	☐	☐
Enabling an active role and democratic say in (local) energy system for the energy community	☐	☐	☐	☐	☐	☐
Facilitation of low energy costs for the energy community	☐	☐	☐	☐	☐	☐
Contribution to related island fuel poverty strategies through inclusion of vulnerable households	☐	☐	☐	☐	☐	☐
Contribution to well-being and strengthening of community through capacity building, economic growth, jobs, awareness, and engagement	☐	☐	☐	☐	☐	☐
Impact on and contribution to social and governance (ESG) responsibilities of mine or my organisation	☐	☐	☐	☐	☐	☐

Possible branding and social advertisement opportunities for me or my organisation	☐	☐	☐	☐	☐	☐

4.a. Among the previously evaluated **social microgrid benefits**, which one is the **most important driver** to influence you/ investors towards a positive investment decision?

4.a.i. If you selected Other, please specify:

4.b. If you would like to include any evidence to support your responses, and/or would like to add any further direct and indirect **social benefits**, please include this in the box below.

TECHNOLOGICAL MICROGRID BENEFITS

Community microgrids provide technological benefits as they serve as a technology integration platform, to produce, consume, store, distribute, and control energy locally. Often the focus is to integrate high shares of renewable energy and smart technologies into microgrids. Technology solutions can either be established or innovative in nature, however, always contribute to the microgrid's overall energy resilience, efficiency, and flexibility.

5.) what extent are the following **technological 'microgrid benefits' unattractive or attractive** drivers for you/ investors to invest?

Please don't select more than 1 answer(s) per row.

	Not sure (0)	Very unattractive (1)	Unattractive (2)	Neither attractive nor unattractive (3)	Attractive (4)	Very attractive (5)
Provision of local power production, consumption, and control to community/ island	☐	☐	☐	☐	☐	☐
Support decrease of power losses and renewable energy curtailments on island	☐	☐	☐	☐	☐	☐
Provision of access to integration of low carbon, renewable energies, and energy efficiency	☐	☐	☐	☐	☐	☐
Ability to electrically connect and disconnect from the main power grid (business models)	☐	☐	☐	☐	☐	☐

Promotion of technologies through applicability in challenging context	☐	☐	☐	☐	☐	☐
Test and demonstration of new products or innovative technologies	☐	☐	☐	☐	☐	☐

5.a. Among the previously evaluated **technological microgrid benefits**, which one is the **most important driver** to influence you/ investors towards a positive investment decision?

5.a.i. If you selected Other, please specify:

5.b. If you would like to include any evidence to support your responses, and/or would like to add any further direct and indirect **technological benefits**, please include this in the box below.

ECONOMIC MICROGRID BENEFITS

Community microgrids provide direct and indirect economic benefits to the different microgrid stakeholders and to the island through various value streams that depend on the configuration of technologies and business models.

6.) what extent are the following **economic 'microgrid benefits' unattractive or attractive** drivers for you/ investors to invest?

Please don't select more than 1 answer(s) per row.

	Not sure (0)	Very unattractive (1)	Unattractive (2)	Neither attractive nor unattractive (3)	Attractive (4)	Very attractive (5)
Contribution to local economic growth in island through capacity building and jobs	☐	☐	☐	☐	☐	☐
Exploration and participation in new markets	☐	☐	☐	☐	☐	☐
Establishment of a business case for profit, monetary value, and revenue and its longevity	☐	☐	☐	☐	☐	☐

Exploration and establishment of revenue from users' flexibility (business models such as auxiliary services to the main grid)	☐	☐	☐	☐	☐	☐
Reduction of energy infrastructure costs	☐	☐	☐	☐	☐	☐
Enable long-term benefits through e.g. translation of 'test- bed' experience to mainland projects and markets	☐	☐	☐	☐	☐	☐

6.a. Among the previously evaluated **economic microgrid benefits**, which one is the **most important driver** to influence you/ investors towards a positive investment decision?

6.a.i. f you selected Other, please specify:

6.b. If you would like to include any evidence to support your responses, and/or would like to add any further direct and indirect **economic benefits**, please include this in the box below.

PRIORITY

7. How would you **rank the importance of environmental, social, technological and economic benefits** as drivers to influence you/ investors towards a positive investment decision?
Please select from 1. (most important) to 4. (least important)
Please don't select more than 1 answer(s) per row. Please select at least 4 answer(s).
Please don't select more than 1 answer(s) in any single column.

	1.	2.	3.	4.
Environmental benefits	☐	☐	☐	☐
Social benefits	☐	☐	☐	☐
Technological benefits	☐	☐	☐	☐
Economic benefits	☐	☐	☐	☐

THANK YOU

Thank you very much for your participation. This survey has come to an end. Before you leave, I would like to know:

8. **Are you happy for me to get in touch with you** to follow-up on your response to this consultation? The reason for this would be to obtain more detail on your views and discuss possible attractive microgrid technologies and business models through **an interview**.

Yes/No

If yes, please provide:

9. Your name:

10. Email address:

11. (If applicable) Organisation & position:

12. If you have some more time, please provide some details on your position, role, and experience (e.g., regarding sustainable investments, renewable energy sector, private or public investments, and your organisation and interests).

Key for selection options

3.a - Among the previously evaluated environmental microgrid benefits, which one is the most important driver to influence you/ investors towards a positive investment decision?

Contribution to overall environmental benefits, clean air, and climate change mitigation for island Supporting compliance with island decarbonisation goals
Reduction of islands' fossil fuel dependency
Impact on and contribution to environmental (ESG) responsibilities Possible branding and green advertisement opportunities
Other

4.a - Among the previously evaluated social microgrid benefits, which one is the most important driver to influence you/ investors towards a positive investment decision?

Provision of power quality and reliability to energy community/island
Enabling an active role and democratic say in (local) energy system for the energy community
Facilitation of low energy costs for the energy community
Contribution to related island fuel poverty strategies through inclusion of vulnerable households
Contribution to well-being and strengthening of community through capacity building, economic growth, jobs, awareness, and engagement
Impact on and contribution to social and governance (ESG) responsibilities of mine or my organization
Possible branding and social advertisement opportunities for me or my organisation
Other

5.a - Among the previously evaluated technological microgrid benefits, which one is the most important driver to influence you/ investors towards a positive investment decision?
Provision of local power production, consumption, and control to community/ island
Support decrease of power losses and renewable energy curtailments on island
Provision of access to integration of low carbon, renewable energies, and energy efficiency
Ability to electrically connect and disconnect from the main power grid (business models)
Promotion of technologies through applicability in challenging context
Test and demonstration of new products or innovative technologies
Other

6.a - Among the previously evaluated economic microgrid benefits, which one is the most important driver to influence you/ investors towards a positive investment decision?

Contribution to local economic growth in island through capacity building and jobs
Exploration and participation in new markets
Establishment of a business case for profit, monetary value, and revenue and its longevity
Exploration and establishment of revenue from users' flexibility (business models such as auxiliary services to the main grid)
Reduction of energy infrastructure costs
Enable long-term benefits through e.g. translation of 'test-bed' experience to mainland projects and markets
Other

A3. Interview guide for energy community perspective

Introduction

- Introduce the project, the aim of the interview, and reflect on the findings from the surveys (e.g., if the participant conducted the survey).
- Repeat the information on PIS and Consent form, which had been provided beforehand. Explain the procedure of him having an individual identification code from which the anonymised data can be identified, which they can use to withdraw within the next 3 weeks. Ask participant if there are any more questions regarding the PIS&Consent form.
- Repeat that the interview participation is voluntary, possibility to withdraw at any time and that there are no right or wrong answers.
- Ask for consent of video recording. Confirm that s/he is happy to proceed with the interview.

Challenges and opportunities - Island context

The islands' sizes, populations, geography, and existing infrastructure varies and overall, the Archipelago is still considered remote and rural. Unfortunately, fuel poverty and curtailment are immense problems. Nonetheless, the Canary/Orkney Islands is seen as a forerunner in renewable energy production that engage in innovative projects. Many projects have been funded through research or local communities.

1. Based on your experiences, why do you think the **Canary/Orkney Islands are attractive or not attractive** for community microgrids?
    - What local circumstances **drive** the attractiveness of community microgrids, how and why?
    - What local circumstances **hinder** the attractiveness of community microgrids, how and why?
    - What are the main motivations for participation and engagement in renewable energy and community projects in your Islands, and why?

Increase and negotiate perceived attractiveness

Making community microgrids mainstream requires

a) people who want to live in it and participate and

b) investors that are willing to pay for the initial investment costs.

For a just energy transition, it is necessary to negotiate the perceived attractiveness of the microgrid configuration between both parties.

2. To engage the communities and their individuals on your island, what will be the **main microgrid benefits** (environmental, social, technological, economic) that contribute to the attractiveness and why?
    - And how important are these for the perceived attractiveness for **a participation decision**?

3. Overall, what other factors, actions, and conditions **influence the perception of attractiveness** of you and other community members for participating and engaging in community microgrids in the Canary/Orkney Islands?

4. How do these factors **influence the final decision-making to participate and engage in** community microgrids and why?
5. How do they **influence the negotiation** with the investors?

- Similarly, what do you think are **important factors that influence the perceived attractiveness and the decision-making of investors** to invest in community microgrids in island environments and why?
- What are **aspects that investors and energy communities have in <u>common</u>** and could be agreed on and what aspects are very different, which all have to be considered **for negotiation of an aligned attractiveness and "win-win" configuration**?
- How could the priorities and perceptions of both community and investors be **aligned**?
- In your opinion, what are the **roles and responsibilities** of the energy community in general, the investors, and maybe other stakeholders **to increase and negotiate the attractiveness** of community microgrids in the Canary/Orkney Islands for both sides?

<u>**Priorities and perceptions regarding microgrid configurations**</u>

<u>Energy Technology (production, consumption, storage, distribution, etc.)</u>

Now that we have talked about attractiveness generally, we can go in-depth on the technology and business model configuration. Community microgrids can be seen as a smart integration platform for energy technologies and business models which provides many value streams to different stakeholders. It is important to consider the priorities and perceptions of the energy community and investors for the design of community microgrids.

6. Asking you the community perspective and under the context of your island, what are important aspects to consider for an **attractive configuration of energy technology** in a local community microgrid?
7. In your opinion, which **combination of technologies** <u>within</u> or <u>between</u> electricity, mobility, heating and cooling; flexible and inflexible technologies, do you see as being the most effective and attractive community microgrid configuration?

- What **benefits and risks** do you see in the combination of the technologies instead of the individual technologies only?
- How would you describe the **importance of fairness of the design** when it comes to different individuals of the community being involved?
- Which of the previously mentioned aspects would you highlight as the **most important for an attractive configuration** from an energy community point of view, and why?
- What aspects do you think would be **most important and most attractive f<u>or investors</u>**?

<u>Business models</u>

Having discussed the technologies, I would like to now ask you some questions regarding the business model side of community microgrids as the different types of technologies and collaborating stakeholders enable business opportunities. Microgrids can even combine different business models and thus stack value streams. On the one hand there is the investment business model which describes where the money for the infrastructure comes from. On the other hand, the energy business model describes how energy can be used, sold, or traded to make efficient use but also create revenue.

8. How would you describe an **attractive investment strategy** for community microgrids in the Canary/Orkney Islands from a community point of view?

    - e.g. third-party, community-shared, or hybrid investment models

9. To make use of all microgrid benefits and ensure attractive revenue streams, **what energy business models or their combination would be most attractive for the community, and why**?
    - For example, simple energy export to the main power grid, local energy market within the microgrid energy community, or flexibility services to the main grid either through incentive or price-based demand response or provision of capacity and storage?

10. Under the context of your island, what are **important aspects** to consider for an attractive community microgrid business model configuration and why?

- How could **inclusive participation** of all microgrid energy community members be facilitated?
- And how could the energy business model be designed for everyone to keep **long-term** participation and engagement attractive?
- What aspects do you think would be **important and attractive to <u>possible investors</u>**?

*(At the end of the interview ask them if they have **anything further to add**, thank them for their time and inform that about the plan of focus group discussions and ask if they are interested in joining)*

<u>END</u>

Thank you :

- Thank for participation and insights
- Ask for willingness to participate in focus group
- Repeat that if interested, I will share results once I complete the study/my PhD

A4. Interview guide for investor perspective

Introduction

- Introduce the project, the aim of the interview, and reflect on the findings from the surveys (e.g., if the participant conducted the survey).
- Repeat the information on PIS and Consent form, which had been provided beforehand. Explain the procedure of him having an individual identification code from which the anonymised data can be identified, which they can use to withdraw within the next 3 weeks. Ask participant if there are any more questions regarding the PIS&Consent form.
- Repeat that the interview participation is voluntary, possibility to withdraw at any time and that there are no right or wrong answers.
- Ask for consent of video recording. Confirm that s/he is happy to proceed with the interview.

Challenges and opportunities - Island context

The islands' sizes, populations, geography, and existing infrastructure varies and overall, the Archipelago is still considered remote and rural. Unfortunately, fuel poverty and curtailment are immense problems. Nonetheless, the Orkney Islands is seen as a forerunner in renewable energy production that engage in innovative projects. Many projects have been funded through research or local communities.

11. Based on your experiences, why do you think the **Orkney Islands are attractive or not attractive** for community microgrids?
    - What local circumstances **drive** the attractiveness of community microgrids, how and why?
    - What local circumstances **hinder** the attractiveness of community microgrids, how and why?
    - What are the **main motivations for investors to invest** in renewable energy and community projects in your Islands, and why?
    - To what extent is there a difference between different investors?

Increase and negotiate perceived attractiveness

Making community microgrids mainstream requires

a) people who want to live in it and participate and

b) investors that are willing to pay for the initial investment costs.

For a just energy transition, it is necessary to negotiate the perceived attractiveness of the microgrid configuration between both parties.

12. To engage investors, what will be the **main microgrid benefits** (environmental, social, technological, economic) that contribute to the attractiveness and why?
    - And how important are these for the perceived attractiveness for **a positive investment decision**?

13. Overall, what other factors, actions, and conditions **influence the perception of attractiveness** of you and other investors to invest in community microgrids in the Orkney Islands?
14. How do these factors **influence the final decision-making to invest in** community microgrids and why?
15. How do they **influence the negotiation** with the investors?

- Similarly, what do you think are **important factors that influence the perceived attractiveness and the decision-making of <u>the energy community</u>** to participate in community microgrids in island environments and why?
- What are **aspects that investors and energy communities have in <u>common</u>** and could be agreed on and what aspects are very different, which all have to be considered **for negotiation of an aligned attractiveness and "win-win" configuration**?
- How could the priorities and perceptions of both community and investors be **aligned**?
- In your opinion, what are the **roles and responsibilities** of the investors, the energy community in general, and maybe other stakeholders **to increase and negotiate the attractiveness** of community microgrids in the Orkney Islands for both sides?

<u>Priorities and perceptions regarding microgrid configurations</u>

<u>Energy Technology (production, consumption, storage, distribution, etc.)</u>

Now that we have talked about attractiveness generally, we can go in-depth on the technology and business model configuration. Community microgrids can be seen as a smart integration platform for energy technologies and business models which provides many value streams to different stakeholders. It is important to consider the priorities and perceptions of the energy community and investors for the design of community microgrids.

16. Asking you the investor perspective and under the context of your island, what are important aspects to consider for an **attractive configuration of energy technology** in a local community microgrid?
17. In your opinion, which **combination of technologies** <u>within</u> or <u>between</u> electricity, mobility, heating and cooling; flexible and inflexible technologies, do you see as being the most effective and attractive community microgrid configuration?

- What **benefits and risks** do you see in the combination of the technologies instead of the individual technologies only?
- How would you describe the **importance of fairness of the design** when it comes to different individuals of the community being involved?
- Which of the previously mentioned aspects would you highlight as the **most important for an attractive configuration** from an investor point of view, and why?
- What aspects do you think would be **most important and most attractive for <u>the energy community</u>**?

<u>Business models</u>

Having discussed the technologies, I would like to now ask you some questions regarding the business model side of community microgrids as the different types of technologies and collaborating stakeholders enable business opportunities. Microgrids can even combine different business models and thus stack value streams.

18. How would you describe an **attractive investment strategy** for community microgrids in the Orkney Islands from an investor's point of view?
    - e.g. third-party, community-shared, or hybrid investment models
19. To make use of all microgrid benefits and ensure attractive revenue streams, **what energy business models or their combination would be most attractive for investors, and why**?
    - For example, simple energy export to the main power grid, local energy market within the microgrid energy community, or flexibility services to the main grid either through incentive or price-based demand response or provision of capacity and storage?

20. Under the context of your island, what are **important aspects** to consider for an attractive community microgrid business model configuration and why?

- How could **inclusive participation** of all microgrid energy community members be facilitated?
- And how could the energy business model be designed for everyone to keep **long-term** participation and engagement attractive?
- What aspects do you think would be **important and attractive to the energy community**?
- In conclusion, what do you think are significant **drivers and barriers regarding your desired configuration** (e.g., economies of scale, aspects of community microgrid governance, regulatory framework, or island context)? How could these barriers be tackled? What actions would be needed?

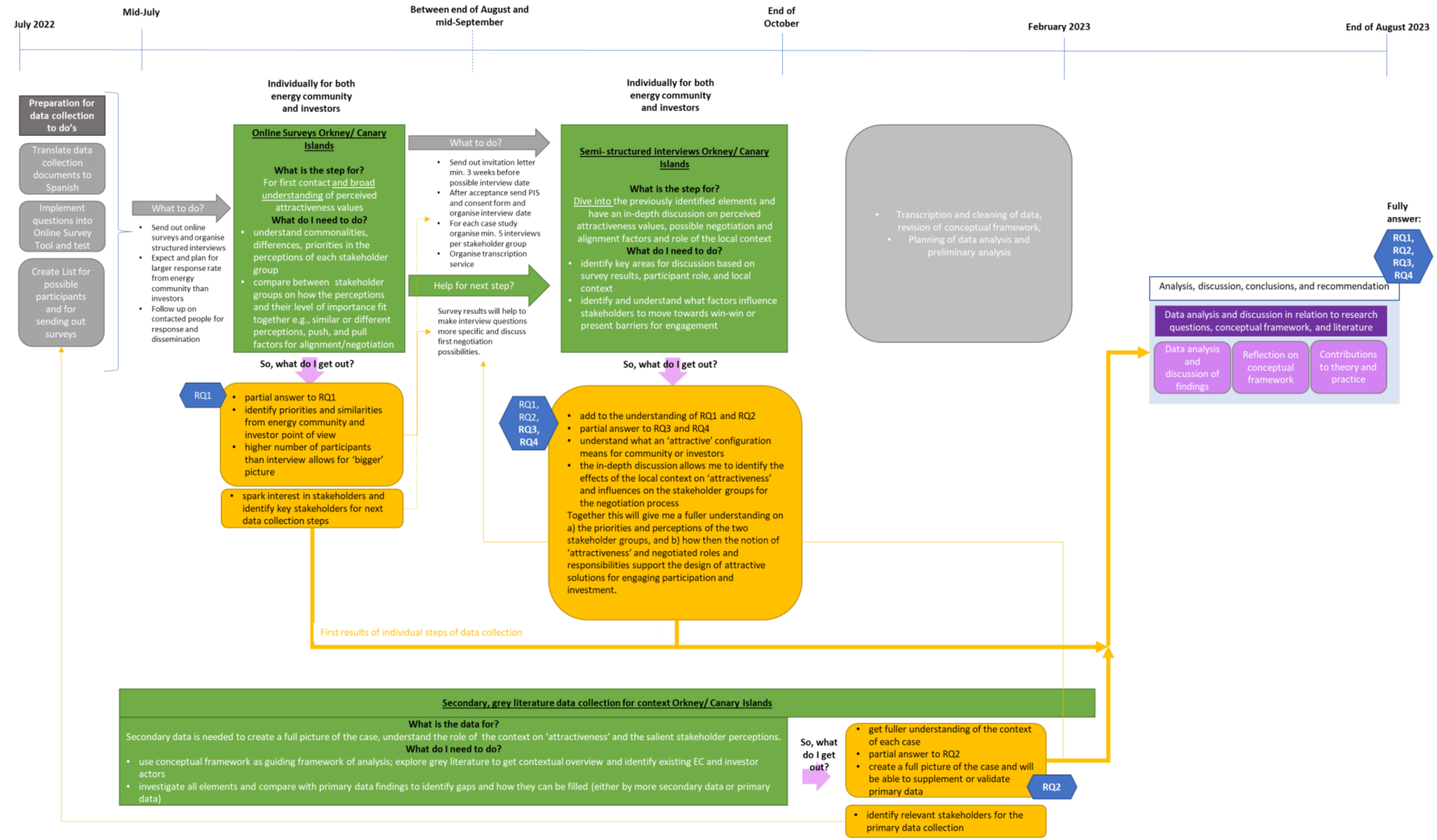
(At the end of the interview ask them if they have ***anything further to add****, thank them for their time and inform that about the plan of focus group discussions and ask if they are interested in joining)*

<u>END</u>

Thank you :

- Thank for participation and insights
- Ask for willingness to participate in focus group
- Repeat that if interested, I will share results once I complete the study/my PhD

A5. Data collection Strategy



Appendix B 1. Plan and steps for data collection.

Appendix B – Overview of data collection process and participants

B1. Overview of survey response and participants

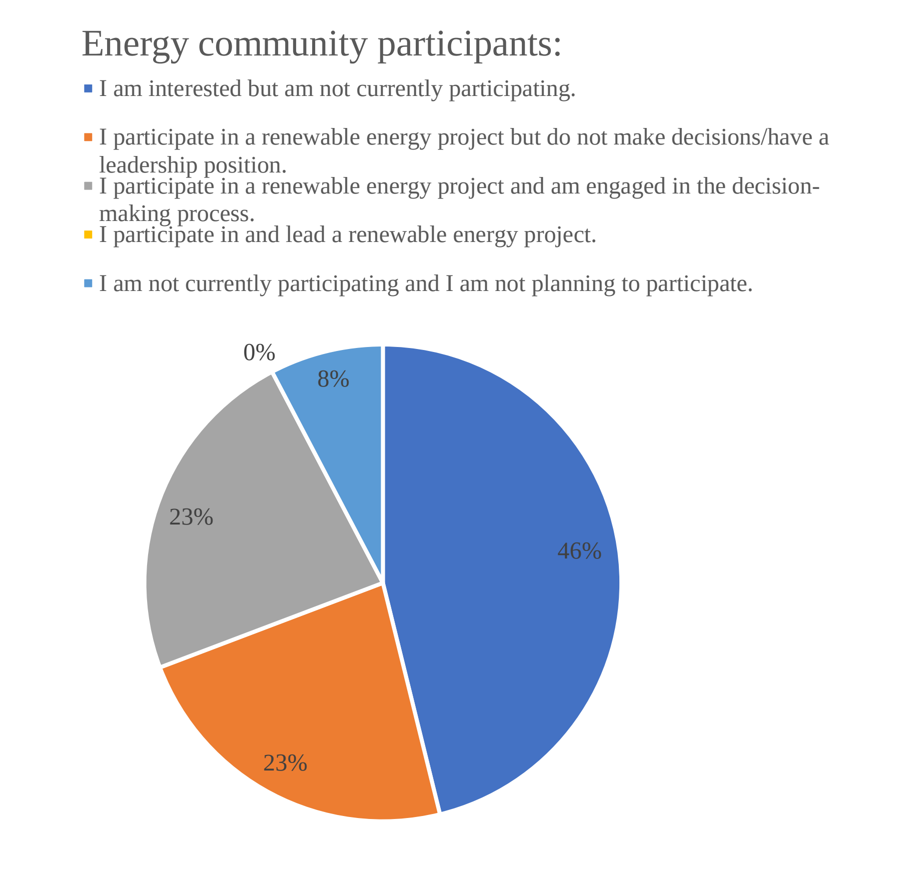
Appendix B 2. Specific survey procedure and sample information for the Orkney Islands case study.

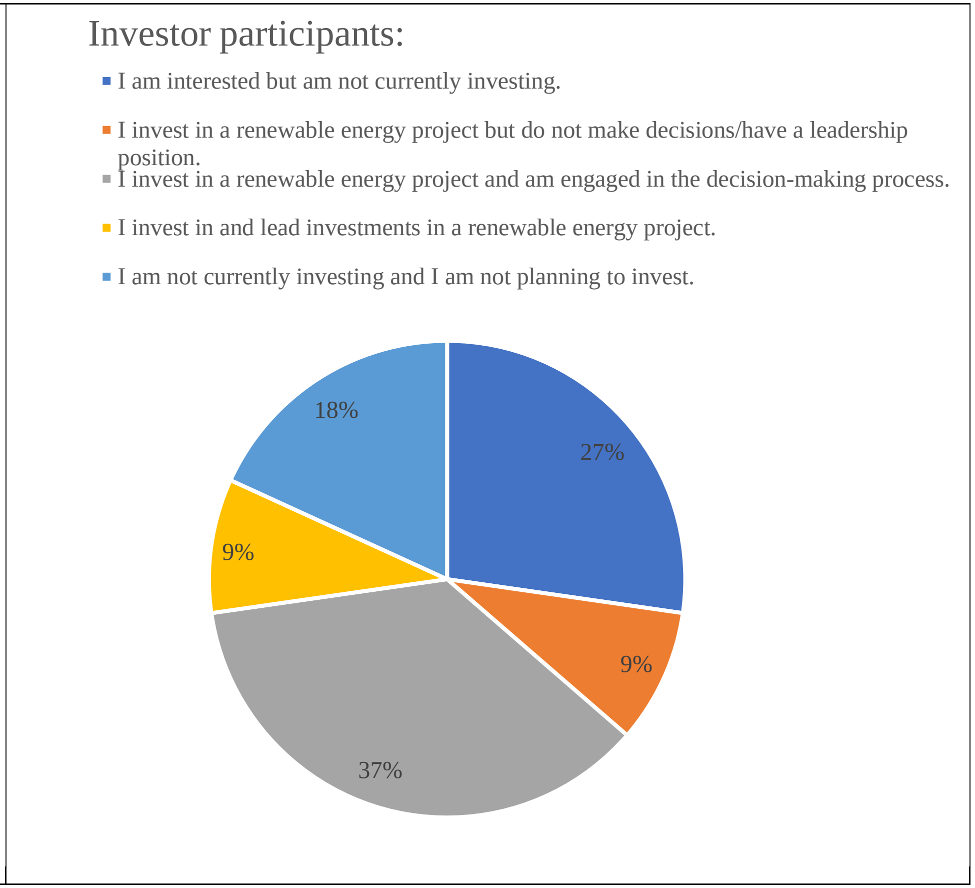
The Orkney Islands	Energy community	Investors
Open date	27.07.2022	27.07.2022
Close date	07.10.2022	07.10.2022
Respondence rate	27	11
People willing for interview	14	4

Appendix B 3. Specific survey procedure and sample information for the Canary Islands case study.

The Canary Islands	Energy community	Investors
Open date	29.08.2022	29.08.2022
Close date	31.10.2022	31.10.2022
Respondence rate	43	11
People willing for interview	25	7

Appendix B 4. Orkney Islands case: survey participant community and investor experience and interest.

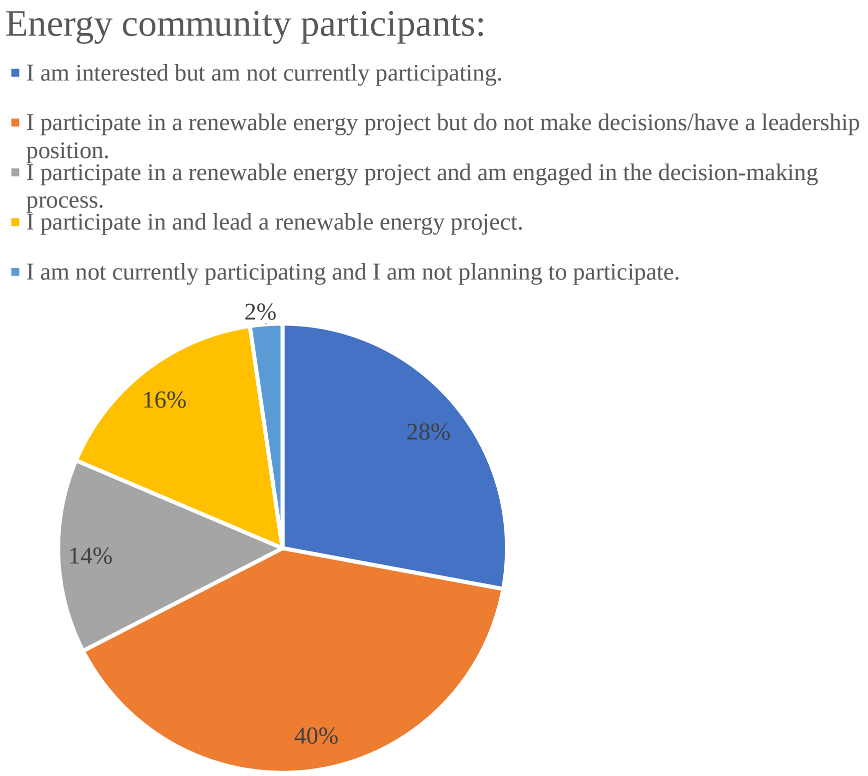


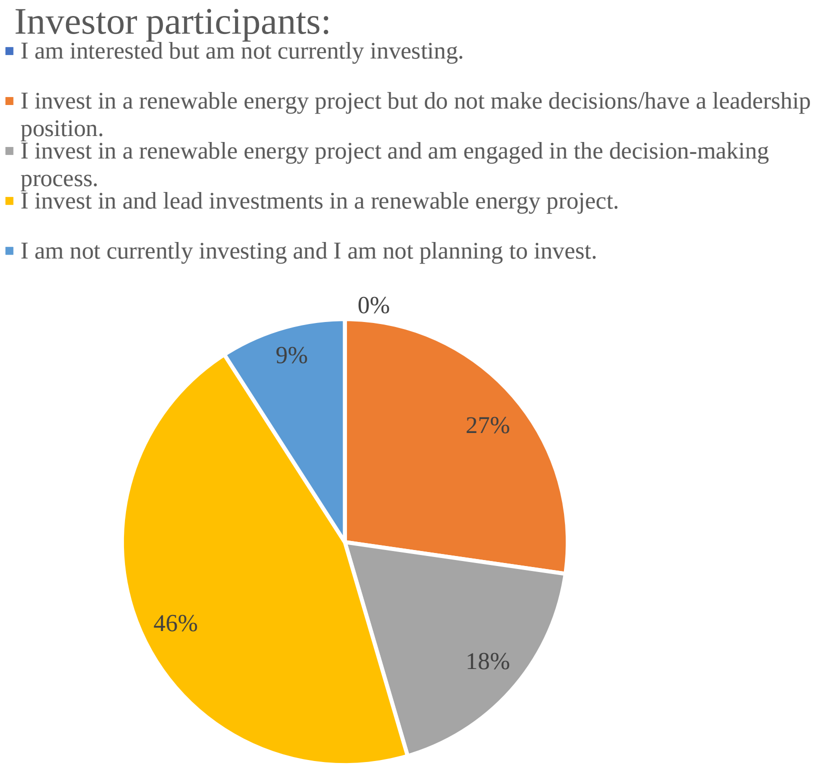


Appendix B 5. Orkney Islands case: Mean energy literacy of energy community and investors.(“0”=no knowledge; “1”=very little knowledge; “2”=little knowledge; “3”=knowledge; "4”=good knowledge; “5”=very good knowledge).

Group	Energy Literacy	N	Minimum	Maximum	Mean	Std. Deviation
Energy community	LEVEL OF ENERGY LITERACY ON **TECHNICAL ASPECTS**	26	1	5	3.12	1.177
	LEVEL OF ENERGY LITERACY ON **BUSINESS ASPECTS**	26	0	5	2.46	1.208
	LEVEL OF ENERGY LITERACY ON **ISLAND ENERGY SYSTEM**	26	1	5	3.00	1.166
	Valid N (listwise)	26				
Investors	LEVEL OF ENERGY LITERACY ON **TECHNICAL ASPECTS**	11	0	6	3.36	1.748
	LEVEL OF ENERGY LITERACY ON **BUSINESS ASPECTS**	11	0	6	2.82	2.228
	LEVEL OF ENERGY LITERACY ON **ISLAND ENERGY SYSTEM**	11	0	5	3.00	1.732
	Valid N (listwise)	11				

Appendix B 6. Canary Islands case: survey participant community and investor experience and interest.





Appendix B 7. Canary Islands case: Mean energy literacy of energy community and investors.("0"=no knowledge; "1"=very little knowledge; "2"=little knowledge; "3"=knowledge; "4"=good knowledge; "5"=very good knowledge).

Group	Energy Literacy	N	Minimum	Maximum	Mean	Std. Deviation
Energy community	LEVEL OF ENERGY LITERACY ON **TECHNICAL ASPECTS**	43	1	5	3.42	1.139
	LEVEL OF ENERGY LITERACY ON **BUSINESS ASPECTS**	43	0	5	2.51	1.298
	LEVEL OF ENERGY LITERACY ON **ISLAND ENERGY SYSTEM**	43	1	5	3.09	1.231
	Valid N (listwise)	43				
Investors	LEVEL OF ENERGY LITERACY ON **TECHNICAL ASPECTS**	10	2	5	3.90	1.101
	LEVEL OF ENERGY LITERACY ON **BUSINESS ASPECTS**	10	3	5	3.70	0.675
	LEVEL OF ENERGY LITERACY ON **ISLAND ENERGY SYSTEM**	10	3	5	4.20	0.789
	Valid N (listwise)	10				

B2. Overview of semi-structured interviews and participants

Appendix B 8. Orkney Islands case overview of semi-structured interviews.

Group	Key	Interviewee	Date	Duration	Language
Energy community	OK_C_EC_8	Representative of local authority/ Resident	26.09.2022	01:17:21	English
	OK_EG_1	Representative of social organisation/ Resident	05.09.2022	01:26:36	English
	OK_EC_2	Representative of social organisation/ Resident	05.09.2022	01:06:16	English
	OK_EC_5	Employee at community energy organisation	14.09.2022	00:57:43	English
	OK_G_EC_7	Representative of voluntary organisation/ Resident	22.09.2022	00:39:09	English
	OK_EC_3	Resident	14.09.2022	00:54:22	English
	OK_SR_EC_6	Resident	19.09.2022	01:08:39	English
	OK_CT_EC_9	Employee at community energy organisation/ Resident	23.9.2022	01:04:18	English
	OK_R_EC_4	Resident	21.09.2022	00:44:51	English
	OK_T_EC_10	Employee at research institute/ Resident	30.09.2022	01:02:43	English
	OK_C_EC_11	Community researcher/ Resident	11.10.2022	00:56:07	English
Investors	OK_Inv_1	Local microgrid or technology innovators	7.09.2022	01:02:25	English
	OK_Inv_2	Local RES investor and advisor/ Resident	7.09.2022	00:57:22	English
	OK_Inv_3	Sustainable Investments	23.09.2022	01:08:43	English
	OK_Inv_4	Local microgrid or technology innovators	03.10.2022	00:49:55	English
	OK_Inv_5	Energy grid	05.10.2022	00:51:03	English
	OK_TP	Energy Flexibility company	07.10.2022	00:28:09	English

Appendix B 9. Canary Islands case overview of semi-structured interviews.

Group	Key	Interviewee	Date	Duration	Language
Energy community	GC_EERR_EC_2	Employee at research institute/ Resident	4.10.22	00:57:49	English
	GC_R_EC_6	Employee at research institute/ Resident	27.09.22	00:59:20	English
	GC_R_EC_4	Resident	24.09.22	00:40:50	Spanish
	LP_R_EC_12	Energy community member/ Resident	18.10.2022	00:34:40	German
	GC_V_EC_5	Representative of social organisation/ Resident	29.09.22	01:00:24	Spanish
	GC_T_EC_3	Employee at research institute/ Resident	5.10.22	01:00:12	Spanish
	GC_A_EC_8	Employee at research institute/ Resident	filled out interview questionnaire due to personal reasons	n/a	English
	LP_EC_7	Employee at community energy organisation/ Resident	10.10.22	00:55:34	English
	GC_LA_EC_9	Representative of local authority/ Resident	17.10.22	00:32:57	Spanish
	C_TP_EC_10	Community and Energy Flexibility researcher	14.10.22	00:45:29	English
	GC_T_13	Employee at research institute/ Resident	20.10.22	01:38:57	Spanish
	C_N_14	Community negotiation consultant/ Resident	07.11.22	00:57:03	Spanish
Investors	GC_Inv_1	Local microgrid or technology innovators/ Resident	20.10.22	01:02:24	Spanish
	C_Inv_3	Local business/ Resident	04.11.22	01:02:31	Spanish
	C_Inv_4	Local RES investor and advisor/ Resident	21.10.22	01:00:14	Spanish
	T_Inv_5	Energy grid/ Energy community investor/ Resident	24.10.22	01:21:31	Spanish
	GC_Inv_6	Energy company/ Resident	31.10.22	01:01:12	English
	GC_Inv_7	Local microgrid or technology innovators/ Resident	07.11.2022	00:57:03	Spanish

Appendix C – Grey Literature coding table

Appendix C 1. The Orkney Islands grey literature.

Ref Code	GL Reference	Type
OC1	Scottish Government. (2023a). *Council Area Orkney Islands Population*. [online] Statistics.Gov.Scot. Available at: https://statistics.gov.scot/atlas/resource?uri=http%3A%2F%2Fstatistics.gov.scot%2Fid%2Fstatistical-geography%2FS12000023 [Accessed 17 Aug. 2023].	website
OC2	Orkney Island Council. (2019). *Orkney Economic Review 2010.* Available at: https://www.orkney.gov.uk/Files/Business-and-Trade/Economic_Review/Orkney Economic Review 2019.pdf [Accessed 17 Aug. 2023].	report
OC3	Scottish Government. (2023b). *Council Area Orkney Islands Economic Activity.* [online] Statistics.Gov.Scot. Available at: https://statistics.gov.scot/atlas/resource?uri=http%3A%2F%2Fstatistics.gov.scot%2Fid%2Fstatistical-geography%2FS12000023 [Accessed 17 Aug. 2023].	website
OC4	Highlands and Islands Enterprise. (2020). *Highlands and Islands Area Profiles 2020: Orkney*. Available at: https://www.hie.co.uk/media/10595/orkney-area-profile-2020.pdf [Accessed 17 Aug. 2023].	report
OC5	Millard, A., McCartney, G., MacKinnon, A., Van Heelsum, A., Gasiorowski, A., & Barkat, S. (2016). *Orkney islands Health and Wellbeing Profiles - key indicators and overview*. Available at: https://www.scotpho.org.uk/media/1047/scotpho-hwb-profiles-aug2016-orkney.pdf [Accessed 17 Aug. 2023].	report
OC6	Scottish Index of Multiple Deprivation. (2016). *Child Poverty in the Orkney Islands - A rural deprivation case study*. Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/research-and-analysis/2017/02/scottish-index-of-multiple-deprivation-rural-deprivation-evidence-and-case-studies/documents/child-poverty-in-the-orkney-islands-a-case-study/child-poverty-in-the-orkney-islands-a-case-study/govscot%3Adocument/chuild%2Bpoverty%2Borkney.pdf [Accessed 17 Aug. 2023].	report
OC7	Watts, L. (2019). *Energy at the End of the World An Orkney Islands Saga.* The MIT Press.	book
OC8	Orkney Island Council. (2017). *Orkney's Fuel Poverty Strategy 2017-2022*. Available at: https://www.orkney.gov.uk/Files/Housing/Housing%20Options/Housing%20Strategy/Fuel_Poverty_Strategy.pdf [Accessed 17 Aug. 2023].	strategy
OC9	Hempseed, R. (2022). *'Situation is not sustainable or acceptable': Figures show Aberdeenshire, Shetland and Orkney paying among highest energy bills in UK.* [online] Press and Journal. Available at: https://www.pressandjournal.co.uk/fp/news/highlands-islands/4427178/aberdeenshire-shetland-orkney-energy-bills/ [Accessed 17 Aug. 2023].	news
OC10	Mauger, R., & Roggenkamp, M. (2021). *Smart Island Energy Systems: Deliverable D7.4 Balancing Local Grids.* H2020 SMILE. Available at: https://h2020smile.eu/wp-content/uploads/2021/12/D7.4_SMILE_final_rev0.pdf [Accessed 17 Aug. 2023].	report
OC11	National Audit Office - Department for Energy Security & Net Zero. (2023). *Update on the rollout of smart meters* (Issue June). Available at: https://www.nao.org.uk/wp-content/uploads/2023/06/update-on-the-rollout-of-smart-meters.pdf [Accessed 17 Aug. 2023].	report
OC12	Energy of Orkney. (2017). *Orkney Sustainable Energy Strategy 2017/2025.* Available at: https://www.oref.co.uk/wp-content/uploads/2017/10/Orkney-Sustainable-Energy-Strategy-2017-2025-1.pdf [Accessed 17 Aug. 2023].	strategy

OC13	Hinson, S., Sutherland, N. (2021) *Research Briefing: Community energy.* House of Commons Library. Available at: https://researchbriefings.files.parliament.uk/documents/CBP-9271/CBP-9271.pdf. [Accessed 17 Aug. 2023].	report
OC14	OREF. (2023). *Orkney' s Energy*. [online]. Available at: https://www.oref.co.uk/orkneys-energy/ [Accessed 17 Aug. 2023].	website
OC15	The Orkney News. (2022). Orkney 2nd Highest Energy Bills In GB. [online]. Available at: https://theorkneynews.scot/2022/06/09/orkney-2nd-highest-energy-bills-in-gb/#:~:text=Orkney households are paying £,out as second most expensive. [Accessed 17 Aug. 2023].	news
OC16	Shetland Islands Council. (2022). Fuel Poverty in Shetland to hit 96%. Shetland Islands Council. [online]. Available at: https://www.shetland.gov.uk/news/article/2380/fuel-poverty-in-shetland-to-hit-96- [Accessed 17 Aug. 2023].	news
OC17	Easson, K. (2022). *Approaching Near Zero Energy in Historic Buildings Deliverable Title: Energy Assessment Results and Retrofit Outcomes* (S. Montgomery (Ed.)). Energy Pathfinder. https://www.energypathfinder.eu/wp-content/uploads/2022/09/T3.3.1-Energy-Assessment-Results-and-Retrofit-Outcomes-i.docx-1.pdf [Accessed 17 Aug. 2023].	report
OC18	SSEN. (2022). *Orkney ANM.* [online]. Available at: https://www.ssen.co.uk/our-services/active-network-management/orkney-anm/ [Accessed 17 Aug. 2023].	website
OC19	ELECTRON. (2021). *Our Projects: Project TraDER – Orkney, U*K. [online]. Available at: https://electron.net/projects/project-trader-orkney-uk/ [Accessed 17 Aug. 2023].	website
OC20	Compton, D., Hull, M., & Kaluza team. (2018). *Heat Smart Orkney (HSO) Project: Final Output Report.* Heat Smart Orkney Ltd. Available at: https://localenergy.scot/wp-content/uploads/2022/02/HSO-report-Final-Version-for-LECF-Nov-2020.pdf [Accessed 17 Aug. 2023].	report
OC21	Fair Internet Report. (2023). *Broadband Providers in Orkney Islands*. [online]. Available at: https://fairinternetreport.com/United-Kingdom/Orkney-Islands [Accessed 17 Aug. 2023].	website
OC22	Long, P. (2021). Presentations by SMILE pilot islands - Samsø, Madeira & Orkney. Smart Islands Energy System: Online Workshop & Matchmaking Event: 8 July 2021. https://match2smile.b2match.io	webinar
OC23	Cook, C., & McPadden, P. (2022). *Renewable energy trailblazers: how Orkney is engineering the future.* Baillie Gifford. [online]. Available at: https://www.bailliegifford.com/en/uk/individual-investors/insights/ic-article/2022-q3-orkney-s-renewable-energy-projects-10013387/ [Accessed 17 Aug. 2023].	website
OC24	ReFlex Orkney. (2023a). *Electric vehicle leases.* [online] Available at: https://www.reflexorkney.co.uk/home/electric-vehicles/electric-vehicle-leases [Accessed 17 Aug. 2023].	website
OC25	ReFlex Orkney. (2023b). *Why Orkney?*. [online]. Available at: https://www.reflexorkney.co.uk/about-reflex/why-orkney [Accessed 17 Aug. 2023].	website
OC26	Smart-BEEjS (2021). *Orkney Islands.* Available at: https://smart-beejs.eu/docs/orkney-islands/ [Accessed 17 Aug. 2023].	report
OC27	Westray Development Trust. (2023). About - Westray Development Trust: Our Mission. [online]. Available at: https://westraydevelopmenttrust.co.uk/about-westray-development-trust/our-mission/ [Accessed 17 Aug. 2023].	website
OC28	Silver, C. (2019). Orkney: The "Energy Islands" Penalised for Becoming Too Clean, Too Soon. Desmoguk. [online]. Available at: https://www.desmog.co.uk/2019/03/10/Orkney-Energy-Islands-Penalised-Too-Clean-Too-Soon [Accessed 17 Aug. 2023].	news
OC29	EMEC. (2020). PRESS RELEASE : ORKNEY AWARDED € 100K EU RESPONSIBLE ISLAND PRIZE. [online]. Available at: https://www.emec.org.uk/press-release-orkney-awarded-e100k-eu-responsible-island-prize/ [Accessed 17 Aug. 2023].	news
OC30	European Commission. (2019). Orkney - How Orkney built a movement for the clean energy transition. Clean Energy for EU Islands. [online]. Available at: https://clean-energy-islands.ec.europa.eu/countries/united-kingdom-uk/orkney [Accessed 17 Aug. 2023].	news

Appendix C 2. The Canary Islands grey literature.

Ref Code	GL Reference	Type
CC1	World Population Review (2023). *Canary Islands Population 2023.* [online] Available at: https://worldpopulationreview.com/regions/canary-islands-population. [Accessed 17 Aug. 2023].	website
CC2	Conference of Presidents. (n.d.). *Canary Islands.* [online] Available at: https://cp-rup.com/en/the-outermost-regions/canary-islands/#:~:text=Due%20to%20its%20privileged%20location [Accessed 17 Aug. 2023].	website
CC3	Gestión y Planeamiento Territorial y Medioambiental S.A. (2022). Estrategia Canaria de Acción Climática Versión Inicial. Gobierno Canarias. Available at: https://www.gobiernodecanarias.org/medioambiente/descargas/Cambio_climatico/Informacion-Publica/20220207_BORRADOR_ECAC.pdf [Accessed 17 Aug. 2023].	strategy
CC4	Lahtinen, H., Viljamaa, K., Buligescu, B., & Wintjes, R. (2013). *Summary Assessment of the Canary Islands* (Issue November 2013). ESIC European Service Innovation Centre. Available at: https://ec.europa.eu/docsroom/documents/5122/attachments/1/translations/en/renditions/native [Accessed 17 Aug. 2023].	report
CC5	BBVA. (2023). *BBVA Research Situación Canarias 2023.* BBVA. Available at: https://www.bbvaresearch.com/wp-content/uploads/2023/02/Situacion-Canarias-2023-1.pdf [Accessed 17 Aug. 2023].	presentation
CC6	Gobierno de Canarias (n.d.). LA ECONOMÍA CANARIA – EL BLOG DE ECONOMIA. [online] Available at: https://www3.gobiernodecanarias.org/medusa/ecoblog/casilher/la-economia-en-espana/la-economia-canaria/#:~:text=La%20econom%C3%ADa%20de%20Canarias%20en [Accessed 17 Aug. 2023].	website
CC7	Gobierno de Canarias (2022). La pobreza energética en canarias - ánalisis de su incidencia y propuestas de acción. Available at: https://occet.es/wp-content/uploads/2022/08/La-pobreza-energetica-en-Canarias.pdf [Accessed 17 Aug. 2023].	report
CC8	De Brouwer, A., Montero Carrero, M., Rakocevic, L. (2022). Clean energy for EU islands: Study on regulatory barriers and recommendation for clean energy transition on the islands - Spain. Available on: https://clean-energy-islands.ec.europa.eu/system/files/2022-12/PUBLIC%20-%20IslandSecretariatII_Study%20on%20barriers%20and%20recommendations%20SPAIN%20FINAL%2020221214%20clean.pdf [Accessed 17 Aug. 2023].	report
CC9	Frieden, D., Tuerk, A., Neumann, C., d'Herbemont, S., Roberts, J. (2020). Collective self-consumption and energy communities: Trends and challenges in the transposition of the EU framework. Working Paper. Compile. Available at: https://www.rescoop.eu/uploads/rescoop/downloads/Collective-self-consumption-and-energy-communities.-Trends-and-challenges-in-the-transposition-of-the-EU-framework.pdf [Accessed 17 Aug. 2023].	report
CC10	La Palma Renovable (2022). *Estudio Pobreza Energética en la Isla de la Palma*. Available at: https://lapalmarenovable.es/wp-content/uploads/2022/10/Estudio_PobrezaEnergetica_LaPalma.pdf	report
CC11	P, E. (2021). *Las familias canarias, las que menos pagan por los suministros del hogar. [online]* Eldia.es. Available at: https://www.eldia.es/economia/2021/08/04/familias-canarias-pagan-suministros-hogar-55894545.html [Accessed 18 Aug. 2023].	news
CC12	Gobierno de Canarias. (2023). *Anuario Energético de Canarias 2021*. Consejería de Transición Ecológica, Lucha contra el Cambio Climático y Planificación Territorial. Available at: https://www.gobiernodecanarias.org/energia/descargas/SDE/Portal/Publicaciones/AnuarioEnergeticodeCanarias_2021_v2.pdf	report
CC13	Instituto Tecnológico de Canarias. (n.d.). *Descripción General Del Proyecto.* [online]. *MICROGRID BLUE*. Available at: https://www.microgrid-blue.com/es/proyecto [Accessed 18 Aug. 2023].	website
CC14	Energia Gran Canaria (2021). *Arinaga se convertirá en la primera comunidad energética industrial de Gran Canaria.* [online]. Available at: https://www.energiagrancanaria.com/2021/06/29/arinaga-se-convertira-en-la-primera-comunidad-energetica-industrial-de-gran-canaria/ [Accessed 18 Aug. 2023].	news

CC15	Endesa. (2022). *What is shared self-consumption and how can your community of residents benefit from it?* [online] Available at: https://www.endesa.com/en/blogs/endesa-s-blog/light/shared-self-consumption [Accessed 17 Aug. 2023].	website
CC16	Clean energy for EU Islands (2021). Kick-off of the island-wide energy cooperative Energía Bonita on La Palma. Available at: https://clean-energy-islands.ec.europa.eu/news/kick-island-wide-energy-cooperative-energia-bonita-la-palma [Accessed 17 Aug. 2023].	news
CC17	Macke, M. (2022). *Energy community on Tenerife: E.ON and the municipality of Adeje pilot innovative concept.* E.ON. [online] Available at: https://www.eon.com/en/about-us/media/press-release/2022/energy-community-on-tenerife:-e.on-and-the-municipality-of-adeje-pilot-innovative-concept%20.html [Accessed 17 Aug. 2023].	website
CC18	Miriam Díaz (2022). Interviewed by El Espejo Canario. Tacoronte crea la segunda comunidad energética de Canarias. 12. Jan. Available at: https://www.elespejocanario.es/secciones/tacoronte-crea-la-segunda-comunidad-energetica-de-canarias/ [Accessed 18 Aug. 2023].	news
CC19	Gobierno de Canarias (2022). Estrategia de Energía Sostenible en las Islas Canarias. Available at: https://www.lamoncloa.gob.es/serviciosdeprensa/notasprensa/transicion-ecologica/Documents/2022/160222_EstrategiaSostenible_Canarias.pdf [Accessed 18 Aug. 2023].	strategy
CC20	Hernández, G. (2022). En estos municipios instalará Naturgy sus más de 70 MW de renovables. [online]. EnergyHub. Available at: http://www.energyhub.es/texto-diario/mostrar/3895612/estos-municipios-instalara-naturgy-70-mw-renovables-canariasL [Accessed 18 Aug. 2023].	news
CC21	Piernavieja, G. (2020). The Canary Islands as platform for the development of green energy technologies and transfer to the African continent. Regional online Teaching & Training on Renewable energy technologies for professionals, practitioners and universities in ecowas member states 13-16 October 2020. Canary Islands Institute of Technology. Available at: https://www.amenet.eu/documents/workshops/WS2020_15_ECREEE-OCT20-GONZALO-PIERNAVIEJA-ITC-Canary-Islands-Green-Energy-Platform.pdf [Accessed 18 Aug. 2023].	presentation
CC22	Energías Renovables (2021). Comunidad, energética, cooperativa, diez megavatios, autoconsumo, industrial, residencial, Canarias. [online] autoconsumo. Available at: https://www.energias-renovables.com/autoconsumo/comunidad-energetica-cooperativa-diez-megavatios-autoconsumo-industrial-20210826 [Accessed 18 Aug. 2023].	news
CC23	Loro Parque (n.d.). Sustainability is a priority for Loro Parque. [online]. Available at: https://www.loroparque.com/en/sustainability-loro-parque/ [Accessed 18 Aug. 2023].	website
CC24	Energia Gran Canaria (2022). La Comunidad Energética Industrial de Arinaga supera un nuevo hito con la presentación de estudios preliminares. [online]. Available at: https://www.energiagrancanaria.com/2022/05/10/la-comunidad-energetica-industrial-de-arinaga-supera-un-nuevo-hito-con-la-presentacion-de-estudios-preliminares/	news
CC25	Adeje verde (n.d.). Tejado Verde. [online]. Available at: https://adejeverde.com/tejadoverde [Accessed 18 Aug. 2023].	website
CC26	Derkenbaeva, E., Galanakis, K., Heinz, H., & Stathopoulou, E. (2022). Smart-BEEjS: Business Models and Consumers ' Value Proposition for PEDs - Value Generation Systems for PEDs: Archetypes for a Networked Europe, 2040: Foresight Report. Available at: https://smart-beejs.eu/wp-content/uploads/2022/03/D6.4_BMs-and-Value-Propositions_final.pdf [Accessed 18 Aug. 2023].	report

Appendix D – Survey results

D1. Sheets for and results of ORCP Solver

- A: environmental benefits; B: social benefits; C: technological benefits; D: economic benefits.
- Order of priority reflected by order 1., 2., 3., 4..
- Results from different models: Borda-Kendall's method of marks (BAK); Maximize agreement heuristic (MAH); Consensus ranking model (CRM); Distance-based ideal-seeking consensus ranking model (DCM) see Mazurek & Fiedor, (2012).

OK_EC
alternatives A, B, C, D
decisions 4
rankings
A,B,C,D
B,A,D,C
D,B,A,C
B,A,D,C
D,A,B,C
A,B,D,C
B,A,D,C
A,B,C,D
D,B,A,C
A,B,D,C
A,B,C,D
D,B,A,C
A,D,B,C
D,B,A,C
D,B,C,A
D,B,C,A
A,D,B,C
D,B,C,A
D,A,B,C
A,B,D,C
A,D,C,B
D,A,B,C
A,B,C,D
D,B,C,A
A,D,B,C
B,A,D,C

bak: [A, B, D, C], [A, D, B, C]
mah: [A, D, B, C]
crm: [A, D, B, C]
dcm: [A, D, B, C]
Entropy (input): 0.7755093217074774
Entropy (bak): 0.25
Entropy (mah): 0.0
Entropy (crm): 0.0
Entropy (dcm): 0.0
Entropy (solutions): 0.18048202372184058
Agreement (bak): 0.9
Agreement (mah): 1.0
Agreement (crm): 1.0
Agreement (dcm): 1.0
Agreement (all): 0.936

OK_Inv
alternatives A, B, C, D
decisions 4
rankings
A,B,D,C
A,D,B,C
A,B,D,C
A,B,D,C
D,B,A,C
D,A,B,C
D,A,B,C
B,A,D,C
A,B,D,C
C,B,A,D
D,C,B,A

bak: [A, B, D, C], [A, D, B, C]
mah: [A, B, D, C]
crm: [A, B, D, C]
dcm: [A, B, D, C]
Entropy (input): 0.7068377585420028
Entropy (bak): 0.25
Entropy (mah): 0.0

Entropy (crm): 0.0

Entropy (dcm): 0.0

Entropy (solutions): 0.18048202372184058

Agreement (bak): 0.9

Agreement (mah): 1.0

Agreement (crm): 1.0

Agreement (dcm): 1.0

Agreement (all): 0.936

C_EC

alternatives A, B, C, D

decisions 4

rankings

B,A,C,D

C,A,B,D

A,C,B,D

D,C,B,A

D,A,C,B

D,A,B,C

A,B,D,C

A,B,C,D

A,C,D,B

D,A,B,C

C,A,D,B

D,C,B,A

D,A,B,C

C,A,B,D

B,A,D,C

C,B,A,D

C,B,A,D

A,B,D,C

D,A,C,B

C,D,B,A

A,C,D,B

A,D,B,C

A,D,B,C

B,C,A,D

D,A,B,C

A,D,B,C

C,B,D,A
D,B,C,A
A,D,B,C
C,B,A,D
A,B,D,C
D,A,B,C
D,A,B,C
D,A,B,C
C,D,B,A
D,A,B,C
C,B,A,D
D,A,C,B
D,C,B,A
B,A,D,C
A,D,B,C
D,B,C,A

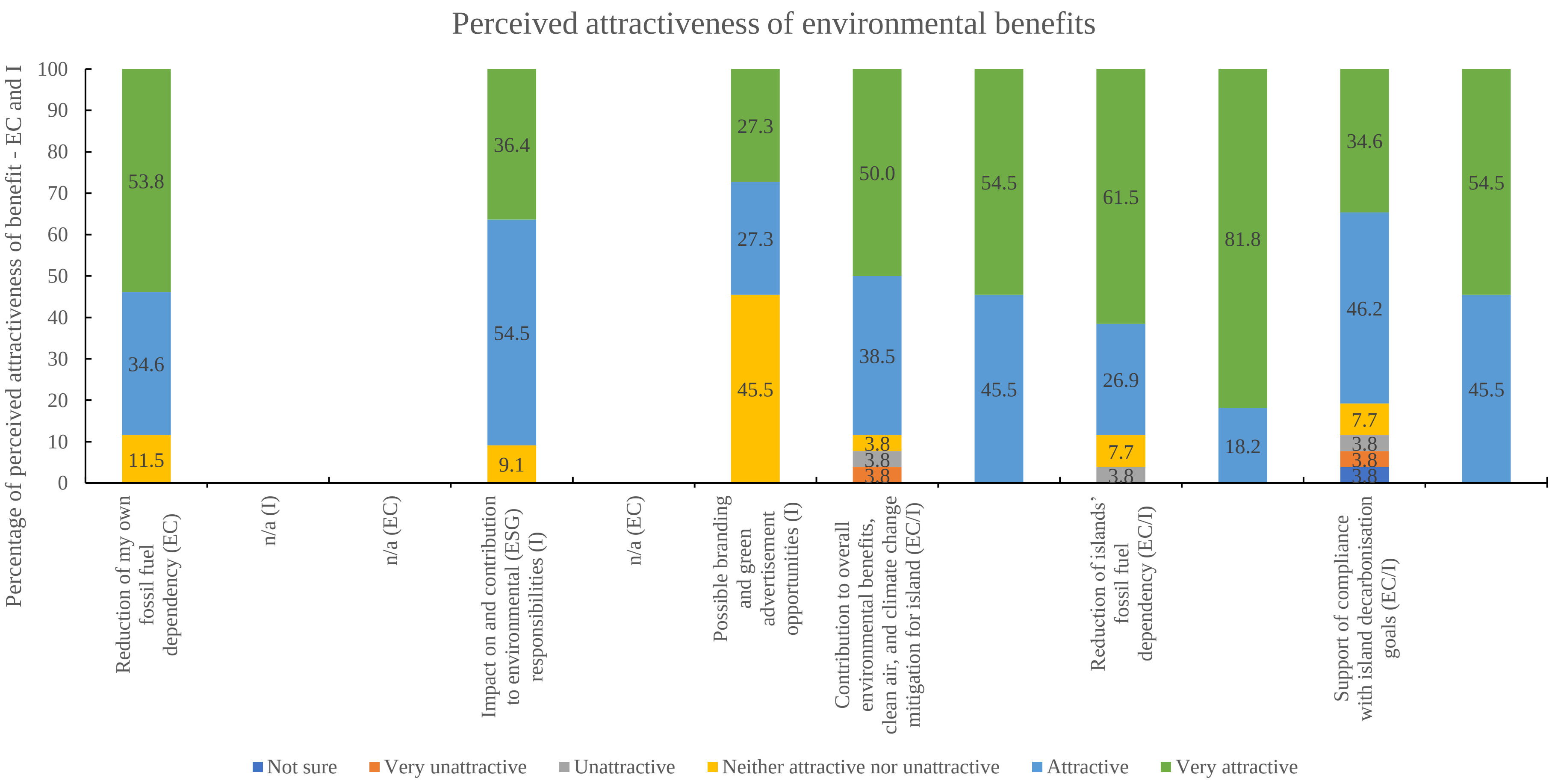
bak: [A, D, B, C]
mah: [A, D, B, C]
crm: [A, D, B, C]
dcm: [A, D, B, C]
Entropy (input): 0.9256252656395676
Entropy (bak): 0.0
Entropy (mah): 0.0
Entropy (crm): 0.0
Entropy (dcm): 0.0
Entropy (solutions): 0.0
Agreement (bak): 1.0
Agreement (mah): 1.0
Agreement (crm): 1.0
Agreement (dcm): 1.0
Agreement (all): 1.0

C_Inv
alternatives A, B, C, D
decisions 4
rankings
D,A,B,C
A,B,C,D

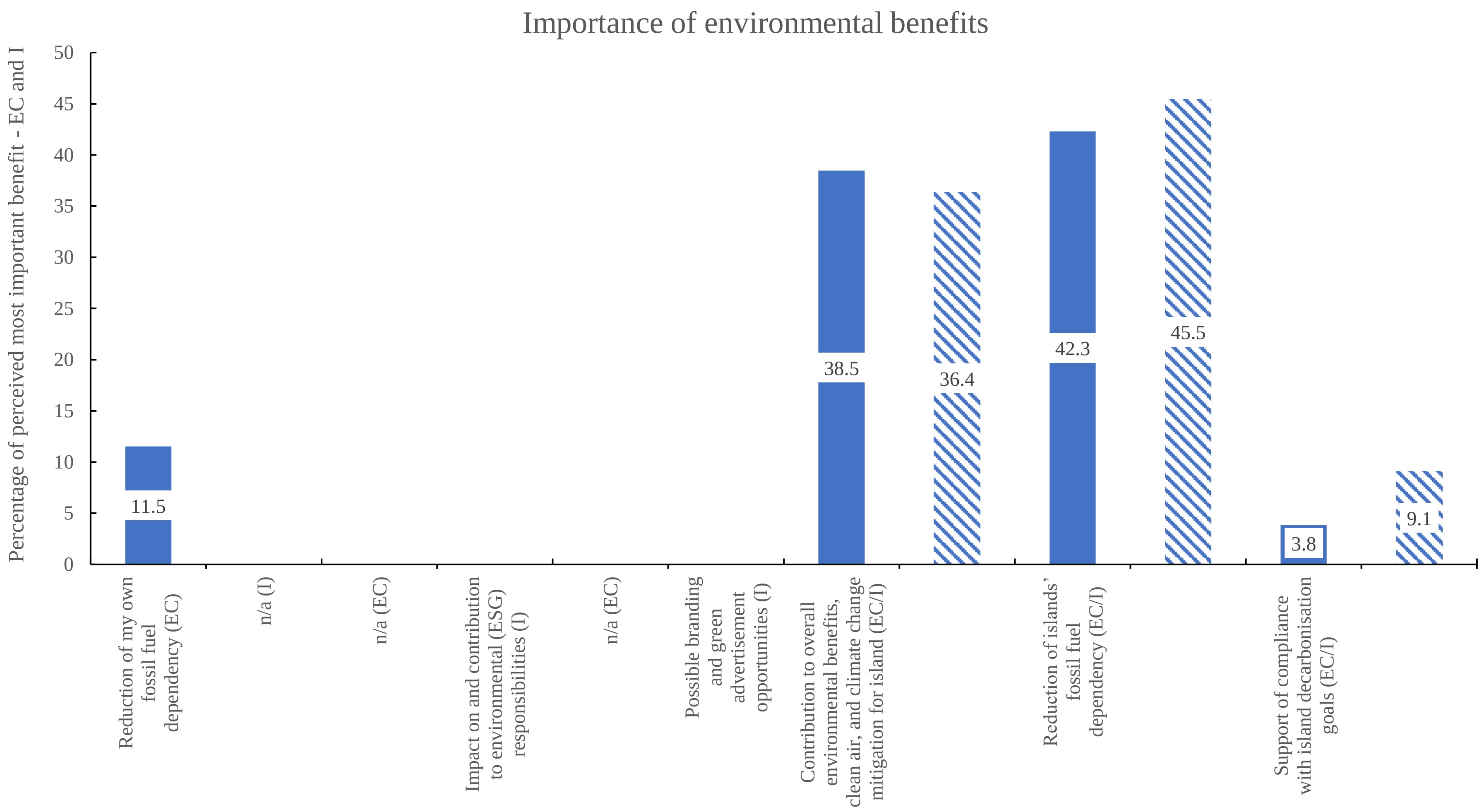
```
B,C,D,A
C,D,A,B
D,B,A,C
C,B,D,A
D,A,B,C
C,B,A,D
C,D,A,B
A,B,D,C
D,C,B,A

bak: [D, C, B, A]
mah: [B, C, D, A], [C, B, D, A], [C, D, B, A], [B, D, C, A], [D, B, C, A], [D, C, B, A]
crm: [C, D, A, B]
dcm: [C, D, A, B]
Entropy (input): 0.9356896390808394
Entropy (bak): 0.0
Entropy (mah): 0.5943609377704335
Entropy (crm): 0.0
Entropy (dcm): 0.0
Entropy (solutions): 0.7250160151531889
Agreement (bak): 1.0
Agreement (mah): 0.6
Agreement (crm): 1.0
Agreement (dcm): 1.0
Agreement (all): 0.5061728395061729
```

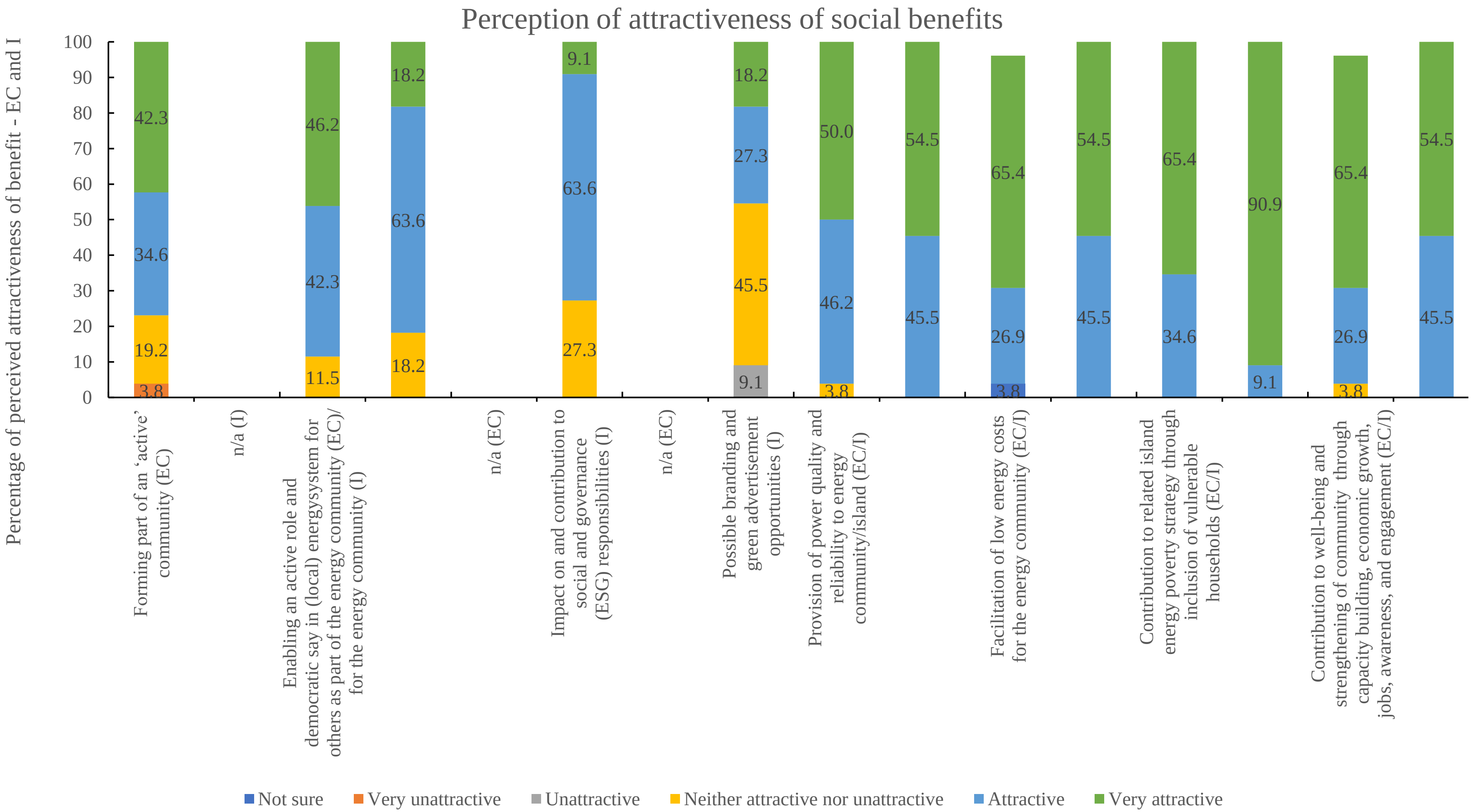
D2. Descriptive analysis of the Orkney Islands survey responses



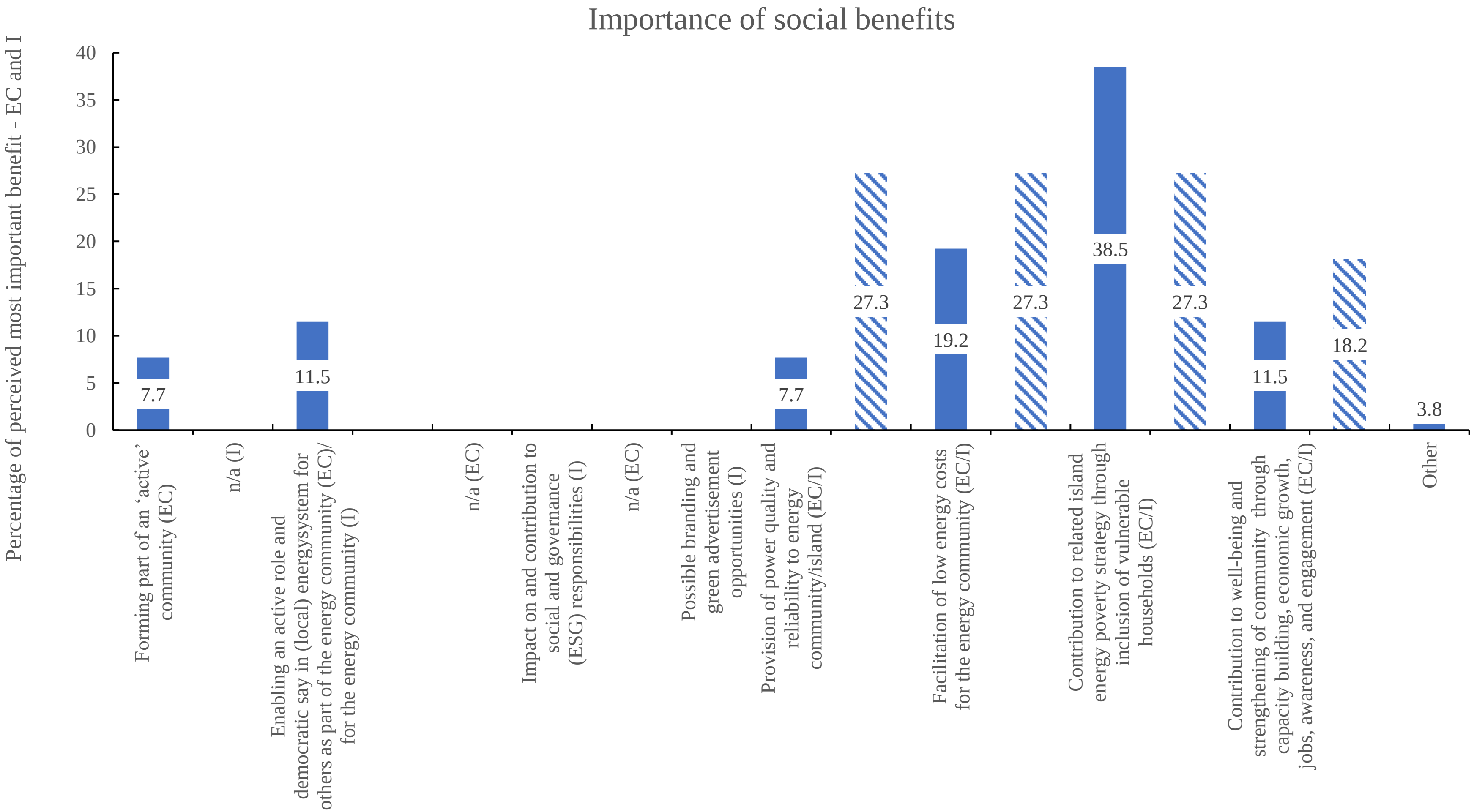
Appendix D 1. Perceived attractiveness of environmental benefits of energy community (EC) and investor (I) perspectives as percentages.



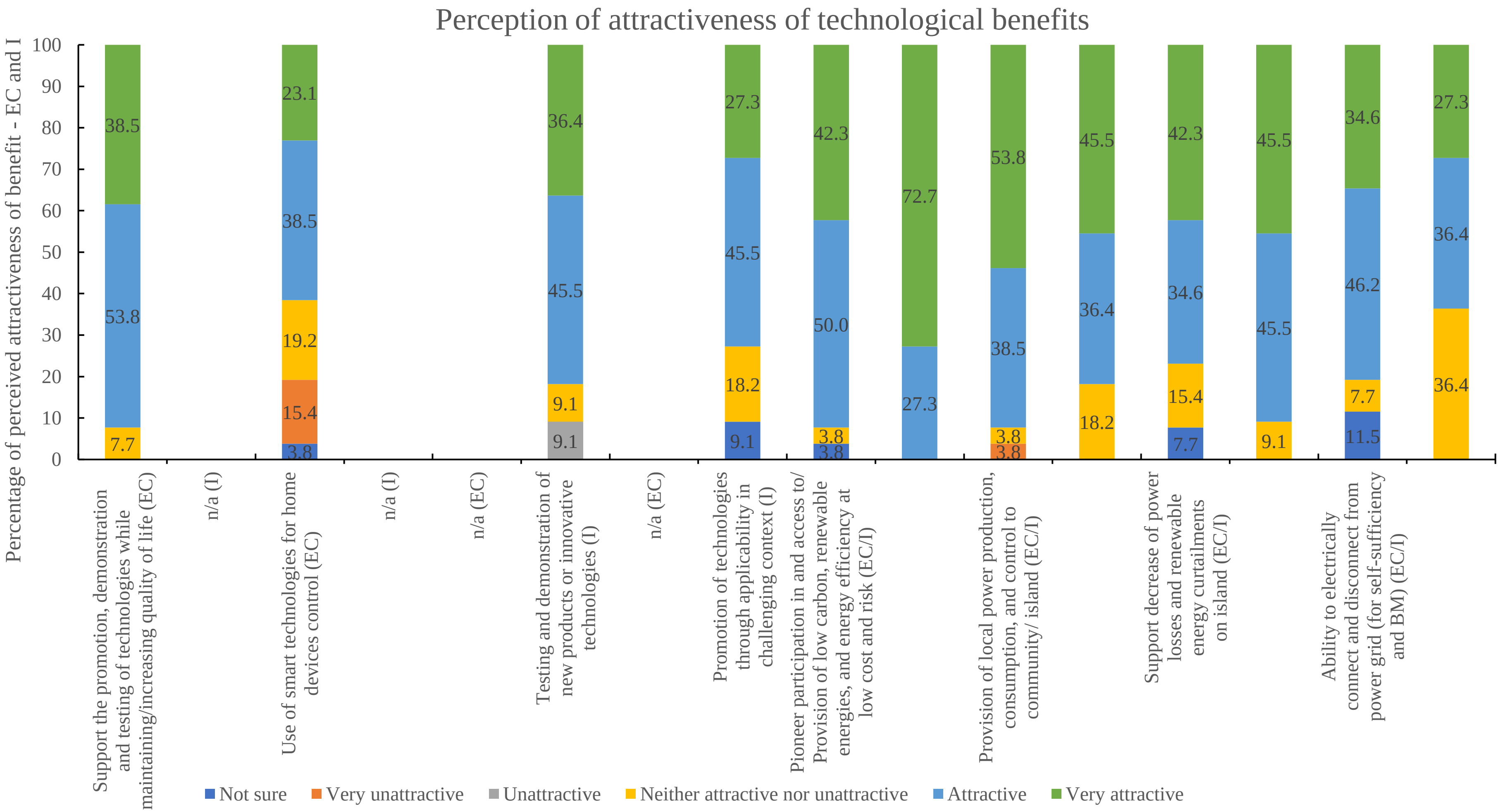
Appendix D 2. Importance of environmental benefits in percentage for energy community perspective (EC) and investor perspective (I) as percentages.



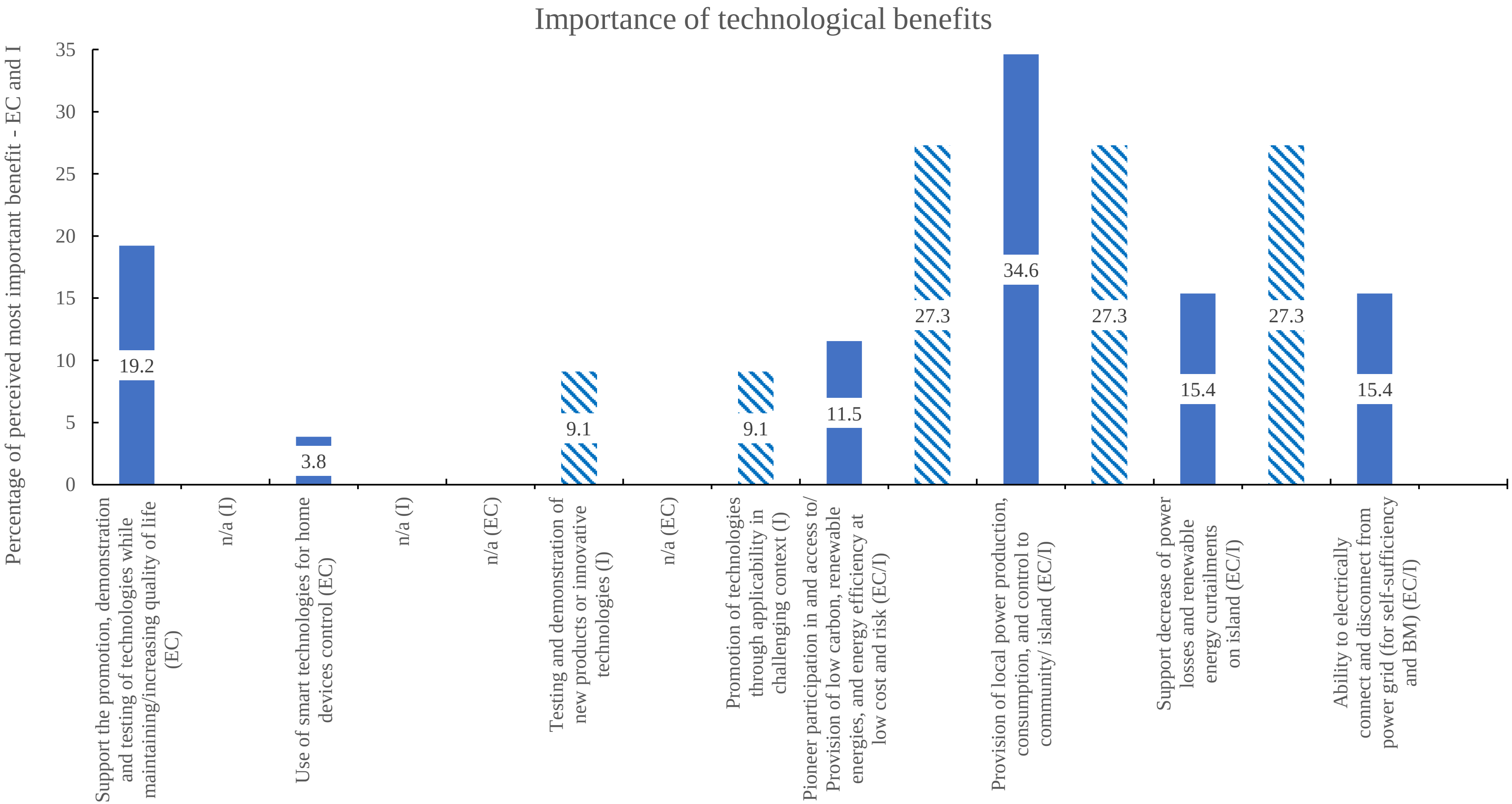
Appendix D 3. Perceived attractiveness of social benefits of energy community (EC) and investor (I) perspectives as percentages.



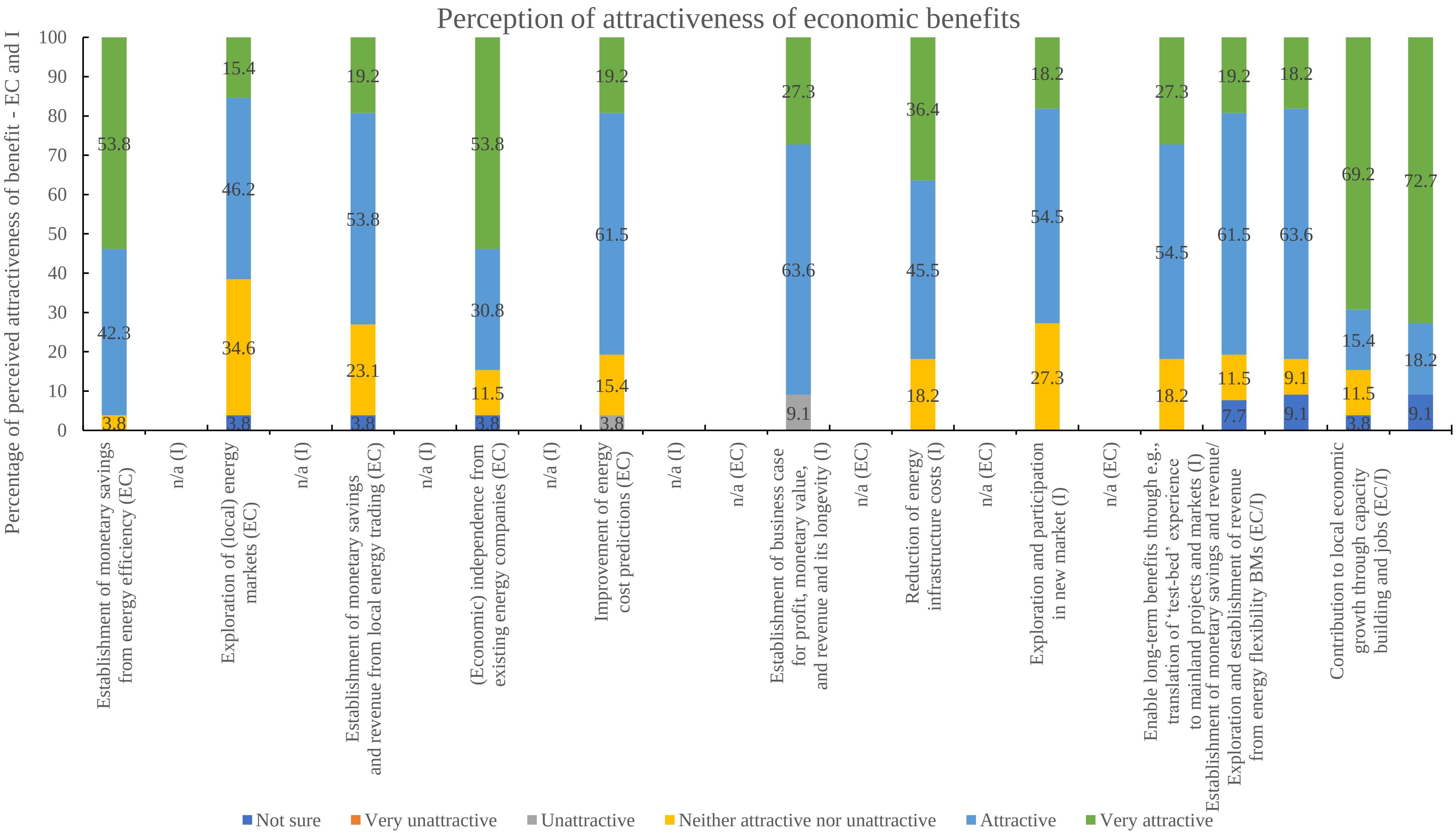
Appendix D 4. Importance of social benefits in percentage for energy community perspective (EC) and investor perspective (I) as percentages.



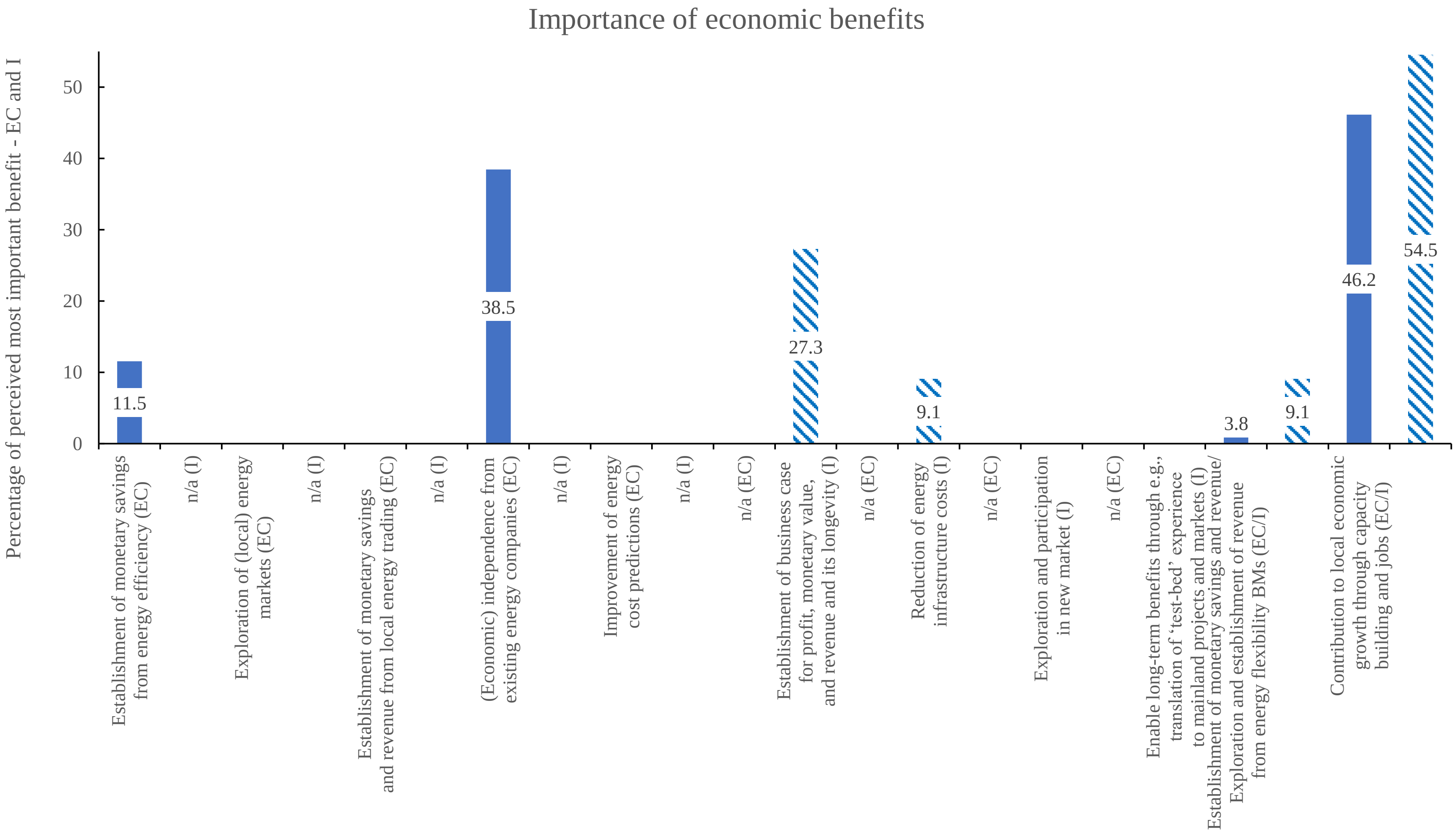
Appendix D 5. Perceived attractiveness of technological benefits of energy community (EC) and investor (I) perspectives as percentages.



Appendix D 6. Importance of technological benefits in percentage for energy community perspective (EC) and investor perspective (I) as percentages.

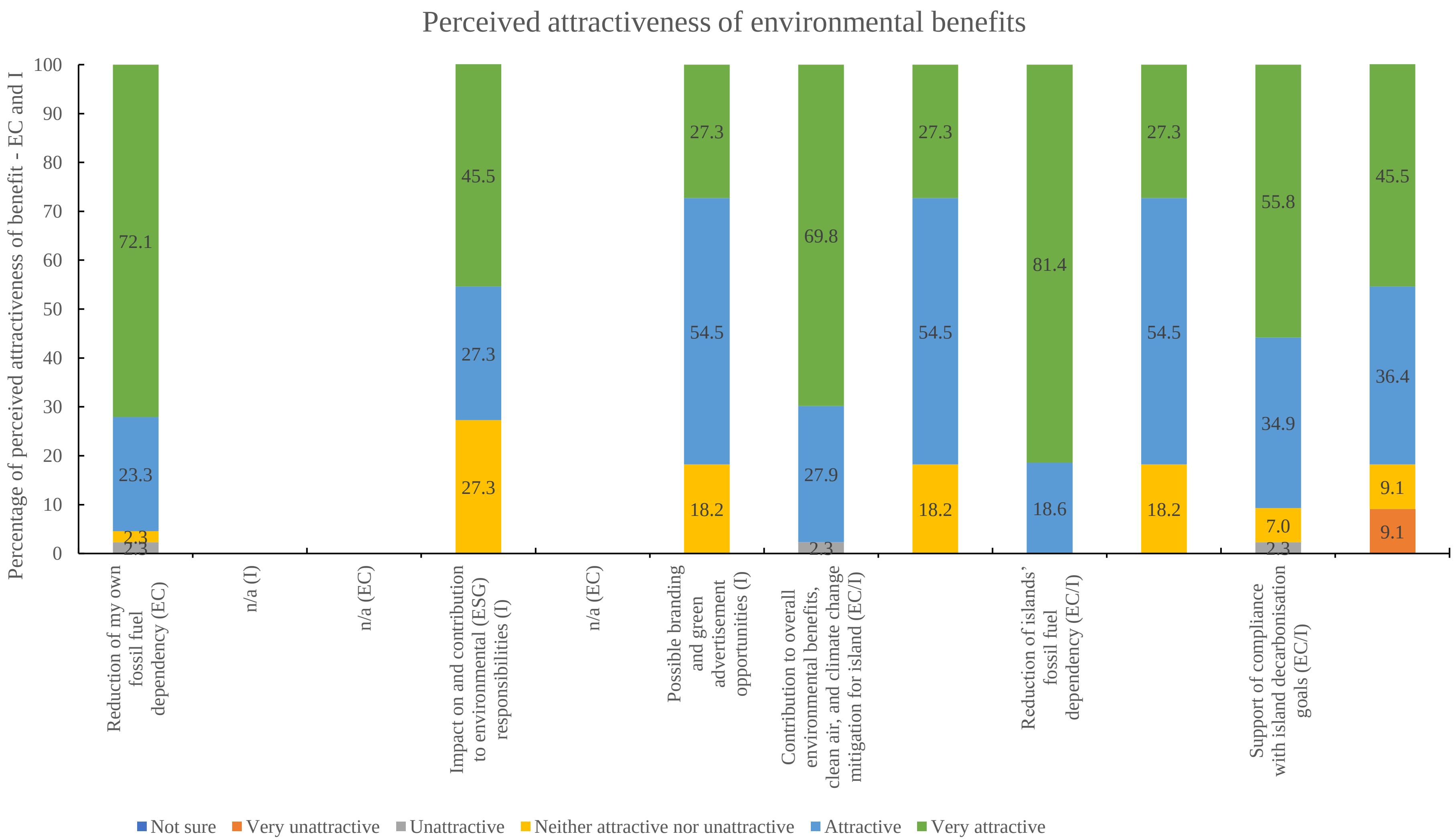


Appendix D 7. Perceived attractiveness of economic benefits of energy community (EC) and investor (I) perspectives as percentages.

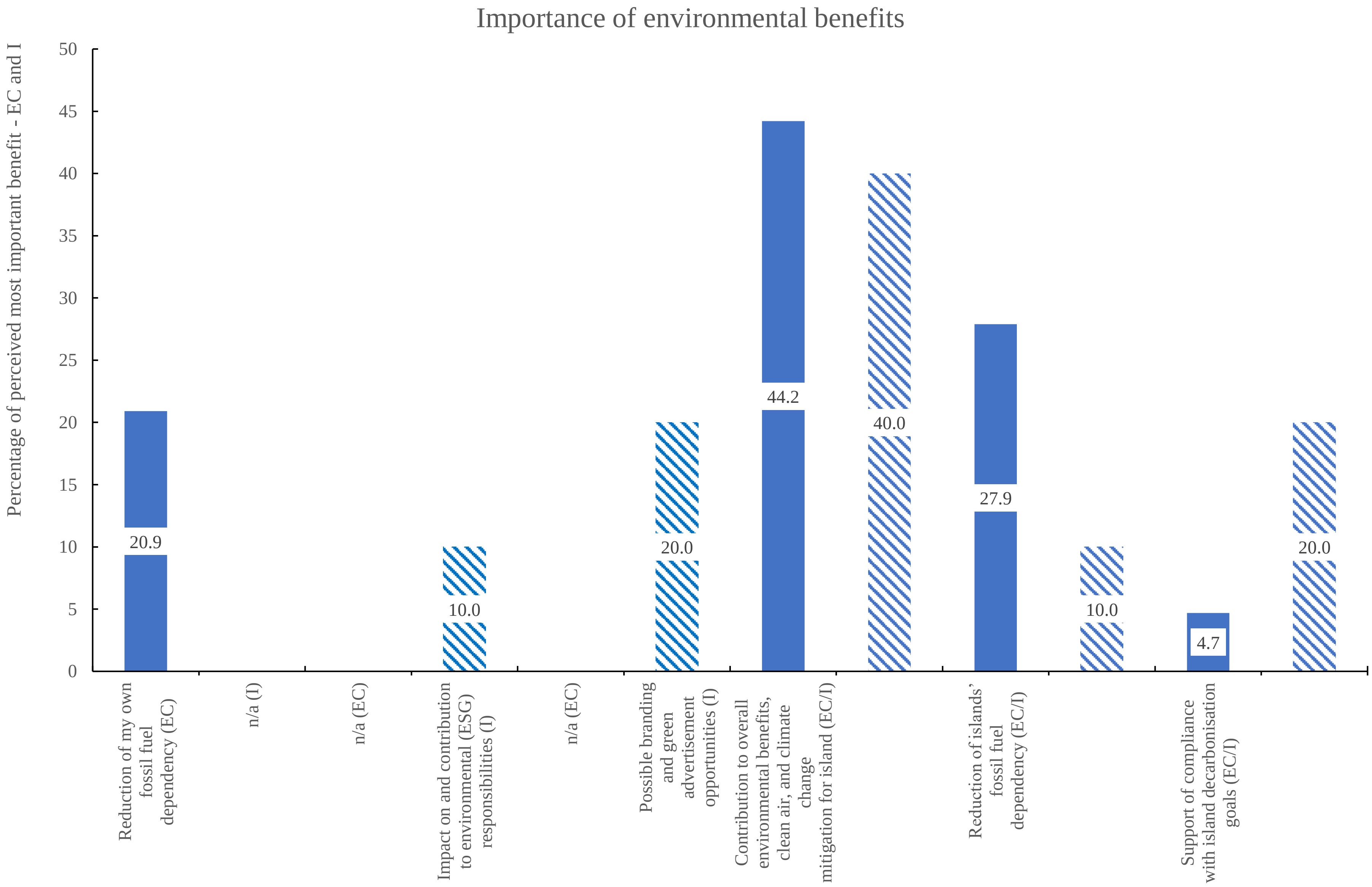


Appendix D 8. Importance of economic benefits in percentage for energy community perspective (EC) and investor perspective (I) as percentages.

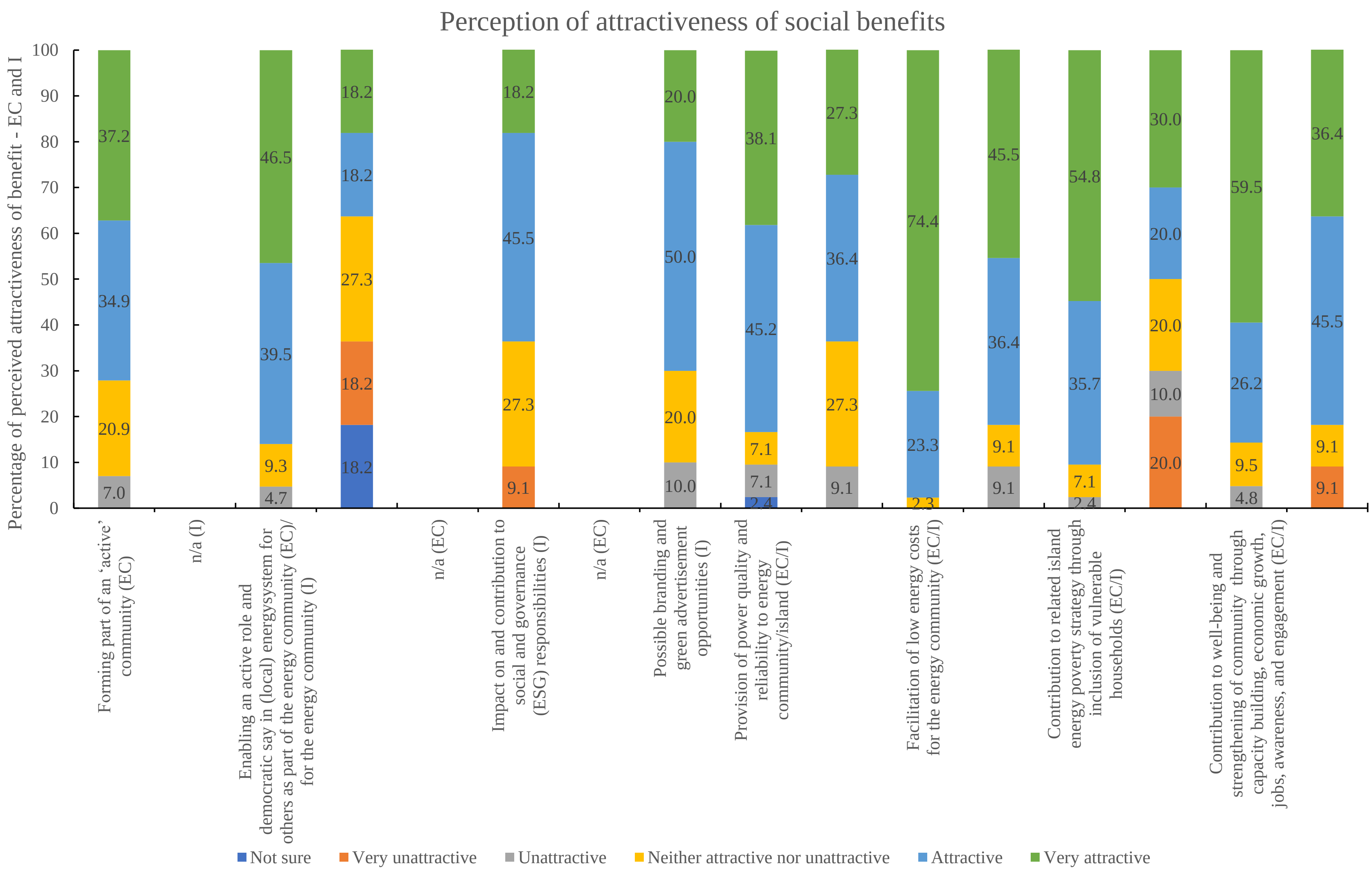
D3. Descriptive analysis of the Canary Islands survey responses



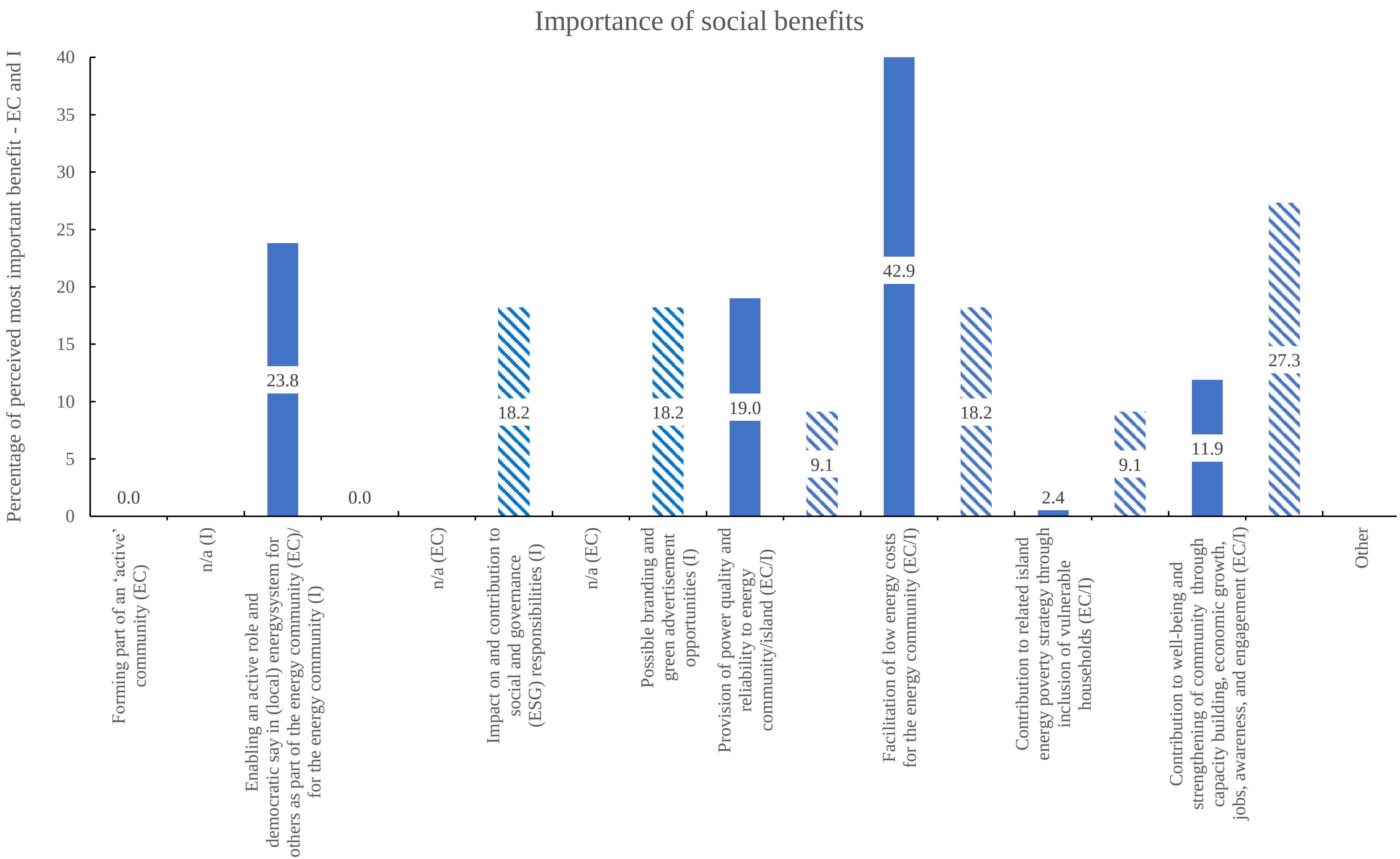
Appendix D 9. Perceived attractiveness of environmental benefits of energy community (EC) and investor (I) perspectives as percentages.



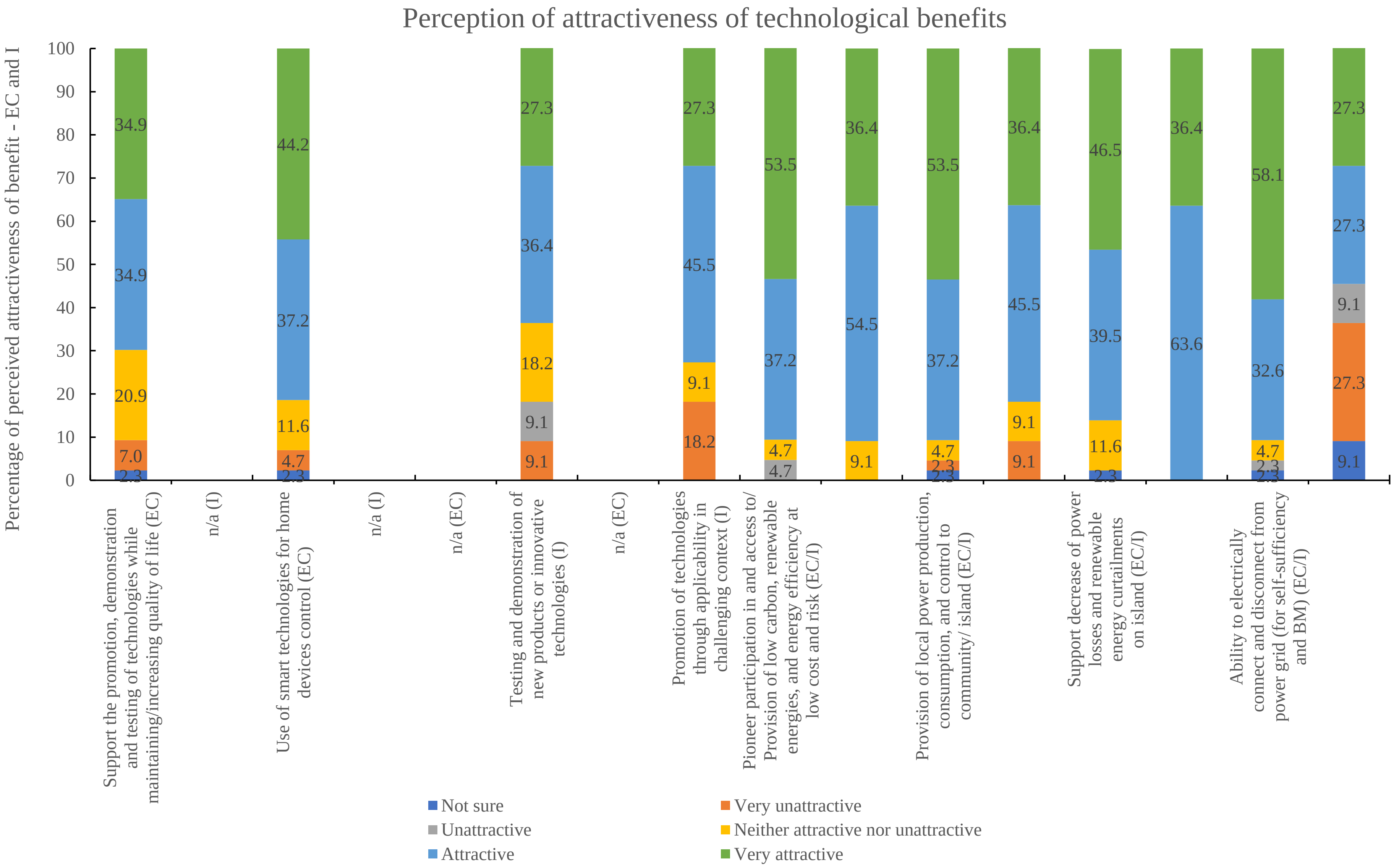
Appendix D 10. Importance of environmental benefits in percentage for energy community perspective (EC) and investor perspective (I) as percentages.



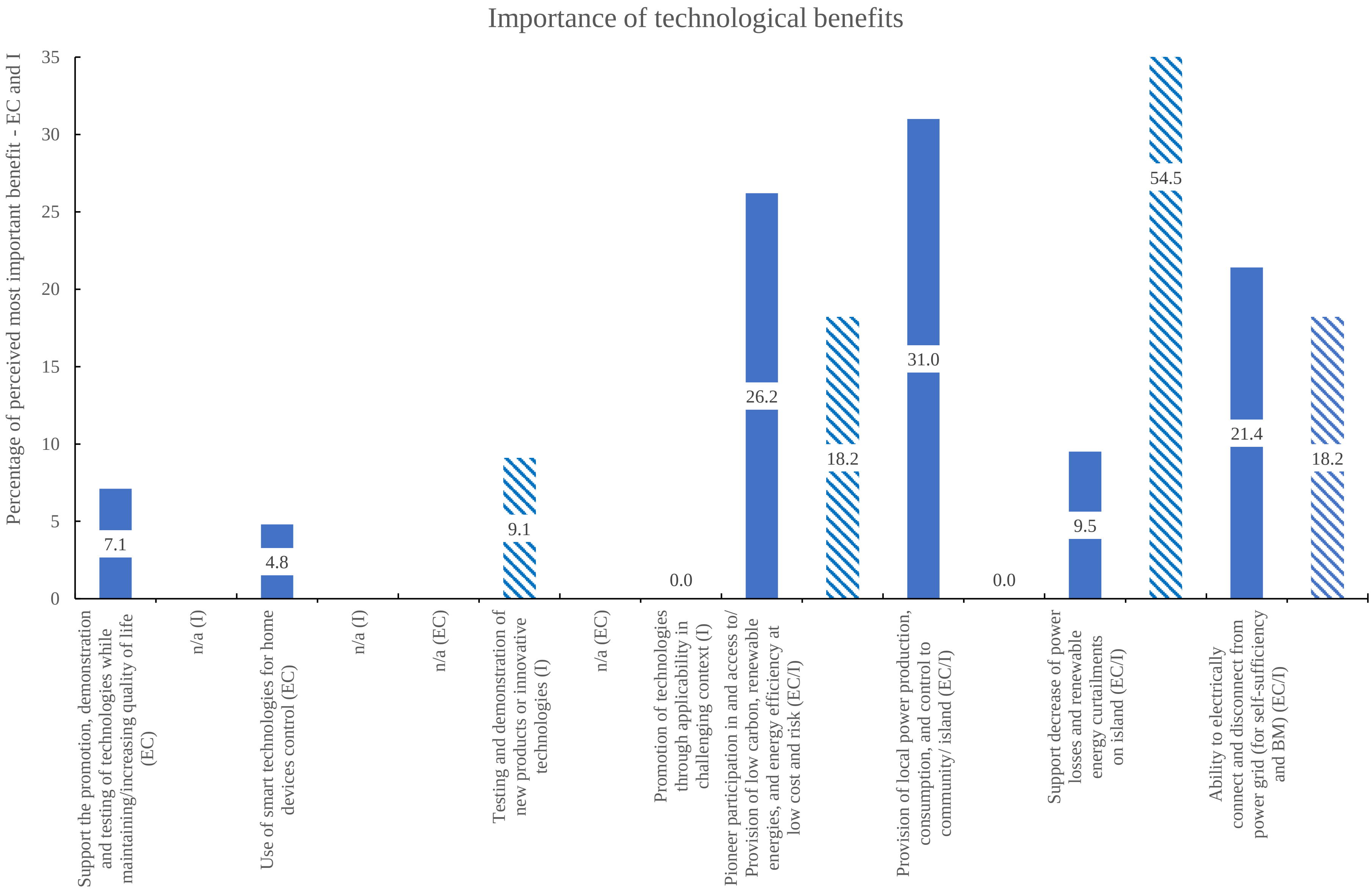
Appendix D 11. Perceived attractiveness of social benefits of energy community (EC) and investor (I) perspectives as percentages.



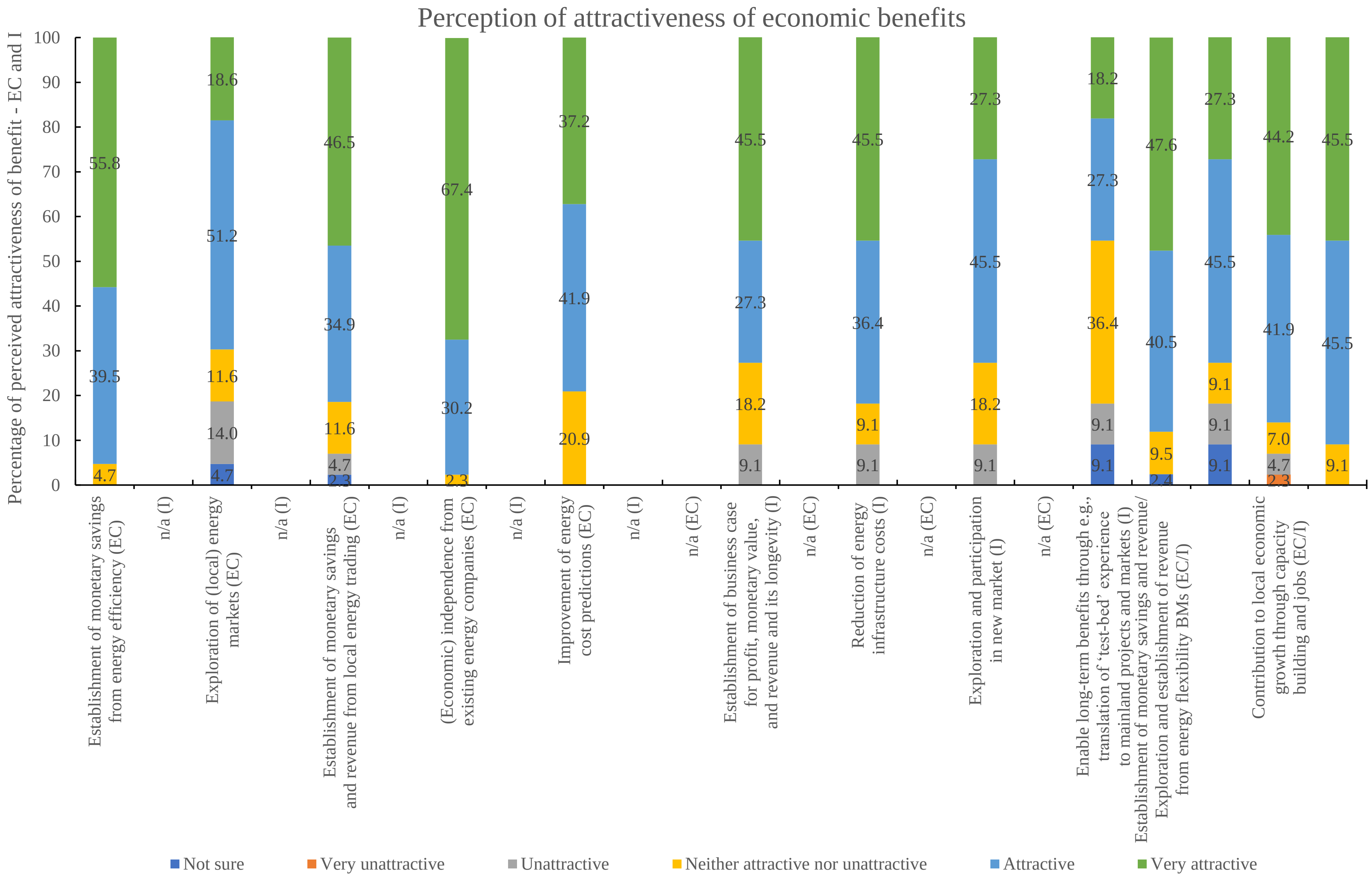
Appendix D 12. Importance of social benefits in percentage for energy community perspective (EC) and investor perspective (I) as percentages.



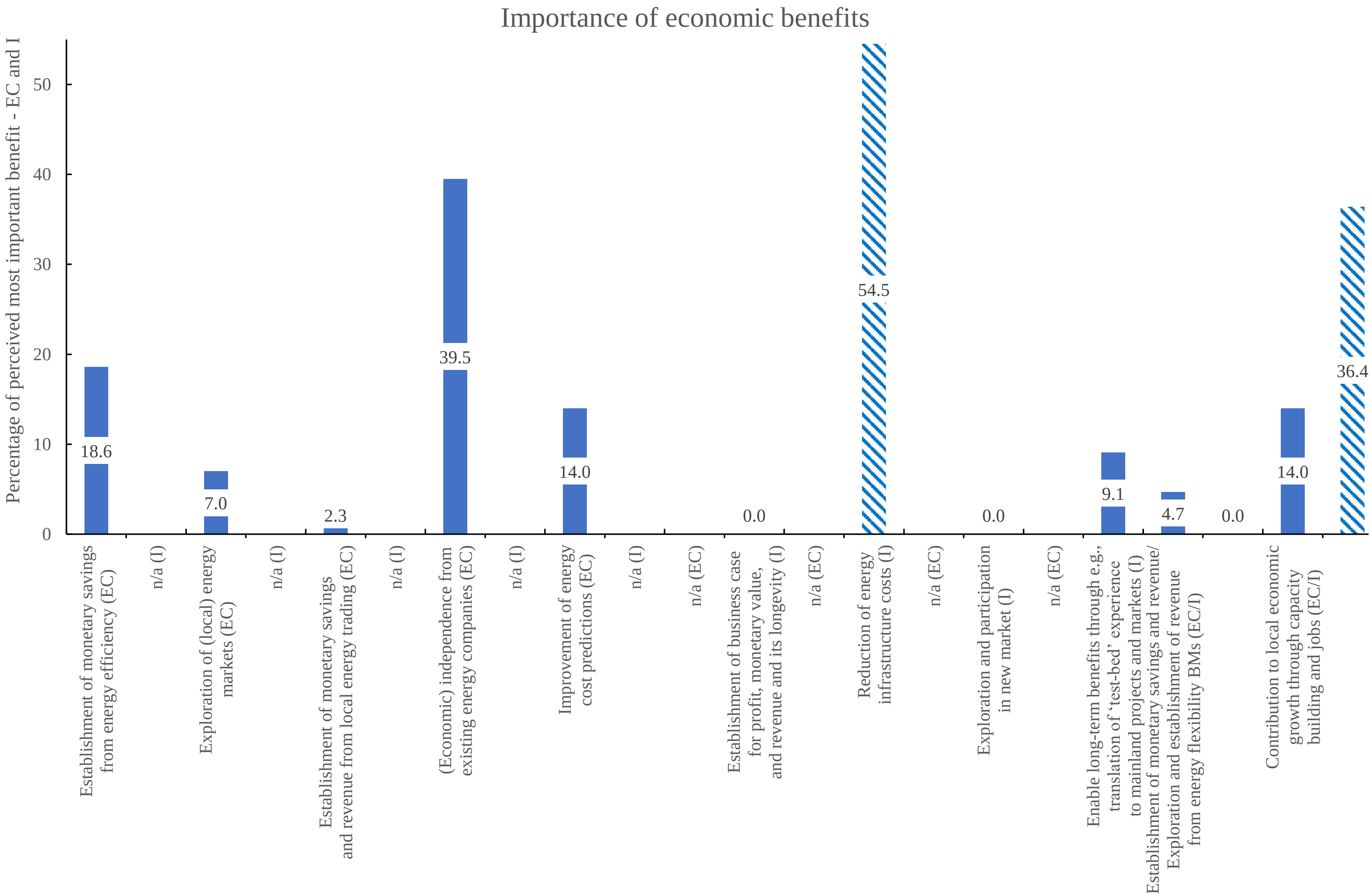
Appendix D 13. Perceived attractiveness of technological benefits of energy community (EC) and investor (I) perspectives as percentages.



Appendix D 14. Importance of technological benefits in percentage for energy community perspective (EC) and investor perspective (I) as percentages.



Appendix D 15. Perceived attractiveness of economic benefits of energy community (EC) and investor (I) perspectives as percentages.

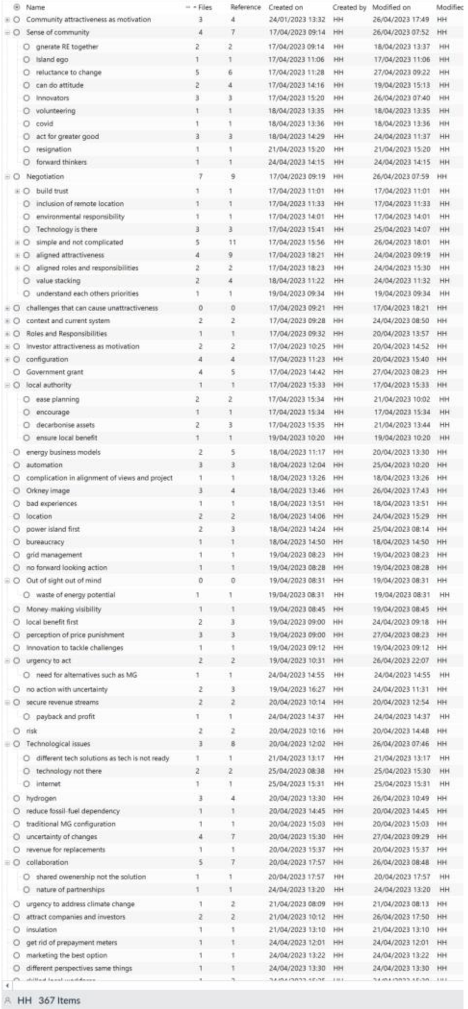


Appendix D 16. Importance of economic benefits in percentage for energy community perspective (EC) and investor perspective (I) as percentages.

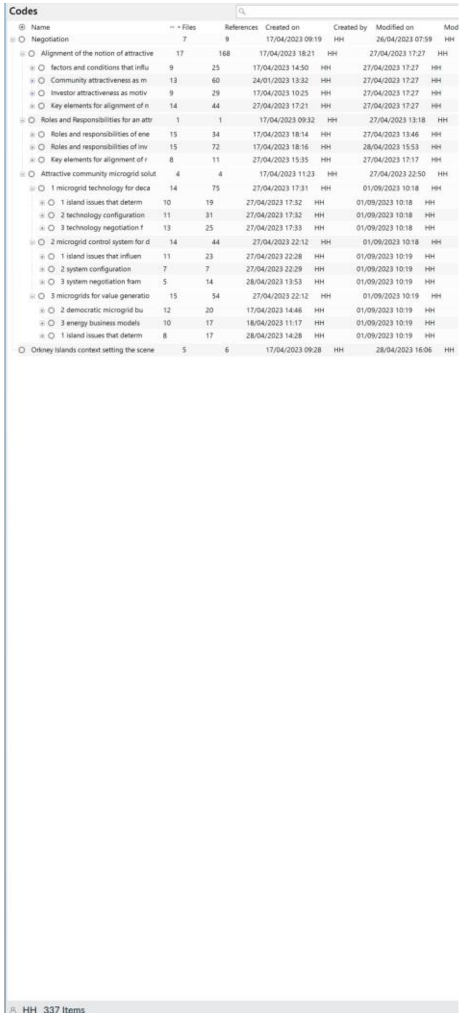
Appendix E – Interview results (Qualitative content analysis/coding)

E1. Exemplary NVivo coding trees to demonstrate iterative nature of coding from Orkney Islands case study

Initial coding



Iteratirve coding, alignment to CMA



Final coding and manageable themes

E2. The Orkney Islands coding tables

Appendix E 1. Baseline scenario coding table – The Orkney Islands.

CM Elements	Drivers	Barriers
Universal	- high level of 'island senses' - long local history of innovation - high levels of fuel poverty	- regulatory environment, grid and market structures - local grid constraints and the non-supportive DSO
Decarbonisation	- great natural resources - high level of fuel dependency - joint purpose as driving force	- need to balance limited space and visual impact - lack of a local supply chain and infrastructure
Decentralisation and Digitalisation	- high level of RES curtailment (incl. community turbines) - variation of existing and past projects and technology opportunities - existing digital exclusion	- low energy demand and seasonal changes - lack of internet infrastructure and digital connectivity
Democratisation	- island community challenges - perception of current 'unjust' energy transition	- high investment costs - resignation within the community

Appendix E 2. Negotiated solution coding table – The Orkney Islands.

CM Elements	Negotiated solution
Universal	- try to achieve island scale with Smart Local Energy System: - build upon existing infrastructure - evolve over time - 'local' benefits have to come first
Decarbonisation	- create modular technology mix and innovations: - uses wind, tidal, bio, and hydrogen energy - include flexible technologies incl. storage, EVs, and large loads - ensure energy efficiency and electrification of heating
Decentralisation and Digitalisation	- learn from local technological issues: - learn from existing projects - ensure island-wide digitalisation - provide automation of control for simplicity
Democratisation	- create community-led project: - prioritise energy resilience followed by local energy trading and future energy flexibility - facilitate community investment, ownership, and governance - ensure fair and transparent price and participation structures

Appendix E 3. Energy community perspective: Notion of attractiveness coding table - The Orkney Islands.

Key CMA aspect	CMA theme	Place-based attractiveness aspects
Roles and Responsibilities for energy community	**Active community: active prosumers and users**	- demonstrate high level of engagement and interest - demonstrate high willingness to participate and engage in energy actions - demonstrate high acceptance
	Investors and initiators	- drive project and allow for more social designs - develop 'relationship' with technology
	Managers and members	- use experienced community representatives and involve local authority - enhance local knowledge, skills, and experience
Perceived attractiveness of benefits for energy community	**Social**	- provision of cheap electricity and tackle fuel poverty - ensure energy security and reliability - have active say for the communities' best - well-being, capacity building and accountable jobs to tackle depopulation
	Economic	- have cheap electricity - economic independence from existing energy companies - support economic growth of and jobs for island
	Environmental	- support overall environmental benefits and address environmental consciousness
	Technological	- ensure local energy production, consumption, and control - efficient use of electricity - minimise curtailment of community turbines - become early adopters - support development of 'lighthouse' island

Appendix E 4. Investor perspective: Notion of attractiveness coding table – The Orkney Islands.

Key CMA aspect	CMA theme	Place-based attractiveness aspects
Roles and Responsibilities for investors	**Forward thinking investors**	- demonstrate strategic, forward-thinking mindset and recognise business opportunities - use and provide innovative financing - cover upfront costs - invest in social and environmental value - prepare for long-term returns on investment
	Educators and supporters	- follow bottom-up engagement shared dialogue - recognise diverse levels of interest, knowledge, and financial capabilities - support community in development of a CM
	Innovators	- share or aggregate roles and responsibilities - learn from each other and others - demonstrate future technology solutions - tackle island challenges through innovation - work around existing regulations
Perceived attractiveness of benefits for investors	**Economic**	- revenue and profitability - make use of 'economic sense' - explore and be ready for future markets - support economic growth, capacity building, and jobs
	Social	- tackle fuel poverty - create benefit for island and overall society - create social impact and improve image
	Environmental	- reduction of islands fossil fuel dependency
	Technological	- demonstrate technology solutions - local production, consumption, control and optimisation of energy flows - limit curtailment

E3. The Canary Islands coding tables

Appendix E 5. Baseline scenario coding table – The Canary Islands.

CM Elements	Drivers	Barriers
Universal	- energy crisis	- regulatory environment, grid and market structures - non-supportive DSO - bureaucracy
Decarbonisation	- great natural resources - need to reduce fossil-fuel dependency for self-sufficiency - climate change	- need to balance deployment and limited space
Decentralisation and Digitalisation	- high level of RES curtailment - grid constraints - variation of existing and past projects	- comfort-loving society
Democratisation	- collective self-consumption - affordability	- individualistic and conservative nature

Appendix E 6. Negotiated solution coding table –The Canary Islands.

CM Elements	Negotiated solution
Universal	- try add solutions to main grid to achieve island in VPP style: - build upon existing infrastructure and regulations - evolve over time - allow participation after showing 'economic' success
Decarbonisation	- focus on established technologies and simple solutions: - initiate with solar PV - include flexible technologies incl. storage, EVs, and large loads
Decentralisation and Digitalisation	- be connected to the grid to support island grid: - support island grid stability - provide automation of control for simplicity
Democratisation	- provide tailored, scalable expert-led service models: - prioritise collective self-consumption with selling surplus and local energy trading and prepare for future BMs - facilitate different investment options for different people (own PV, ESCO style, community investment, or CM shares) - ensure fair, transparent, tailored price and participation structures and rules

Appendix E 7. Energy community perspective: Notion of attractiveness coding table – The Canary Islands.

Key CMA aspect	CMA theme	Place-based attractiveness aspects
Roles and Responsibilities for energy community	**Active community and initiators** **Active consumers and prosumers**	- demonstrate high sense for environment - be patient and collaborate - take tasks based on needs and abilities - participate in collective self-consumption and share, trade, and sell energy - comply with co-responsibility for energy conscious behaviour and set rules
	Investors and members	- overcome distrust and share costs - develop sense of ownership for technology - involve local authority and CM manager
Perceived notion of attractiveness for energy community	**Economic**	- have cheaper electricity for improved quality of life - economic independence from existing energy companies - support economic growth of and jobs for island
	Environmental	'- contribute to overall environmental benefits - reduce islands fossil fuel dependency for self-sufficiency - provide green electricity
	Social	- provision of cheap electricity - have active say to gain independence from energy companies
	Technological	- technology attractiveness of energy security and independence

Appendix E 8. Investor perspective: Notion of attractiveness coding table – The Canary Islands.

Key CMA aspect	CMA theme	Place-based attractiveness aspects
Roles and Responsibilities for investors	**Forward thinking investors**	- align business strategy - lower investment costs for community - invest in stable long-term returns
	Innovators	- increase engagement in R&D&I - consider innovative solutions in the future
	Educators and supporters	- support community in development of CM solution - demonstrate benefits and provide information through different channels
Perceived notion of attractiveness for investors	**Economic**	- revenue and profitability - make use of 'economic sense' - explore and be ready for future markets - reduction infrastructure costs - support economic growth
	Environmental	- support energy transition and tackle climate change - take advantage of sustainable island image
	Technological	- decrease power losses and RES curtailment - benefit from ability to connect and disconnect - test and learn for future operability of smart grids
	Social	- provide lower energy costs - create social impact and improve image